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PROCEEDING

**The 3rd Engineering Science and Technology
International Conference (ESTIC) 2016**

**August 30th – 31st, 2016
Pangeran Beach Hotel, Padang**



**Organized by:
Department of Chemical Engineering
Faculty of Industrial Technology
Bung Hatta University
Padang, West Sumatera, Indonesia**

Chairman of ESTIC 2016

On behalf of The Organizing Committee, we are pleased to welcome you in Padang, West Sumatera, Indonesia, to The 3rd Engineering, Science, and Technology International Seminar 2016 (ESTIC 2016).



The conference was initiated on 2011 and 2013
by the Faculty of Industrial Technology of

Universitas Bung Hatta under previous name of National Conference of Science and Technology (Resatek) at the UBH campus. The conference then changes its name into Engineering Science and Technology International Conference on 2016 and expands its scope to international conference. This conference has facilitated the communication between scientists across applied in engineering technology science and allows the applied technology professionals to contribute their expertise to deal with empowerment issues.

The aimed of the conference is promoting engineering technology research activities in Indonesia and overseas, in the hope of building and strengthening networks and collaborations. Therefore, the theme is "Applied Technology for Sustainable Development" and encompassing many relevant topic such as: Energy, Material Science And Technology, Environmental Science And Technology, Food Processing Technology, Industrial Management Technology, Technical Vocational Education and Training, and other related topic. As a new comer, we proudly announced that we have about 80 abstract coming from Saudi Arabia and Asian countries such as Japan, Malaysia, Thailand and Indonesia. The selected paper will publish on two Scopus Indexed Journals: The International Journal on Advanced Science, Engineering and Information Technology (IJASEIT) and Asian Research Publishing Network (ARPN).

We thank for all the participant of committee which has done their duty to select abstract which fulfill to the level appropriately to be published on journal or proceeding. The participant will be divided into 4 parallel sessions which comprise of seven categories, due to the topic of this conference.

The conference will hold for two days and hope you will enjoy interaction other participant. We hope you will have an interesting experience during your stay in Padang.

Finally, we thank for all sponsors and other parties that we cannot possibly mention one by one. We apologize for any inconveniences during the conference and we hope we can improve it much better next time.

Padang, August, 30th 2016.

Dr. Mulyazmi, S.T., M.T.

Rector of Universitas Bung Hatta

On behalf of Universitas Bung Hatta, we are delighted to welcome you in Padang (the Rendang city), West Sumatera, Indonesia.

It is a great honor for us to have you from all over the world to attend to The 3rd Engineering, Science, and Technology International Seminar 2016 (ESTIC 2016). For the first time, this conference is held by Chemical Engineering Department of Universitas Bung Hatta, after



several years has been successfully hold National Conference of Science and Technology (Resatek) since 2011. There are about 80 participants will attend on this conference. The participants include our colleagues from many university around in Asian, such as Japan, Malaysia, Thailand, and Indonesia, which mean that the improvement of knowledge would cross any borders including island.

The theme was chosen for this conference is "Applied Technology for Sustainable Development". Applied engineering technology was progressing rapidly and enables us to reveal and comprehend how this universe works. I believe that this theme has challenges for all engineers how to develop of sustainable industry process and energy, innovative materials, conceptual and process design. However, the aim of the research is how to create the better life for the future without neglect the negative impact due to the activities incurred.

Finally, I would like to thank to the member of committee, who has worked very hard to run the conference. I would like to express our gratitude to keynote speakers and invited speakers for the active participant in this conference. I thank to our participants to present and share the experiences with other colleague in the same field, and we hope the communication among us can always be maintained.

Padang, August 30th, 2016

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Rezi Hidayati

Keynote Speakers

Prof. Dr. Yazid Bindar

Institut Teknologi Bandung, Indonesia

“Closing the Gaps Between Designed and Operational Unit Process Performances”

Prof. Dato’ Dr. Kamaruzzaman Sopian

Universiti Kebangsaan Malaysia

“Evaluation And Optimization Of A Multi Ejectors -Flash Tank Absorption Refrigeration”

Dr. Toshiro Yamada

Gifu University, Japan

“Water And Sediment Quality In Open Channels Receiving Of Effluents From Small-Scale Onsite Wastewater Treatment Facilities (Johkasou)”

Dr. Krittiya Lertpocasombut

Thammasat University, Thailand

“Use of Natural Materials Wasted for Water Treatment and Wastewater Treatment Plants”

Dr. Oki Muraza

King Fahd University, Saudi Arabia

“Catalytic Technologies To Convert (Bio-) Natural Gas Derivatives To Industrial Chemicals”

Prof. Dr. Shinji Kambara

Gifu University, Japan

“Innovative Hydrogen Production, Storage, and Utilization System”

Ir. Benny Wendry, M.M*

PT. Semen Padang, Indonesia

Invited Speakers

Dr. Eng. Reni Desmiarti

Universitas Bung Hatta, Indonesia

“Disinfection of Salmonella Thypi ‘O’ by Inductively Coupled Plasma Radio Frequency”

Dr. Inna Kholida Sari

Universitas Bung Hatta, Indonesia

*“Human Judgment in a Stock Control System - A review
for a Disaster Situation”*

Dr. Muchamad Oktaviandri

Universitas Bung Hatta, Indonesia

“An ANN model for designing Micro-hydro Turbine”

Dr. Hidayat, ST., MT

Universitas Bung Hatta, Indonesia

*“Evaluation of Micro Hydropower Using Overall Equipment Effectiveness (OEE)
Methode”*

Technical Program

Tuesday, August 30th, 2016.

Time	PROGRAM
07.30-08.30	Registration of participants
08.30-09.00	Opening ceremony: <ul style="list-style-type: none">▪ Chairman of The Committee▪ Rector of Universitas Bung Hatta
09.00-09.40	Keynote Speaker 1: Prof. Dr. Yazid Bindar
09.40-10.20	Keynote Speaker 2: Prof. Dr. Shinji Kambara
10.20-10.40	Coffee Break I
10.40-11.20	Keynote Speaker 3: Prof. Dato' Dr. Kamaruzzaman Sopian
11.20-12.00	Keynote Speaker 4: Ir. Benny Wendry, M.M
12.00-13.30	Lunch
13.30-15.25	Parallel session 1
15.25-16.00	Coffee break 2
16.00-17.35	Parallel session 2
19.00-20.00	Gala Dinner

Wednesday, August 31st, 2016.

Time	PROGRAM
07.30-08.30	Registration of participants
08.30-09.10	Keynote Speaker 5: Dr. Toshiro Yamada
09.10-09.50	Keynote Speaker 6: Dr. Krittiya Lertpocasombut
09.50-10.30	Keynote Speaker 7: Dr. Oki Muraza
10.30-11.00	Coffee break 1
11.00-12.55	Parallel session 3
12.55-13.30	Lunch
13.30-15.25	Parallel session 4
15.25-16.00	Coffee break 2
16.00-16.30	Announcement of Oral Presentation Award Closing Ceremony

Tentative Program

Tuesday, August 30th, 2016.

Time	Program			
07.30-08.30	Registration of participants			
08.30-08.45	Chairman of The Committee			
08.45-09.00	Rector of Universitas Bung Hatta			
09.00-09.40	Keynote Speaker 1: Prof. Dr. Yazid Bindar			
09.40-10.20	Keynote Speaker 2: Prof. Dr. Shinji Kambara			
10.20-10.40	Coffee Break I			
10.40-11.20	Keynote Speaker 3: Prof. Dato' Dr. Kamaruzzaman Sopian			
11.20-12.00	Keynote Speaker 4: Ir. Benny Wendry, M.M			
12.00-13.30	Lunch			
	Parallel session 1			
	Basa 1	Basa 2	Batuah	Anai
13.30-13.45	IS 01	IS 02	IS 03	IS 04
13.50-14.05	A 001	B 001	E 001	G 001
14.10-14.25	A 002	B 002	E 002	G 002
14.30-14.45	A 003	B 003	E 003	G 003
14.50-15.05	A 004	B 004	E 004	G 004
15.10-15.25	A 005	B 005	E 005	G 005
15.25-16.00	Coffee break 2			
16.00-17.35	Parallel session 2			
	Basa 1	Basa 2	Batuah	Anai
16.00-16.15	A 006	C 001	D 001	F 001
16.20-16.35	A 007	C 002	D 002	F 002
16.40-16.55	A 008	C 003	D 003	F 003
17.00-17.15	A 009	C 004	D 004	F 004
17.20-17.35	A 010	C 005	D 005	F 005
19.00-20.00	Gala Dinner			

Wednesday, August 31st, 2016.

Time	Program			
07.30-08.30	Registration of participants			
08.30-09.10	Keynote Speaker 5 Dr. Toshiro Yamada			
09.10-09.50	Keynote Speaker 6 Dr. Krittiya Lertpocasombut			
09.50-10.30	Keynote Speaker 7 Dr. Oki Muraza			
10.30-11.00	Coffee break 1			
11.00-12.55	Parallel session 3			
	Basa 1	Basa 2	Batuah	Anai
11.00-11.15	A 011	B 006	G 006	E 006
11.20-11.35	A 012	B 007	G 007	E 007
11.40-11.55	A 013	B 008	G 008	E 008
12.00-12.15	A 014	B 009	G 009	E 009
12.20-12.35	A 015	B 010	G 010	E 010
12.40-13.30	Lunch			
13.30-15.25	Parallel session 4			
	Basa 1	Basa 2	Batuah	Anai
13.30-13.45	F 006	B 012	A 016	C 006
13.50-14.05	F 007	B 013	A 017	C 007
14.10-14.25	F 008	B 014	A 018	C 008
14.30-14.45	G 011	B 015	E 011	C 009
14.50-15.05	D 006		E 012	C 010
15.10-15.25				
15.25-16.00	Coffee break 2			
16.00-16.30	Announcement of Oral Award Closing Ceremony			

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KEYNOTE SPEAKERS

Closing the Gaps Between Designed and Operational Unit Process Performances

Yazid Bindar

Departments of Chemical Engineering, Food, and
Bioenergy/Chemurgy Engineerings
Faculty of Industrial Technology,
Institut Teknologi Bandung



ABSTRACT: Proven technologies are always required in any industrial business implementation. However, the development and establishment a proven technology require strong resources and support. The designed process performances and capacity are fulfilled by the selected proven technology with a set of allowable gaps. There is a need to shorten the development time and to cut the development cost to arrive on a targeted proven technology. In this topic, the focus is directed to the chemical process engineering type of technologies. Beside the mechanical operational guarantee, the process performances must be guaranteed. These must cover each unit and the whole integrated process performances. The performances of a unit process are quantified temperature T , pressure p , process yield or conversion α , product purity Y_i , flow mass capacity and flow behaviors. The designed performances were commonly obtained from long time experiences in the process technological development. It can start from available empirical correlations, and or from a comprehensive process mathematical modeling. The gaps between the designed performances and the operational performances exist and can be reduced. One factor that causes the gaps is a geometrical factor. The designed performances may not yet consider the detail geometries that are constructed for the operational performances. The other factor is the simplification approach that is used in the designed stage that does not fit to the real condition of the process. This paper explores the unit process development that starts from a comprehensive mathematical process modeling by including the detail three dimensional unit process geometries. The Computational Fluid Dynamic (CFD) technique is employed for the purpose of the study.

Innovative Hydrogen Production, Storage, and Utilization System

Shinji Kambara

Environmental and Renewable Energy Systems
Division, Graduate school of engineering,
Gifu University
Yanagido 1-1, Gifu, 501-1193, Japan
kambara@gifu-u.ac.jp



ABSTRACT: The introduction of a hydrogen economy has been an available strategy to control climate change when hydrogen is produced without CO₂ emission. However, use of hydrogen has a large energy loss for its transportation and physical storages. Ammonia is one of hydrogen storage material that may solve several problems related to the hydrogen transportation and storage in a hydrogen economy.

An innovative energy storage and carrier system has built from our recent some research results. The system has three kind of chemical reactors, which are a HNO₃ production reactor, a NH₃ production reactor, and a H₂ production reactor. HNO₃ is an available material for NH₃ production, because NH₃ can generate from HNO₃ by reduction at atmosphere pressure and a low temperature.

In this paper, we focused on characteristics of HNO₃ production originated from nitrogen oxides in flue gas. HNO₃ was produced by photochemical oxidation of nitric oxide (NO_x) using vacuum ultraviolet irradiation of 172 nm wavelength. HNO₃ production was affected by the flow rates of the model flue gas. It found that a high NO conversion rate was obtained in the NO/O₂/H₂O/N₂ system. A maximum NO conversion to HNO₃ was 97.4%.

KEYWORDS: Hydrogen; Ammonia; Nitric acid; NO_x; VUV

Evaluation And Optimization Of Multi Ejectors -Flash Tank Absorption Refrigeration

K. Sopian^{a}, AzherM.Abed^{a,b*}, Ali Najah Al-Shamani^a, Husam Abdulrasool Hasan^a, A.M.Elbreki^a, M.M.S.Dezfouli^a, B.Elhub^a*

^a*Solar Energy Research Institute (SERI), Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor Malaysia*

^b*Department of Air conditioning and Refrigeration,
E-mail:ksopian@ukm.edu.my,azhermuhson



ABSTRACT: A theoretical analysis of solar assisted multi ejectors -flash tank absorption cooling system have been investigated. In these study, energy balance analysis is performed to predict the potential optimization of the components thermal loads of the combined multi ejectors-flash tank absorption cooling cycle. A computer simulation program has been used to evaluate the performance of single, double and triple ejectors absorption cooling system using ammonia –water solution as working fluid, operating under steady –state conditions. Results indicated that the generator and condenser loads for the cycle using double ejectors are found permanently less than the other cycles. The results indicated that the improvement in overall COPs of the combined cycle using double ejectors under different operating conditions higher than the others combined cycles. The overall COPs are found higher at the double ejector cycle by about 9.2 % and 5 % at higher and lower operation conditions respectively than that of combined triple ejectors cycle

KEYWORDS: single ejector-flash tank absorption cooling cycle, double and triple ejectors, components thermal loads, cycle performance.

Water And Sediment Quality In Open Channels Receiving Of Effluents From Small-Scale Onsite Wastewater Treatment Facilities (*Johkasou*)

Toshiro Yamada^{*}, Joni A. Fajri^{**}

^{*}Department of engineering, Gifu University, Japan

^{**}Islamic University of Indonesia, Jogjakarta,
Indonesia

^{*}ymd@gifu-u.ac.jp



ABSTRACT: Onsite wastewater treatment systems in rural areas are important for preventing pollution of aquatic environments and sanitation of the local environment. In Japan, a small-scale onsite wastewater treatment facility named *johkasou* has been used for household wastewater treatment in the rural areas. Field surveys on water and sediment quality in drainages and open channels in a small rural residential area have been conducted to make clear effects of effluents from *johkasou* on the local water environment. The concentrations of total coliforms, *E.coli*, organic matters and nutrients were always higher at the *johkasou* drainage than at its downstream open channel. The significant impacts of effluents from *johkasou* on the water environment downstream were not observed through the study period due to high dilution capacities of the channels. In contrast with most physicochemical parameters, total coliforms and *E.coli* were always detected at their high concentrations throughout the season. The presence of total coliforms and *E.coli* both in water and sediment of the open channel indicates that the open channel plays a role as a reservoir for enteric bacteria. Deterioration of water quality in terms of organic matters and nutrients was observed during cold-low flow seasons mainly due to low mixing with other water environments such as rainwater and irrigation water. Seasonal maintenance of discharged water quality and controlling downstream network capacities are necessary to reduce the potential impact of *johkasou* effluents into local water environment.

KEYWORDS: Fecal indicators; *johkasou*; local water environment; on-site wastewater treatment; sediment.

Natural Materials Wasted for Water Treatment and Wastewater Treatment Plants

Krittiya Lertpocasombut

Department of Civil Engineering, Faculty of
Engineering, Thammasat University
Rangsit Campus.
Klong Luang, Pathumthani 12120, Thailand
E-mail: lkrittiy@enr.tu.ac.th



ABSTRACT: It has known about potentials of vetiver grass roots that can absorb heavy metals into the trunk, and roots by means of soil-water contamination. Coffee grounds wasted in terms of solid waste generated had about 8.8 ton per year in the year 2012 and trended to increase in university campus each year. Shrimp is famous as food like Tomyum Kung, its shells are also wasted. The startup experiment which carried out on the properties of the vetiver grass roots ash (VGRA) indicated the potential of the VGRA to remove estrogen in the water. Four natural materials wasted as vetiver grass roots, coffee grounds used, shrimp shells and sludge from the WSTP were investigated to utilize in the treatment of water and wastewater as mediums. Using the VGRA in a circular shape to filter water as a medium under 2 atm was demonstrated up to 75 % of efficiency to remove water turbidity. Among the tree types of treated natural material wastes, the VGRA was the most powerful to attach estrogen in the form of soluble compound in water, compared to shrimp shells and sludge, respectively. Whereas, waste of the coffee grounds used to eliminate bacteria in the effluent was indicated its removal of total coliform bacteria down to 2.2 MPN/100 ml. The capability of disinfection in water made coffee grounds worthy of further studies and its applications for WWTP as well.

KEYWORDS: Coffee grounds; estrogen removal; disinfection; filtration; vetiver grass roots ash (VGRA).

Catalytic Technologies To Convert (Bio-)Natural Gas Derivatives To Industrial Chemicals

Oki Muraza
Chemical Engineering Department and CENT
King Fahd University of Petroleum and
Minerals, Saudi Arabia
*E-mail: omuraza@kfupm.edu.sa



ABSTRACT: The oversupply of natural gas due to successful production of shale gas in the North America and the availability of bio natural gas from waste stimulated many countries to revisit technologies to convert natural gas to chemicals. In addition to the classical use of natural gas in ethane crackers to produce ethylene, the monetization of cheap natural gas to propylene can be classified into three technologies namely (i) propane dehydrogenation, (ii) olefin metathesis and (iii) methanol-to-propylene. The latter was the main interest for us by considering the large production volume of methanol in the world in the coming years. Methanol as an important derivative of natural gas (methane) can be converted to fuels (such as gasoline and diesel) or chemicals (propylene and ethylene) over solid acid catalysts [1-2]. Methanol to gasoline is a promising route, mostly using three-dimensional zeolites such as ZSM-5 [3]. Methanol can also be converted to diesel first to olefins using ZSM-22 (TON) and later the olefins can be transformed into diesel using oligomerization process over hierarchical one-dimensional pore zeolites. [1, 4].

The objective of this work was to highlight some of remarkable heterogeneous catalysts applied in methanol-to-propylene as an important edge of methanol-to-olefin technologies and the valorization of natural gas resources in general. The transformation from methanol to dimethyl ether (DME), DME to olefins and methanol to propylene were investigated using different series of solid acid catalysts, especially zeolites [4-6].

The catalyst effectiveness factor of zeolite-based catalysts has been significantly improved by using three different approaches: (i) fabrication of nanocrystals of ZSM-22 (TON) which were applied in methanol-to-propylene [4], (ii) the fabrication of hierarchical EU-1 (EUO) by alkaline and acid post-treatments [5-6] and (iii) the fabrication of SAPO-34 (CHA) coated on SiC foams [7]. Nanocrystals of ZSM-22 (TON) and hierarchical EU-1 (EUO) zeolites were applied in the transformation of the methanol to olefins. The keys of finding better catalysts were the fabrication of nanosized zeolite crystals, the adapted methods to synthesize hierarchical zeolites and the procedures to deposit CHA zeolite of 3D solid foams as structured catalysts. We developed different catalysts mostly derived from one dimensional pore zeolites such as (i) nanosized ZSM-22 (TON framework) and (ii) hierarchical EU-1 (EUO framework). In addition, we also developed SAPO-34 (CHA) coated on SiC foams as structured catalysts. Pure nanosized ZSM-22 crystals (100 nm) were synthesized with low aspect ratio by using a hydrothermal autoclave with horizontal rotation, while the submicrometer ZSM-22 crystals (~300 nm) were achieved by using 5 wt.% ethylene glycol as a crystal growth modifier. The textural properties were almost similar for both samples with different crystal sizes, except the smaller crystals had larger external surface area. Production of light olefins from methanol conversion was examined over ZSM-22 (TON) zeolites with different crystal lengths (100 and 300 nm). High selectivity to light olefins (>86%) combined with low selectivity toward the undesired over C5 hydrocarbons (10%) and paraffins (4%) was observed initially over all ZSM-22 zeolite samples. As compared with the submicrometer crystals (300 nm), the 100 nm crystals showed better catalytic activity. The higher catalytic activity of TON nanocrystals can be attributed to the higher external surface area. Therefore, the diffusion problem caused by pore blocking was noticeably reduced.

Apart from nanosized TON, our hierarchical EUO is also promising catalysts for methanol to olefins

and dimethylether (DME) to olefins. Hierarchical (or mesoporous) zeolites present one of the promising solutions of the diffusion problem in the catalytic reaction. Creating mesoporous was performed by removing some elements from the zeolite structure either by desilication or dealumination depending on (Si/Al) of the synthesized zeolite. Introduction of mesoporosity into the surface of the zeolite catalyst has many advantages and disadvantages, generally demetalation increases the surface area and consequently enhances the mass transfer. On the other hand, it affects the acidity which plays a key role in methanol-to-olefins and also it will affect thermal stability of the crystals. Developing mesoporosity on the surface of one-dimensional zeolites is still more promising as compared with three-dimensional zeolites because of diffusion limitations. Applying this hierarchical technique on EU-1(EUO) zeolite in methanol and dimethyl ether to olefins improved the conversion and the selectivity towards a specific valuable products.

ORAL PRESENTATION

A 003

Numerical Investigations on Heat Transfer Enhancement by Using SiO₂-Water Nanofluid in a Parabolic Trough Solar Collector

Kamaruzzaman Sopian^a, Husam Abdulrasool Hasan^{a*}, Ali Najah Al-Shamani^{a,b}, Azher M. Abed^a, M.M.S. Dezfouli^a, B. ELHUB^a, A.M. Elbreki^a

^aSolar Energy Research Institute, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia.

^b Department of Machinery Equipment Engineering Techniques, Technical College Al-Musaib, Foundation of Technical Education, Baghdad, Iraq.

*hussam2003hussam@yahoo.com (Husam Abdulrasool Hasan).

Abstract This paper presents the improvement of the performances of the parabolic trough solar collector system (PTC) by using SiO₂ nanofluid as a heat transfer fluid. The effect of SiO₂ nanofluid on the thermal and thermodynamic performance of a high concentration ratio parabolic trough solar collector was studied numerically. The momentum and energy equations are solved by using a finite volume method (FVM). The top and the bottom walls of the tube are heated with a different heat flux boundary condition. In this study a Reynolds number range of 10,000 to 30,000. Results show that the thermal performance of the receiver improves as the SiO₂ used. From the results, it is clearly seen that The Nusselt number considerably increased with increasing Reynolds number, Re in the range of 10000-30000. The SiO₂ nanofluid has the highest Nusselt number value, followed by pure water. The results show that the Nusselt number increases with decreasing the nanoparticles diameter and it increases with increasing the volume fraction (concentration) of nanoparticles.

Keywords: Heat transfer enhancement; nanofluid; finite volume method; parabolic trough solar collector; Nusselt number.

1. Introduction

Solar parabolic trough collector (SPTC) consists of an absorber (working fluid chamber), a concentric transparent cover and a Parabolic reflector plate. The absorber is fixed permanently at the focus of the parabolic concentrator. The concentric transparent cover is used to protect the absorber tube from the heat losses and hence a vacuum pressure is maintained. The parabolic concentrator is placed on a rigid structure and the solar tracking mechanism is placed on the rigid structure to track the solar radiation by the parabolic concentrator. Focused on there reflecting plate with rigid link of PT. Candspecified that the main factor for deformation of solar collector is self-weight [1]. Numerous researcher shave studied the design performance issues of solar PTC structures and parabolic concentrator. Eckhard and Michael have studied these If-weight issue sand done a performance enhancement by experimental prototy petesting [2]. Vasquez Padillaetal. Have done a one dimensional heat transfer analysis on parabolic trough solar receiver and concluded that there duction of 41.8% of convective heat loss resultinan improvement of performances [3]. Edenburn has done a performance study on cylindrical parabolic collector by comparing theoretical evaluation with the experimental result [4]. Naeni and Yaghoubi have performed wind flow analysis on PTC by changing the orientation of the collector with wind

velocities of 2.5, 5, 10 and 15m/s. Ther resultant force acting on the collector structure was found to be normal and the pressure fields acting around the collector are found 15–20 times lesser than the collector aperture area [5]. Rojasetal. Heat transfer enhancement by using nanofluids has gained significant attention by researchers and scientists past few years. Preparing new fluids which can enhance the heat transfer because ofThe limitation of thermophysical properties and poor thermal conductivity of conventional fluids (pure water, ethylene-glycols etc.). Many researches used nanofluids as a working fluidto enhance the transfer performance by improved thermal conductivity of working fluid. The concept of nanofluid was studied by Choi [6] in 1995. Nanofluids showed a promising future as heat transfer fluids due its better stability and anomalous increase in thermal conductivity even for small volume fraction of suspended nanoparticles [7] and [8]. There are many advantages of use nanofluids such as higher thermal conductivities than that predicted by currently available macroscopic models, excellent stability and negligible penalty in pumping power due to pressure drop and pipe wall abrasion. Different types of nanoparticles such as metallic particles (Cu, Al, Fe, Au, and Ag), non-metallic particles (Al₂O₃, CuO, Fe₃O₄, TiO₂, and SiC) and carbon nanotubes were studied experimentally [9]. Past experimental studies presented that the use of nanofluids enhanced the thermal properties and convective heat transfer

coefficients compared to the base fluid [10],[11], [12],[13].

2. Material and Methods

2.1. Governing equations

Fig. 2.1 shows a schematic diagram of the geometry and the computational domain used in the present work. According to the geometrical dimensions chosen in the experimental study the tube diameter $d=20$ mm have been considered. In this problem, a steady and turbulent two-dimensional flow is considered. It is also assumed that the nanofluid is Newtonian and incompressible. In view of the above assumptions, the governing equations of the problem are the continuity, momentum, and energy equations and the transport equations for the turbulent kinetic energy and its dissipation rate.

$$\frac{\partial u_i}{\partial x_i} = 0 \quad (1)$$

$$\rho U_i \frac{\partial u_i}{\partial x_i} = -\frac{\partial p}{\partial x_i} + \frac{\partial}{\partial x_i} \left[\mu \left(\frac{\partial u_i}{\partial x_j} + \frac{\partial u_j}{\partial x_i} \right) - \rho \overline{u'_i u'_j} \right] \quad (2a)$$

$$-\rho \overline{u'_i u'_j} = \mu_t \left(\frac{\partial u_i}{\partial x_j} + \frac{\partial u_j}{\partial x_i} \right) - \frac{2}{3} \delta_{ij} \rho k \quad (2b)$$

$$\rho C_p U_i \frac{\partial T}{\partial x_i} = \frac{\partial}{\partial x_i} \left[k \frac{\partial T}{\partial x_i} - \rho \overline{u'_i T'} \right] \quad (3)$$

The turbulent viscosity term μ_t is to be computed from an appropriate turbulence model. The expression for the turbulent viscosity is given as

$$\mu_t = \rho C_\mu \frac{k^2}{\varepsilon} \quad (4)$$

In the present study, $k-\varepsilon$ RNG turbulence model is used as follows:

$$\frac{\partial}{\partial x_i} (\rho k u_i) = \frac{\partial}{\partial x_j} \left[\left(\mu + \frac{u_t}{\sigma_k} \right) \frac{\partial k}{\partial x_j} \right] + G_k - \rho \varepsilon \quad (5)$$

Similarly the dissipation rate of TKE, ε is given by the following equation:

$$\frac{\partial}{\partial x_i} (\rho \varepsilon u_i) = \frac{\partial}{\partial x_j} \left[\left(\mu + \frac{u_t}{\sigma_k} \right) \frac{\partial \varepsilon}{\partial x_j} \right] + C_{1\varepsilon} \frac{\varepsilon}{k} G_k - C_{2\varepsilon} \rho \frac{\varepsilon^2}{k} \quad (6)$$

Where G_k is the rate of generation of the TKE while $\rho \varepsilon$ is the destruction rate

G_k is written as:

$$G_k = (-\rho \overline{u'_i u'_j}) \frac{\partial u_j}{\partial x_i} \quad (7)$$

2.2. Boundary conditions

The boundary conditions applied in the present work are illustrated in Fig. 1. As shown in

this figure, a velocity-inlet boundary condition at constant temperature (298 K) is assumed at inlet with a velocity magnitude compatible with Reynolds number. The inlet turbulence intensity and hydraulic diameter were set to be 5% and 20mm respectively. The thermal boundary condition at the bottom well surface is a constant heat flux. Also at the flow outlet, the pressure-outlet boundary condition has been assumed. To attain accurate prediction in the circular tube, the standard $k-\varepsilon$ turbulence model, the Renormalized Group (RNG) $k-\varepsilon$ turbulence model were selected. The time-independent incompressible Navier-Stokes equations and the turbulence model analysis were solved using finite volume method. To evaluate the pressure field, the pressure-velocity coupling algorithm SIMPLE (Semi Implicit Method for Pressure-Linked Equations) was selected. The solutions are considered to be converged when the normalized residual values reach 10^{-5} for all variables.

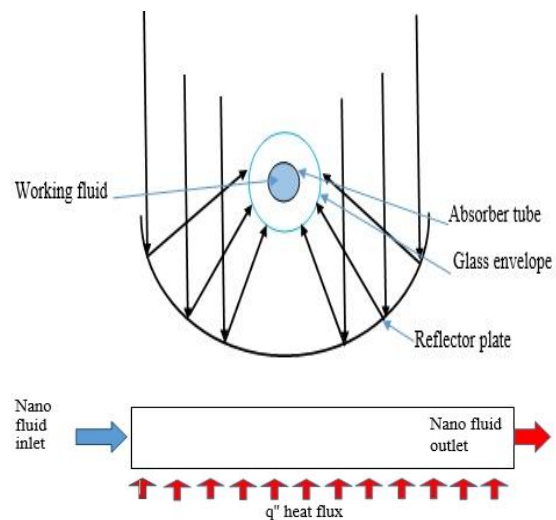


Figure 2.1. Schematic Diagram of Solar Parabolic Trough Collector

2.3 Thermophysical Properties of Nanofluids

In order to carry out the simulations for nanofluids, the effective thermophysical properties of nanofluids must be calculated first. In this case, the nanoparticles being used is SiO_2 . Basically the required properties for simulations are effective thermal conductivity (k_{eff}), effective dynamic viscosity (μ_{eff}), effective mass density (ρ_{eff}), and effective specific heat (cp_{eff}). Regarding these, the effective properties of mass density, specific heat, thermal conductivity, and viscosity are actually calculated according to the mixing theory.

For the density

The density of nanofluid, ρ_{nf} can be obtained from the following equation [13]:

$$\rho_{nf} = (1 - \phi) \rho_f + \phi \rho_{nf} \quad (8)$$

Where ρ_f and ρ_{nf} are the mass densities of the based fluid and the solid nanoparticles, respectively.

For the heat capacity

The effective heat capacity at constant pressure of nanofluid, can be calculated from the following equation [38]:

$$(\rho c_p)_{nf} = (1 - \phi)(\rho c_p)_f + \phi(\rho c_p)_{np} \quad (9)$$

Where $(\rho c_p)_f$ and $(\rho c_p)_{np}$ are the heat capacities of the based fluid and the solid nanoparticles, respectively.

Effective thermal conductivity By using Brownian motion of nanoparticles in circular tube, the effective thermal conductivity can be obtained by using the following mean empirical correlation [38]:

$$k_{eff} = k_{static} + k_{Brwnian} \quad (10)$$

$$k_{static} = k_f \left[\frac{(k_{np} + 2k_f) - 2\Phi(k_f - k_{np})}{(k_{np} + 2k_f) + \Phi(k_f + k_{np})} \right] \quad (11)$$

$$k_{Brwnian} = 5 * 10^4 \beta \phi \rho_f C_{p_f} \sqrt{\frac{KT}{2}} f(T, \phi) \quad (12)$$

Where:

$$\text{Boltzmann constant: } k = 1.3807 * 10^{-23} \frac{J}{K}$$

Values of β for different particles are listed in Table 2.1

Table 2.1 Values of β for Different Nanoparticles

Type of partials	B	Concentration (%)	Temperature (K)
SiO ₂	1.9526	1% ≤ φ ≤ 10%	298K ≤ T ≤ 363K
	$(100\phi)^{-1.4594}$ [13]		

Modelling, $f(T, \phi)$

$$f(T, \phi) = (2.8217 * 10^{-2} \phi + 3.917 * 10^{-3}) \left(\frac{T}{T_0} \right) + (-3.0669 * 10^{-2} \phi - 3.3991123 * 10^{-3}) \quad \text{For } 1\% \leq \phi \leq 4\% \text{ and } 300K \leq T \leq 325K$$

Effective viscosity

The effective viscosity can be obtained by using the following mean empirical correlation [82]:

$$\mu_{eff} = \mu_f * \left(\frac{1}{1 - 34.87 \left(\frac{d_p}{d_f} \right)^{-0.3} * \phi^{1.03}} \right) \quad (3.12)$$

$$d_f = \left[\frac{6M}{N\pi\rho_{f_0}} \right]^{1/3} \quad (3.13)$$

Where M is the molecular weight of base fluid, N is the Avogadro number = 6.022*10²³ mol⁻¹, ρ_{f_0} is the mass density of the based fluid calculated at temperature T₀=293K. Table 2 shows the thermophysical properties of water and nanoparticle.

Table 2.2 The thermo-physical properties of water and different nanoparticles at T=300K.

Thermo-physical Properties	Water	SiO ₂
Density ρ (Kg/m ³)	998.2	2200
Dynamic viscosity, μ (Ns/m ²)	1.00E-03	0
Thermal conductivity, k (W/m.K)	0.6	1.2
Specific heat, C_p (J/kg.K)	4182	703

3. Results and Conclusions

3.1 The Effect of SiO₂ Nanoparticles

The effect of used SiO₂ Nanoparticles with pure water as a base fluid is studied. In order to study the effect of SiO₂-water nanofluid on the heat transfer enhancement of parabolic trough collector and all other parameter of the system of heat transfer should be fixed. The variation of Nusselt number versus different Reynolds number is shown in Fig.3 with using SiO₂-water nanofluid for volume fraction of 0.04 and practical diameter of 20nm of nanofluid and pure water at the tube diameter (d = 20mm) in this case. As shown in this figure, the Nusselt number of nanofluid is higher than that of the base fluid (water) as the presence of nanoparticles directly results in an increase of thermal conductivity. Besides, the heat transfer improvement is also associated by the collision among nanoparticles and also between the nanoparticles in fluid and surface wall, leading to an increase in the energy exchange rate. Nusselt number increases with increasing Reynolds number due the intensification of the nanofluid mixing fluctuation. In addition, with using nanofluid as a working fluid, it is clearly seen a significant enhancement on tube surface resulting in a thinner thermal boundary layer and thus superior convective heat transfer.

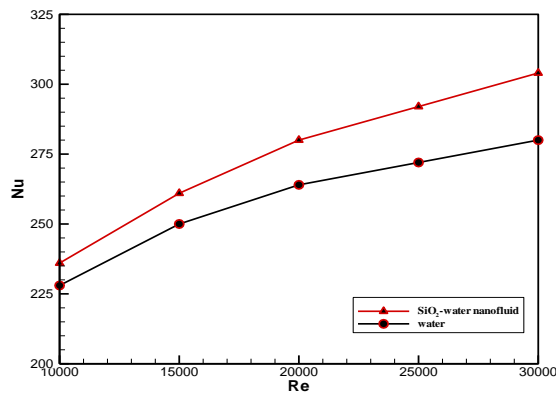


Figure 3 the variation of Nusselt number versus different Reynolds number with SiO₂-water nanofluid at volume fraction of 0.04, practical diameter dp=20nm in parabolic trough collector

3.2 The Effect of Different Volume Fractions of Nanoparticles

This section analyses the effects of Different Volume Fractions of SiO₂-water nanofluid in parabolic trough collector on the Nusselt number. The effect of various volume fractions on Nusselt number is shown in Fig.4. In this study the Reynolds number varies from 10000 to 30000 and the nanoparticle concentration in the range of 0-4% is investigated. From the results, it is clearly seen that SiO₂ nanofluid with highest volume fractions of 4% has the highest average Nusselt number at all Reynolds numbers. In fact, by increasing the volume fractions of nanofluid lead to increase the thermal conductivity of the fluid and the increases of thermal conductivity and collision of nanoparticles which are favorite factors for heat transfer enhancement. Pure water has zero volume fractions and provides the lowest average Nusselt number. It is also noted that the average Nusselt number increases with the increase of Reynolds number.

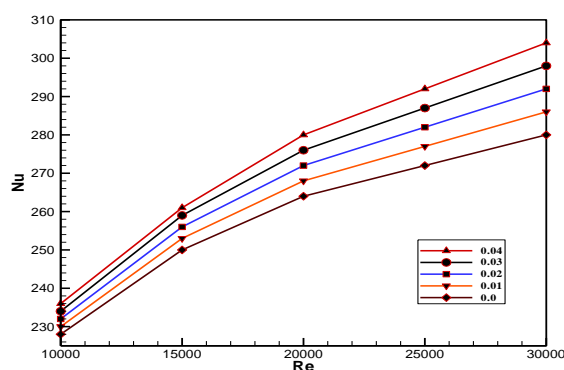


Figure 4 the variation of Nusselt number versus different Reynolds number with different nanoparticle concentrations of SiO₂ nanofluid at nanoparticle diameter of 20nm in parabolic trough collector

3.3 The Effect of Different Nanoparticles Diameters, dp

The effect of different nanoparticles diameters of SiO₂ nanofluid on heat transfer enhancement in the tube of parabolic trough collector. The influence of different nanoparticles on the Nusselt number with different Reynolds number are investigated in this section. The range of nanoparticles diameter are varied from 20nm-50nm with fixed other parameters such as the concentrations of SiO₂ nanofluid is 4%. As illustrated in Fig 4, the results show that the Nusselt number increases with decreasing the nanoparticles diameter for all Reynolds numbers. The maximum Nusselt number is found at nanoparticles diameter of 20nm. The effective dynamic viscosity of the nanofluid increases with the decrease of the nanoparticles diameter resulting in better heat transfer.

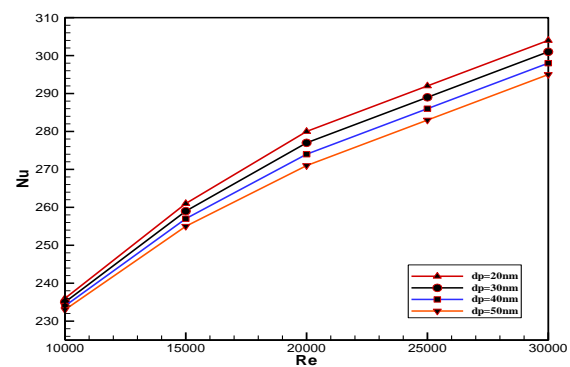


Figure 5 The variation of Nusselt number versus different Reynolds number with different nanoparticles diameters of SiO₂ nanofluid at volume fraction of 0.04 in parabolic trough collector

As a results, the effects of using SiO₂-water nanofluids on the heat transfer field in the tube of parabolic trough collector were numerically analyzed. The influence of different volumes fractions in the range of 0% to 4% and different nanoparticle diameters in the range of 20nm to 50nm, dispersed in a base fluid (water) have been discussed in detail. From the results, it is clearly seen that The Nusselt number considerably increased with increasing Reynolds number, Re in the range of 10000-30000. The SiO₂ nanofluid has the highest Nusselt number value, followed by pure water. The results show that the Nusselt number increases with decreasing the nanoparticles diameter and it increases with increasing the volume fraction (concentration) of nanoparticles.

Nomenclature

A jet-exit cross section area

Cp	specific heat (J/kg K)		Eq. (12)
d	diameter of nozzle	ε	dissipation rate of turbulent kinetic energy nanoparticles volume fraction
f	friction factor		
H	nozzle-to-surface spacing, [m]	μ	dynamic viscosity (N. s. m ⁻²)
k	thermal conductivity (Wm ⁻¹ K ⁻¹)	μ_t	turbulent or eddy viscosity
k	turbulent kinetic energy (m ² /s ²)	ν	kinematics viscosity (m ⁻² .s ⁻¹)
kB	Boltzmann constant (=1.3807×10 ⁻²³ j/k)	ρ	density (kg . m ⁻³)
l	turbulence length scale		
Nu	average Nusselt number	α	thermal diffusivity
P	pressure (Pa)	δ	distance between particles (m), defined in Eq. (12)
PP	pumping power	ε	dissipation rate of turbulent kinetic energy nanoparticles volume fraction
Pr	Prandtl number		
q	Uniform heat flux (W.m ⁻²)	μ	dynamic viscosity (N. s. m ⁻²)
Re	Reynolds number	μ_t	turbulent or eddy viscosity
T	temperature (k)	ν	kinematics viscosity (m ⁻² .s ⁻¹)
A	jet-exit cross section area	ρ	density (kg . m ⁻³)

Cp	specific heat (J/kg K)
dp	Nanoparticle diameter[nm]
f	friction factor
H	nozzle-to-surface spacing, [m]
k	thermal conductivity (Wm ⁻¹ K ⁻¹)
k	turbulent kinetic energy (m ² /s ²)
kB	Boltzmann constant (=1.3807×10 ⁻²³ j/k)
l	turbulence length scale
Nu	average Nusselt number
P	pressure (Pa)
PP	pumping power
Pr	Prandtl number
q	Uniform heat flux (W.m ⁻²)
Re	Reynolds number
T	temperature (k)

Greek letters

α	thermal diffusivity
δ	distance between particles (m), defined in

4.References

- [1] Bello-Garcia Antonio, Garcia-Cortes Silverio, Ordonez Celestino. Estimating Intercept factor of a parabolic solar trough collector with new supporting structure using off-the-shelf photogrammetric equipment . Appl Energy 2012;92:815–21.
- [2] Eckhard Lupfert, Michael Geyer (2001). Eurotrough design issues and prototype testing at PSA. In : Proceedings of solar forum 2001. Solarenergy, 21 –25 April.
- [3] Vasquez Padilla Ricardo, Demir kaya Gokmen, Yogi Goswami D, Stefanakos Elias, Rahman Muhammad M. (2011) Heat transfer analysis of parabolic trough solar receiver. Appl Energy; 88:5097–110.
- [4] Edenburn Michael W. (1976) Performance analysis of a cylindrical parabolic focusing and comparison with experimental results. Sol Energy; 18:437–44.
- [5] Naeeni N, Yaghoubi M. (2007) Analysis of wind flow around a parabolic collector (1) fluid flow. Renew Energy; 32:1898–916.

- [6] S.U.S. Choi (1995), Enhancing thermal conductivity of fluids with nanoparticles, in: D.A.Signer, H.P. Wang (Eds.), *Developments Applications of Non-Newtonian Flows*, FED- vol. 231/MD, 66, pp. 99–105.
- [7] H. Masuda, A. Ebata, K. Teramae, N. Hishinuma,(1993) Alteration of thermal conductivity and viscosity of liquid by dispersing ultra-fine particles (dispersion of α -Al₂O₃,SiO₂ and TiO₂ ultra-fine particles), *NetsuBussei (Japan)* 4,227–233.
- [8] S. Lee, S.U.S. Choi, S. Li, J.A. Eastman, (1999) Measuring thermal conductivity of fluid containing oxide nanoparticles, *Journal of Heat Transfer* 121,280–289.
- [9] H.A. Mohammed, A.A. Al-Aswadi, N.H. Shuaib, R. Saidur, (2011) Convective heat transfer and fluid flow study over a step using nanofluids: a review, *Renewable & Sustainable Energy Reviews* 15,2921–2939.
- [10] R. Saidur, K.Y. Leong, H.A. Mohammed,(2011) A review on application and challenges of nanofluids, *Renewable & Sustainable Energy Reviews* 15,1646–1668.
- [11] R. Saidur, S.N. Kazi, M.S. Hossain, M.M. Rahman, H.A. Mohammed,(2011) A review on the performance of nanoparticles suspended with refrigerants and lubricating oils in refrigeration systems, *Renewable & Sustainable Energy Reviews* 15,310–323.
- [12] H.A. Mohammed, G. Bhaskaran, N.H. Shuaib, R. Saidur,(2011) Heat transfer and fluid flow characteristics in microchannels heat exchanger using nanofluids: a review, *Renewable & Sustainable Energy Reviews* 15 (2011) 1502–1512
- [13] Mohammed HA, Hasan HA, Wahid MA.(2013) Heat transfer enhancement of nanofluids in a double pipe heat exchanger with louvered strip inserts. *International Communications in Heat and Mass Transfer*;40:36–46

A 008

Optimizing Nanofluids with the Optimum of Round Tube Design on the Performance of PVT Collector

K. Sopian^{1*}, Ali Najah Al-Shamani^{1,2**}, Sohif Mat¹, Husam Abdulrasool Hasan¹, Azher M. Abed¹, M. M. S. Dezfouli³, A.M Elbreki¹, B. Elhub¹

¹Solar Energy Research Institute (SERI), Universiti Kebangsaan Malaysia, 43600 Bangi, Malaysia

²Al-Musaib Technical College, Al-Furat Al-Awsat Technical University, 51009 Babylon, Iraq

³Institute of Product Design & Manufacturing (IPROM), Universiti Kuala Lumpur, 56100 Kuala Lumpur, Federal Territory of Kuala Lumpur

*e-mail: ksopian@ukm.edu.my

ABSTRACT

The main motivation of combining the Photovoltaic (PV) and Thermal collector (T) to be photovoltaic thermal collector (PVT) systems is to increase the efficiency of the collectors. It is known fact that the efficiency of the photovoltaic decreases when the ambient temperature increased and vice versa. The system works by absorbing the heat gain from the sun using the photovoltaic module and convert it to electrical energy. Some of this energy is then transferred to the absorber collector underneath the PV module as a waste energy. **Problem statement:** Simulations have been performed to investigate the optimum round tube design using water with and without nanofluids as base fluid, and the effect of various mass flow rates against the thermal, electrical and combined PVT efficiencies. **Approach:** different diameters of Round tube absorber have been designed and sublimated using water with and without nanofluids. In this simulation, it is assumed that the absorber collectors were attached underneath the flat plate polycrystalline silicon photovoltaic module and fluids have been used as a heat transfer medium in absorber collectors. **Results:** The CFD simulation results have been show that the best Round tube absorber design is R20mm-SiO₂ generated combined PVT efficiency of 73.78% with PVT electrical efficiency of 13.67%. The mass flow rate is set (0.068-0.170) kg/s for all absorber collectors and solar irradiance test for the whole day. **Conclusion/Recommendations:** The best mass flow rate has been achieved for R20mm-SiO₂ absorber collector was 0.170 kg/s. It was recommended for PVT system to further improve its efficiency by optimizing the contact surfaces between the PV module and the tubes underneath and using different types of nanofluid such as (SiC, TiC and TiO₂).

Keywords: Round absorber collector; CFD, Nanofluids; Energy; Photovoltaic thermal (PVT); Electrical; thermal and combined efficiency.

1. Introduction

A hybrid PV/Thermal (PVT) system, in which heat from the PV panel is removed by a working fluid, can simultaneously convert solar energy into electrical and thermal energy. Compared with separate PV or thermal systems, the hybrid system has several advantages, including high total energy conversion efficiency, low cost, and small installation areas. Solar PVT applications can provide heat and electricity. To achieve high efficiency and significant amounts of power and heat from PVT systems, PV module should be cooled, particularly in areas with hot and humid climate. Thus, the overall efficiency of solar energy is improved. Fluid-based PVT collectors are more desirable and effective than existed air systems. Temperature fluctuations in the base fluid (water) of PVT are significantly less than those in the air-based PVT collectors, which are subjected to varying solar irradiance levels. Over the past decades, various PVT systems or collectors that use water as working fluid

for heat removal have been numerically and experimentally studied.

Research in this field was carried out in the middle of 1970s to early 1980s. As mentioned by Zondag, Jong [2] combining the PVT collector will answer the problems such as PV efficiency increasing due to the cooling effect, provide more architectural uniformity by aesthetical design and finally, minimized the usage of space on the roof will reduce the payback period.

Nanotechnology is important vis-à-vis the promotion of technology and applications. Nanofluids are a mixture of liquid (base fluid) and nanoparticles [3]. Nanofluids improve thermo-physical properties, such as thermal conductivity, viscosity, and convective heat transfer coefficients compared to conventional fluids [4]. A new and simple way to improve the performance of solar collector is to use nanofluids in place of conventional heat transfer fluids.

Joshi et al. [5] studied and compared two PV configurations namely; model (I) glass-to-tedlar

and model (II) glass-to-glass. They concluded from the two proposed models that increases the duct length leads to decrease the overall thermal efficiency. These results agree with the results obtained from [6, 7]. Several investigator have presented the effect of the space between the tubes with respect to tube diameter ratio (W/D) and the fin thickness on the PVT energy performance. Bergene and Løvvik [8] studied the relation between the geometric parameter W/D and the performance of

$$\eta_{\text{combined}} = \eta_{\text{th}} + \eta_{\text{el}} \quad (1)$$

PVT system. They reported that as the fin width to tube diameter “W/D” increases from 0.01m to 0.1m the thermal efficiency is approximately halved. Also, the thermal efficiency maybe increased only with a factor 0.1 if the mass flow rate increases from 0.001 to 0.075 kg/s while increasing the W/D from 1 to 10, the outlet temperature decreases. Zondag [9] reviewed various concepts of combined PV-thermal collector technologies by introducing and evaluating nine different designs, ranging from the complicated to the simple, in order to investigate the maximum yield. They concluded that the design of the channel below the transparent PV, with its PV-on-sheet and tubes design, gives the best efficiency overall.

PVT collectors have been recently utilized in different industries, and such collector motivated researchers in different fields of study to carry out experimental and numerical investigations [11-20]. Literature showed that the PVT technology has an inherent drawback of producing lower efficiencies compared to their individual units, due to lower absorption coefficient and higher thermal resistance. Meanwhile, nanofluids with properties leading to superior heat transfer characteristics encouraged the researchers to also introduce these nanofluids into PVT collectors. Therefore, enhancing heat transfer using nanofluids is implemented in this work. The present work is a simulation study using CFD-ANSYS to investigate the effects of optimum round tube absorber using water-based and different nanofluids (CuO and SiO₂) on the PVT’s collector performance to determine the maximum enhancement that can be achieved.

2. Material And Methods

2.1 Governing Equations

The governing equations (continuity, momentum, and energy) must be set to complete CFD analysis of the PVT collector. The phenomenon under consideration was governed by the steady 3D computational domain of the continuity, time-averaged incompressible Navier–Stokes equations, and energy equation. In the Cartesian tensor system, these equations could be written as (Eiamsa-ard and Promvongse 2008).

2.2 Energy Analysis of PVT Collector

The efficiency of the photovoltaic cells depends on module temperature (Duffie & Beckman 1980). Furthermore, the performance of PVT collectors can be depicted by the combination of the efficiency expression. It comprised of the thermal efficiency (η_{th}) and the PV efficiency (η_{el}), which usually include the ratio of the useful thermal gain and electrical gain of the system to the incident solar irradiance on the collector within a specific time or period. The combined photovoltaic thermal (PVT) efficiency (η_{combined}) was used to evaluate the overall performance of the system (Duffie & Beckman 1980).

The thermal performance of the PVT unit was evaluated for its thermal and PV performance. Thus, the derivation of the efficiency parameters based on the Hottel–Whillier equations (Hottel & Woertz 1942) was used. The thermal efficiency (η_{th}) of the conventional flat plate solar collector can be calculated as follows:

$$\eta_{\text{th}} = \frac{Q_u}{I_{(t)} * A_c} \quad (2)$$

The useful collected heat (Q_u) from water in terms of its temperature increase can be expressed as follows:

$$Q_u = \dot{m} C_p (T_o - T_i) \quad (3)$$

The difference between thermal heat losses

$$F_R = \frac{\dot{m} C_p}{A_c U_L} * \left[1 - \exp \left(- \frac{A_c U_L F'}{\dot{m} C_p} \right) \right] \quad (4)$$

and the absorber solar irradiance was identified using the Hottel–Whillier equations, then; the energy balance equation for the collector is:

$$Q_u = A_c F_R [S - U_L (T_i - T_a)] \quad (5)$$

The solar irradiance absorbed by a collector per unit area of absorber (S) can be expressed as follows:

$$S = (\tau\alpha)_{PV} I_{(t)} \quad (6)$$

The heat removal efficiency factor (F_R) can be calculated using:

The corrected fin efficiency (F') is:

$$F' = \left[\frac{\frac{1}{U_L}}{W \left[\frac{1}{U_L (D + (W - D) F)} + \frac{1}{c_b} + \frac{1}{\pi D_i h_{fi}} \right]} \right] \quad (7)$$

Therefore, the efficiency factor (F) can then be calculated using:

$$F = \frac{\tanh [M(W - D)/2]}{M(W - D)/2} \quad (8)$$

$$\text{where: } M = \sqrt{\frac{U_L}{(K_{abs} \cdot L_{abs}) + (k_{pv} \cdot L_{pv})}}$$

The useful heat gain of the solar collector can be calculated, while the thermal efficiency of the collector can be expressed as (Vokas et al. 2006):

$$\eta_{th} = F_R(\tau\alpha) - F_R U_L \left(\frac{T_i - T_a}{I(t)} \right) \quad (6)$$

The temperature-dependent electrical efficiency of the PV module η_{th} is expressed as follows (Tiwari & Sodha 2006 a):

$$\eta_{el} = \eta_r (1 - \beta(T_{pm} - T_r)) \quad (7)$$

η_{el} is the electrical efficiency, η_r is the reference efficiency of the PV module ($\eta_r = 0.14$), β is the temperature coefficient ($0.0045 \text{ }^\circ\text{C}^{-1}$), T_{pm} is the temperature of the solar cells ($^\circ\text{C}$), and T_r is the reference temperature.

2.3 Thermo-physical Properties of Nanofluid

In order to simulate nanofluids, the effective thermo-physical properties of nanofluids have been calculated. In this case, the nanoparticles being used (CuO and SiO₂). Basically, the required properties for simulations are effective thermal conductivity (k_{eff}), effective dynamic viscosity (μ_{eff}), effective mass density (ρ_{eff}), and effective specific heat (Cp_{eff}). In terms of these factors, the effective properties of mass density, specific heat, thermal conductivity, and viscosity are actually calculated according to the mixing theory.

2.4 Design Configurations of the Absorber

As the PV cells in the PV module are exposed to the sun, they generate electricity while absorbing heat, causing the absorber to increase its temperature. During this time, the base fluid passing inside the absorber tubes is heated because of the contact underneath the PV module. The base fluid flows along the absorber through a manifold and pipes before being finally fed to tank. The absorbers are equipped with an inlet and outlet at opposite ends of the hollow tubes, which ensure that the trapped base fluid in the absorber can be released. The system is considered a closed-loop system, wherein the fresh and cool base fluid that enters the round tubes is heated continuously. The collector conceptual designs used in this study are shown in Figure 1.

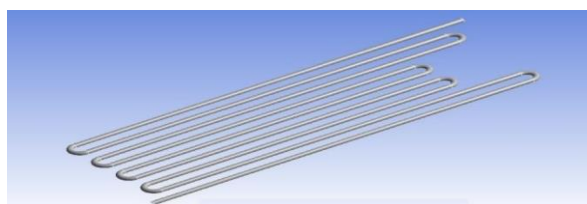


Figure 1 Round Absorber Design for PV/T Collector

3. Results And Conclusions

In this round of analysis, the optimum absorber dimensions (Round [d]) that can realize the best PVT module temperature reduction has been determined. Figure 2 illustrate the effect of absorber dimensions on the mean PVT module temperature at different solar irradiance (400-1000)W/m² and mass flow rate $\dot{m} = 0.068 \text{ kg/s}$. It is clearly to see that the when increased the tube diameter [d] the T_{pm} decreases and it is be almost constant at Round tube [d=20mm] therefore form all these dimensions [d=10-27.5] mm, the Round tube [d=20mm] for simulation has been selected because it is give the lowest T_{pm} can achieved.

Based on the CFD numerical analysis on the PVT collectors, it is proved that both efficiencies increased when the mass flow rate increased. For electrical PVT efficiency (η_{el}) and mean PVT plate temperature (T_{pm}) over mass flow rate for nanofluids and water as shown in Figure 3, it is clear to see that the electrical efficiency for nanofluids (CuO and SiO₂) increased and enhanced for optimum round absorber design compare with water. The highest and best numerical enhancement for η_{el} have been found to SiO₂ nanofluid [d=20mm], it is increased from 11.93 to 12.13% for SiO₂ nanofluid, followed by CuO nanofluid increased from 11.71% to 11.93%, Water increased from 10.77% to 10.94%, and PV module reference of 6.5%.

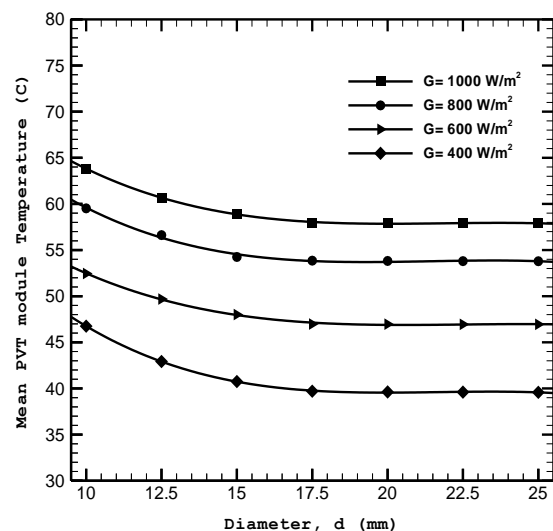


Figure 2 T_{pm} versus PVT absorber (Round tube) at different solar irradiance and $\dot{m} = 0.068 \text{ kg/s}$

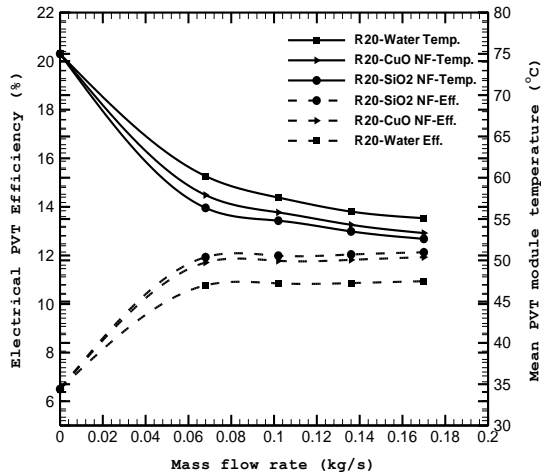


Figure 3 η_{el} with T_{pm} over mass flow rate for optimum Round tube [R20mm] water and nanofluids (CuO and SiO₂)

In order to numerically evaluate the performance of the best Round tube with nanofluid [R20mm-SiO₂] PVT Collector, the whole day numerical results have been shown in Figure 4 and Figure 5, which illustrate solar irradiance, mean PVT module temperature, and (electrical, thermal and combined) PVT power and efficiency. According to Figure 4, the maximum mean PVT plate temperature and electrical PVT efficiency from the [R20mm-SiO₂] design absorber reached approximately 56.35°C and 11.70% respectively at mass flow rate 0.068 kg/s, by increased the mass flow rate the T_{pm} decreasing and η_{el} increased till optimum mass flow rate of 0.170 kg/s. Heat loss between the PVT collector and environment was altogether higher than that between the conventional solar collector and environment. Hence, the thermal effectiveness of the PVT collector was marginally lower than that of the conventional solar collector because of the expanded hear-loss coefficient.

Figure 4 shows the trends of solar irradiance, electrical, thermal, and combined PVT power for the whole day. Electrical, thermal, and combined PVT power varied continually with increasing solar irradiance and time. The results indicated that the electrical, thermal, and combined PVT power used for the [R20mm-SiO₂] PVT collector varied (20-60.46) W, (125-456.22) W, and (145-516.67) W, respectively, at mass flow rate of 0.170 kg/s. Based on Figure 4 and the equations of PVT energy balance, the electrical, thermal, and the combined PVT efficiency over daytime have been determined. Figure 5 illustrates the variation in the (electrical, thermal, and combined) PVT efficiency with hourly solar irradiance over daytime with the R20mm-SiO₂ absorber flow and a mass flow rate of 0.170 kg/s. The results shown that the electrical efficiency was 12.43-13.67%, thermal efficiency was 51.01-60.08%, and combined PVT efficiency was 63.98-73.78%. The total of both efficiencies, which is

known as combined PVT efficiency, was used to evaluate the combined performance of the system. Figure 6 and Figure 7 show the contour profile of temperature distributions on the R20mm-SiO₂ absorber. It is clear that the temperature profile was uniform.

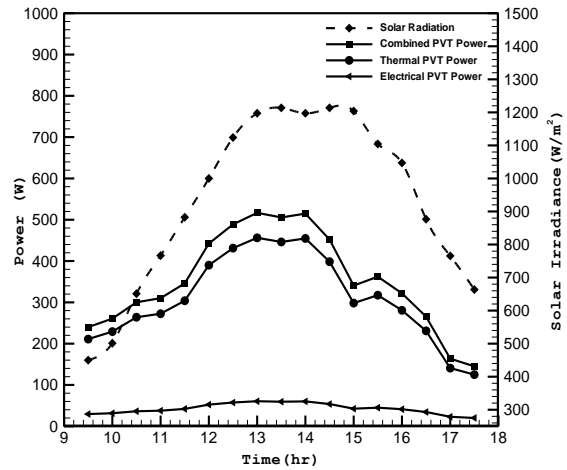


Figure 4 Power variation of (el, th and combined) PVT with hourly solar irradiance, $\dot{m} = 0.170$ kg/sover daytime

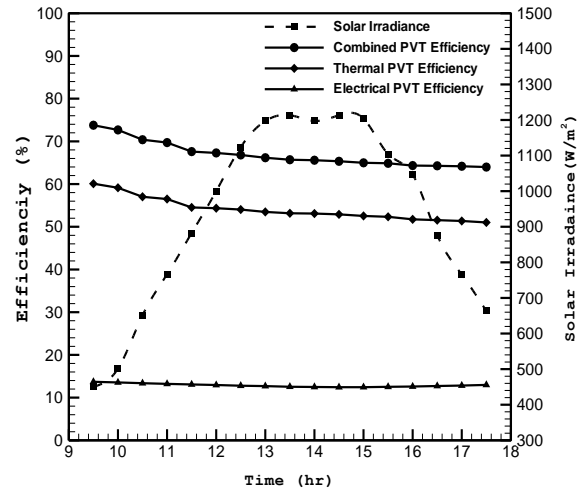


Figure 5 Efficiency variation of (el, th and combined) PVT with hourly solar irradiance, $\dot{m} = 0.170$ kg/sover daytime

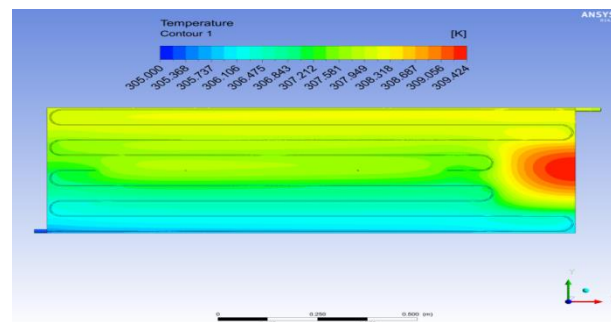


Figure 6 Top view isotherms profile of R20mm-SiO₂ absorber design with PV module

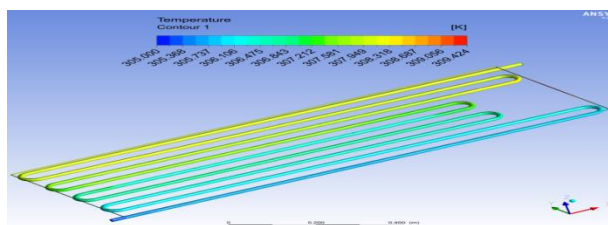


Figure 7 3D streamlined profile of R20mm-SiO₂ absorber design

4. Conclusion

Solar cells generate large amounts of electricity when large amounts of solar irradiance are received. However, the efficiency drops when the temperature of solar module increased. Hybrid PVT Collector can solve this problem. The PVT collector with a Round tube using Nanofluids exhibited effective performance in cooling, as well as high electrical and thermal efficiency. The electrical and thermal production of a PVT hybrid system increased with decreasing temperature of the environment. At a mass flow rate of 0.170 kg/s, electrical PVT efficiency of 13.67% and combined PVT efficiency of 73.78% have been achieved. The efficiency of the PVT system has been improved by numerical study using CFD for optimum round tube absorber designs using water and different types of nanofluids as base fluid.

5. Acknowledgement(S)

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6. References

- [1] Sok, E., Y. Zhuo, and S. Wang (2010), Performance and economic evaluation of a hybrid photovoltaic/thermal solar system in Northern China. *International Journal of Electrical, Computer, Energetic, Electronic and Communication Engineering*, Vol. 10 (12), pp 176-81.
- [2] Zondag, H., M. Jong, and W. Van Helden, Development and applications for PV thermal. 2001: Energy research Centre of the Netherlands ECN.
- [3] Sani, E., et al. (2010), Carbon nanohorns-based nanofluids as direct sunlight absorbers. *Optics express*, Vol. 18 (5), pp 5179-5187.
- [4] Wong, K.V. and O. De Leon (2010), Applications of nanofluids: current and future. *Advances in Mechanical Engineering*, Vol. 2010.
- [5] Joshi, A., et al. (2009), Performance evaluation of a hybrid photovoltaic thermal (PV/T)(glass-to-glass) system. *International Journal of Thermal Sciences*, Vol. 48 (1), pp 154-164.
- [6] Sarhaddi, F., et al. (2010), An improved thermal and electrical model for a solar photovoltaic thermal (PV/T) air collector. *Applied Energy*, Vol. 87 (7), pp 2328-2339.
- [7] Moradi, K., M.A. Ebadian, and C.-X. Lin (2013), A review of PV/T technologies: Effects of control parameters. *International journal of heat and mass transfer*, Vol. 64, pp 483-500.
- [8] Bergene, T. and O.M. Løvvik (1995), Model calculations on a flat-plate solar heat collector with integrated solar cells. *Solar energy*, Vol. 55 (6), pp 453-462.
- [9] Zondag, H. (2008), Flat-plate PV-Thermal collectors and systems: A review. *Renewable and Sustainable Energy Reviews*, Vol. 12 (4), pp 891-959.
- [10] Ibrahim, A., et al. (2009), Performance of photovoltaic thermal collector (PVT) with different absorbers design. *WSEAS Transactions on Environment and Development*, Vol. 5 (3), pp 321-330.
- [11] Mbeve, D., H. Card, and D. Card (1985), A model of silicon solar cells for concentrator photovoltaic and photovoltaic/thermal system design. *Solar energy*, Vol. 35 (3), pp 247-258.
- [12] Tripanagnostopoulos, Y. (2007), Aspects and improvements of hybrid photovoltaic/thermal solar energy systems. *Solar energy*, Vol. 81 (9), pp 1117-1131.
- [13] Cox, C. and P. Raghuraman (1985), Design considerations for flat-plate-photovoltaic/thermal collectors. *Solar energy*, Vol. 35 (3), pp 227-241.
- [14] Takashima, T., et al. (1994), New proposal for photovoltaic-thermal solar energy utilization method. *Solar energy*, Vol. 52 (3), pp 241-245.
- [15] Skoplaki, E. and J. Palyvos (2009), On the temperature dependence of photovoltaic module electrical performance: A review of efficiency/power correlations. *Solar energy*, Vol. 83 (5), pp 614-624.
- [16] Chow, T. (2003), Performance analysis of photovoltaic-thermal collector by explicit dynamic model. *Solar Energy*, Vol. 75 (2), pp 143-152.
- [17] Coventry, J.S. (2005), Performance of a concentrating photovoltaic/thermal solar collector. *Solar Energy*, Vol. 78 (2), pp 211-222.
- [18] Huang, H., et al. (2011), Photovoltaic-thermal solar energy collectors based on optical tubes. *Solar energy*, Vol. 85 (3), pp 450-454.
- [19] Al-Shamani, A.N., et al. Numerical Study on the Characteristics of a Specially Designed Rectangular Tube Absorber Photovoltaic Thermal Collector (PVT).
- [20] Al-Shamani, A.N., et al. (2014), Nanofluids for improved efficiency in cooling solar collectors—A review. *Renewable and Sustainable Energy Reviews*, Vol. 38, pp 348-367.

A 009

Effect Of Temperature Setting On Energy Consumption Of Electrical Air Conditioning On Campus II Aie Pacah

Eddy Soesilo

Electrical Departementt, Faculty Of Industrian Engineering Bung Hatta University, Jl Gajah Mada, No.19;Olo Nangalo ; Padang, West Sumatera Indonesia

*soesiloeddy62@yahoo.com

Abstract Bung Hatta University is one of the largest colleges in West Sumatra, at this time of Bung Hatta University has three campus locations which campus I , Campus II, and III campus. AC loads are used with varying load consumption patterns of 640,375 kVA. Therefore, the consumption levels are quite high, therefore the consumers make efforts to save electricity consumption. On Government Regulation No. 70 of 2009 states that users of energy sources and energy use of energy resources greater than or equal to 6,000 tons of oil equivalent per year are required to conduct energy conservation through energy management. For the HVAC system as the Regulation No.14 of 2012 of the Minister of Energy and Mineral Resources Chapter III on the implementation of energy savings, that the temperature is between 24 °C workspace is set up to 27 °C with relative humidity between 55% to 65%. Performance assessment method Air Conditioning (AC) includes detailed calculations COP (coefficient of Performance) and the cooling effect in terms of the external fluid is air. There is a linear relationship between temperature settings to energy consumption, and COP refrigeration effect. Decrease the temperature setting from 25 °C to 17 °C causes a linear reduction in energy consumption, increased refrigeration effect and increased COP linearly. Based on efficiency opportunities derived from the lights and air conditioning in Campus II University of Bung Hatta when setting air conditioning is carried out at 17 °C, the total average efficiency of 42.78% with a total energy 62,680.31 kWh kWh or Rp 23,773,702 per month if using air conditioning with a capacity of 1 PK so that every space there are 4 air conditioning. If using AC 2 PK then an efficiency of 37.13% with energy at 54402.05 kWh or Rp 20,633,884. So that every room there are 2 AC 2 PK

Keywords: Air conditioning; temperature setting; energy efficiency; cost efficiency.

1. Introductions

The times will always be accompanied by the development of technology, the technology development the necessities of life will also continue to increase. Electrical energy is a very important requirement in fulfilling the needs of human life, both in the governance, economic, social, education and so forth. The level of electrical energy consumption in every aspect of life varies greatly depending on the type and amount of weight used, one aspect of education that requires electrical power which is large enough that of the University.

Power requirements that exist on the campus of the University of Bung Hatta II can be seen from electrical loads such as lights, Air Conditioning, and the pump motor is an electric load dominant use. AC load and the lights are very widely used on each floor of the building and use patterns loads pretty much in a day, in this case the AC power sometimes does not match the size of the room and the lights remain lit even if the room is not in use.

Therefore, the consumption levels are quite high, therefore the consumers make efforts to save electricity consumption. Saving electricity consumption will have an impact on the costs to be incurred consumers each month, at the current spending on electric bill Bung Hatta University is large enough that Rp 55,572,400 per month for

virtually every energy consuming electrical appliances. Bung Hatta University Campus II requires power to electricity which is large enough that 935 kVA.

One of the actions in the program evaluation is to increase the efficiency of electrical energy use, in this research the method used is energy conservation. Conserving energy is increased efficiency of energy used or the energy savings, this process includes the evaluation of power requirements and calculate the level of energy consumption of a building by regulating the temperature setting of air conditioner operation. From the results of the count will be seen the amount of savings that can be done. The more efficient use of electrical energy the less the costs to be incurred for the level of energy consumption.

2. Material And Methods

2.1. Research purposes

The purpose of that is expected from this research are :

- Knowing the amount of electrical energy consumption of air conditioning in the campus of the University of Bung Hatta II .
- Calculating the power of the load is attached to every building , especially air conditioning (AC) , lights and other electrical equipment .

- c . Looking for a solution to the achievement of the efficiency of energy use on the campus of the University of Bung Hatta II .
- d Determine the amount of energy saved through the setup of the operating temperature of the AC
- e . Knowing the costs can be saved after the setup of the operating temperature

2.2. State of the art review

In conducting this study, researchers took reference from research Yadi Mulyadi and Anggi Riski discuss energy audit analysis for the achievement of energy efficiency in building FPMIPA JICA Indonesia University of Education and the its relation to the impact on the electricity bill.

Hidayati daughter in her study describes the effect of setting the temperature on the performance of AC Split. Yoga Prasetya also explain the increased efficiency of energy use in lighting systems and Air Conditioning (AC) at the Public Library and Archives Malang, on conserving the use of Air Conditioning (AC) and lighting systems. Seeing the effect of efficiency between the floor and the building does not use air conditioning to the floor using AC. Therefore, it is necessary austerity measures among which the increase in the efficient use of air conditioning and lighting systems of buildings. Of the final calculation of the value obtained IKE to the floor do not use the AC is 4.12 kWh / m² / month including the category of very wasteful and to the floor using the AC that is 12.12 kWh / m² / month including ketegori fairly efficient.

Based on some of the above references researchers developed an energy audit of electricity and cost reductions from existing methods into an implementation Setting Effect on Consumption Temperature Electrical Energy on Campus II University of Bung Hatta.

2.3. Method of Analysis

a) Literature

The study of literature is done by obtaining information from books, scientific journals, and browsing through the internet on the electric power and energy use efficiency efforts in various cracked. By collecting various sources of data available on the campus of the University of Bung Hatta II, to plan the calculation load attached to then look for energy saving solutions. In this case also learn about the research, namely:

- i Learn about the characteristics load electricity and electrical energy consumption in each building.
- ii. Studying the potential energy-saving opportunities that can be done such as lighting systems, air conditioning and other electrical loads located in the Campus II University of Bung Hatta.

b) Data collection on Campus II University of Bung Hatta

The data collection was conducted to determine the actual circumstances and conditions , such as : the condition of the building at Campus II University of Bung Hatta or the number of buildings that are still used , the type of device used , and usage patterns of electrical load on Campus II University of Bung Hatta .

c) the collection and compilation of data bills electrical energy consumption last year .

d) Analysis of energy-saving opportunities (PHE)

Follow-up analysis of energy-saving opportunities , namely by adjusting the operating temperature setting air-conditioning, energy-saving opportunities analysis is done by businesses as follows :

- i. Reducing the lowest possible energy consumption (reducing kW and hours of operation) .
- ii. Improve the performance of equipment

2.4. Air Conditioning (AC)

Air Conditioning (AC) is the equipment used to take the mouth of an area or provide heat in an area , using a refrigeration cycle. In general , the current AC is also used to cool and heat the room in a building or on a vehicle . The main function of AC, namely :

1. Obtain the desired temperature and constant throughout the day .
2. Obtain cash humidity throughout the day .
3. Obtain circuit / air flow can be adjusted as needed.
4. Clean / filter dust and smoke from the air .

A system that combines heating, ventilation and air-conditioning is often called HVAC (heating, ventilation, and air conditioning). The system serves to provide filtered fresh air, heating or air cooling, as well as control of air humidity on a room.

Generally AC consists of four main parts:

1) **Condensing coil**

Condensing coil that is a pipe through which the coolant (refrigerant) with a temperature higher than the liquid refrigerant in the evaporator coil. This section is outside the room. Its function is to remove heat is brought to the outside air so that the liquid refrigerant to cool back, resulting in a change of the refrigerant vapor to a liquid phase.

2) **Expansion valve**

Expansion valve (valve developer), in the form of a turning point refrigerant from liquid to gas phase.

3) **Evaporator coil**

Evaporator coil that is a pipe through which the coolant temperature is low, this section will reduce the humidity of the air space in its path and take the heat resulting in a change of the liquid phase refrigerant into vapor. The evaporator coil is a part that is located indoors.

4) **Compressor**

Compressor function continuously feed and suction pressure in the coolant (refrigerant).

2.5. Efficiency Air Conditioning System

Judging from the composition of the load used in the Campus II University of Bung Hatta, the AC load power consumption is large enough that 79% of the total load is calculated. To obtain comfort in the room, the temperature should be in accordance with the implied ranged between 18 °C- 22 °C. For each room is used and the type of air conditioning cooling capabilities differ according to their needs in order to avoid waste, the level of electricity consumption for the air system is affected by total AC power, the amount of time the old dam operate the air conditioning on each room.

Based on the data captured in the field, the average consumption of a conventional AC for 1 PK has a 736 Watt, 1 ½ PK with 1104 Watt power, and 2 PK has a 1472 Watt power. With a conventional AC power that is big enough then the level of electricity energy consumption in the Campus II Bung Hatta University will be great as well. then to saving electrical energy consumption levels should be taken in the air system , one of the things that can be done is to adjust the temperature setting operation .

2.5.1. Evaluation AC

Data from the main measurement results are good temperature and humidity as well as temperature and humidity chamber at ambient plots on software - T3 CAT (Computer Aided-Thermodynamic) in order to obtain air enthalpy . The parameters of the study results and measurement data is shown as follows :

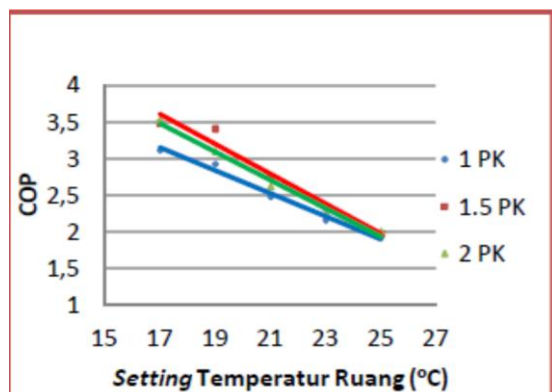


Figure 1 : Chart the influence of temperature settings to COP

COP generated drops linearly with increase in temperature setting. At AC 1 PK obtained the lowest COP on the setting of 25 ° C of 1.93 , and the highest at 17 oC setting of 3.12 and COP obtained rise of 38.14 % . For AC 1.5 PK lowest COP at 17 ° C temperature setting of 3.49 and the lowest setting of 25 ° C of 1.98 , the obtained COP rise of 43.26 % as

well as AC 2 PK , the lowest COP of 2.01 and the highest was 3.53 , the obtained COP rise 43.2 % .

As a result of reduced temperature setting, the refrigerating effect increases as in Figure 5.1

Refrigeration effect rises linearly with the decreasing temperature setting. With the reduced temperature setting is obtained increase in refrigeration effect of 9.34 % for AC 1 PK , 7.72% for AC 1.5 PK and 9.65 % for AC 2 PK . Setting temperature changes affect the amount of energy consumption as shown in Figure 5.2

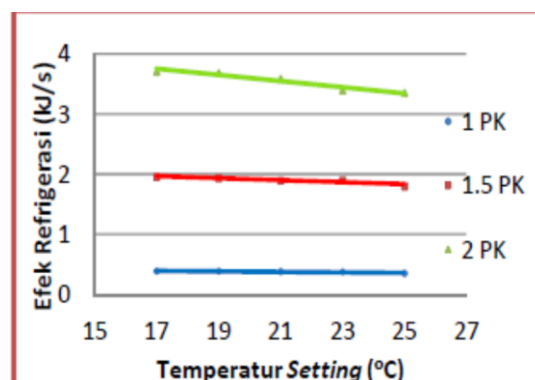


Figure 2: Chart the influence of temperature settings to refrigeration effect

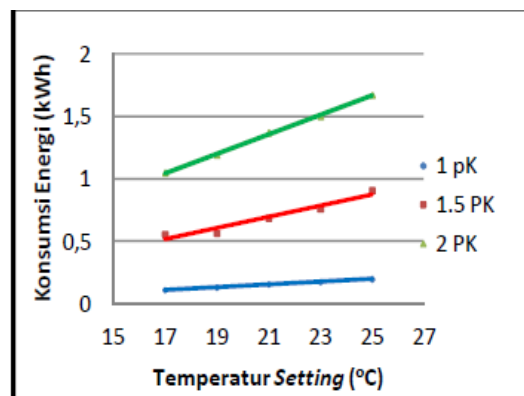


Figure 3: Chart the influence of temperature settings to energy consumption

3. Result and Conclusions

3.1. Analysis

- i. After a field survey on Campus II University of Bung Hatta to calculate the load attached there, then the largest consumption rate that is the AC load at 68, 96%, amounting to 29.56% of the light load, and other expenses amounted to 1.48%. From the pattern of use of the burden on the number of kWh used, the average electricity consumption amounted to 5635.3 kWh per day with 11 hours of operating hours (hours are from 07:30 to 18:30). With the use of a large enough then the bill payment of electricity bills by an average of Rp. 40.3705 million, accounting for consumption and the burden of bills is a merger between the use OPLT (outside

- peak load time) and the use of PLT (peak load time).
- ii. From the results of calculations performed on the kWh meter knowable maximum load that is used to load attached that is 928.578 kVA, while the installed power at the Bung Hatta University Campus I amounted to 935 kVA. The maximum load is used occurred at 15.00 hours, on the ratio between the maximum load and the load is attached the result is that the load used is 68.49% of the available capacity.
 - iii. Based on efficiency opportunities derived from the lights and air conditioning in Campus II University of Bung Hatta when setting air conditioning is carried out at 17 ° C, the total average efficiency of 42.78% with a total energy 62680.31 kWh kWh or Rp 23,773,702 per month if using air conditioners with a capacity of 1 PK so that every space there are 4 air conditioning. If using AC 2 PK then an efficiency of 37.13% with energy at 54402.05 kWh or Rp 20,633,884. So that every room there are 2 AC 2 PK

PARAMETER	1 HP		%	1.5 HP		%	2 HP		%
	25 C	17 C		25 C	17 C		25 C	17 C	
COP	1,93	3,12	61,86	1,98	3,49	56,73	2,01	3,53	56,94
REF	-	-	9,34	-	-	7,72	-	-	9,65
ENERGY	-	-	42,78	-	-	38,59	-	-	37,13
EFF (Wh/days)	2.410,78			2.174,66			2.092,39		
EFF (kWh/month)	62.680,31			56.541,22			54.402,06		
EFF (Rp/month)	23.773.702			21.445.235			20.633.884		

Figure 4 : The results table efficiencies gained due to the effects of air conditioning temperature setting

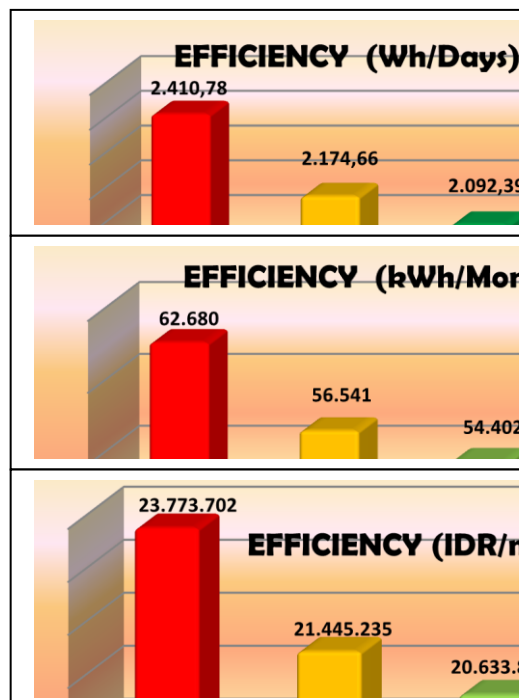


Figure 5 : Granh the result

All paragraphs must be indented. All

4. Conclusions

- 1) For each AC obtained with a reduced tendency of increase in the COP setting temperature. With the drop in temperature setting obtained COP rise of 38.14% for AC 1 PK, 43.26% for AC 1.5 PK and 43.2% for AC 2 PK.
- 2) For every capacity air-conditioning refrigeration effect is obtained trend of the increase with a decrease in room temperature setting. With the drop in temperature setting is obtained increase in refrigeration effect of 7.72% for AC 1 PK, 9.34% for AC 1.5 PK and 9.65% for AC 2 PK.
- 3) Increasingly setting the room temperature, the compressor energy consumption is increasing. The greater the capacity of the AC, the energy consumption increases. Retrieved decline in consumption of 42.78%, for AC 1.5 PK amounted to 38.59% and AC 2 PK amounted to 37.13%.
- 4) Setting air conditioning temperature in each room must be made 17 ° C so that an efficiency of 42.78% with a total energy 62680.31 kWh kWh or Rp 23,773,702 per month if using air conditioners with a capacity of 1 PK so that every space there are 4 air conditioning. If using AC 2 PK then an efficiency of 37.13% with energy at 54402.05 kWh or Rp 20,633,884. So that every room there are 2 AC 2 PK

5. Acknowledgment

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6. References

- [1] Basri, Mohammad Hasan, "Rancang Bangun Diagram Satu Garis Rencana Sistem Distribusi Tenaga Listrik Dgedung Bertingkat (Highrise Building)" Universitas Indonesia, 2008.
- [2] Elektrik cable. "Building, underground dan control cable"
- [3] Firdaus, Hendra, ST, M.Eng. "Analisis Kebutuhan Listrik Daya Terpasang Di Kampus Universitas Galuh Ciamis". Fakultas Teknik Universitas Galuh 2012. (UNIGAL) Ciamis.
- [4] Hendrawan, Herman. Suhendi dede, ir., mt. Analisis back-up system sebagai penyuplai daya listrik dgedung bertingkat bogor trade mall (btm). Schneider, electric. "Katalog peralatan instrumentasi lengkap". 2012.
- [5] Sudiharto, Indhana dkk. Rancang Bangun Sistem Automatic Transfer Switch (ATS) dan Automatic Main Failure (AMF) PLN - Genset Berbasis PLC Dilengkapi Dengan Monitoring. Jurnal Jurusan Teknik Elektro Industri PENS-ITS, Surabaya 2011.
- [6] Suryaman, Maman. "Perakitan dan Pengujian Panel Automatic Transfer Switch (ATS) dan Automatic Main Failure (AMF) Produksi PT. Berkat Manunggal Jaya" Universitas Diponegoro, 2012.
- [7] Suyono. "Tingkat Keandalan Utilitas Kelistrikan Bangunan Gedung Bertingkat Di Kota Semarang" Universitas Muhammadiyah Semarang, 2011.
- [8] Wiranto. "Integrasi Solar Home System Dengan Jaringan Listrik PLN Menggunakan Kendali Relay dan Kontaktor Magnet" Universitas Tanjung pura 2014.
- [9] Ismed. 2008. " Studi Optimalisasi Kapasitas Daya (Aplikasi: Kampus I Universitas Bung Hatta)". Padang: Jurusan Teknik Elektro Universitas Bung Hatta.
- [10] Yadi Mulyadi, Anggi Riski. 2013. "Analisis Audit Energi Untuk Pencapaian Efisiensi Penggunaan Energi di Gedung FPMIPA JICA Universitas Pendidikan Indonesia". Bandung: Program Studi Teknik Elektro FPTK UPI.
- [11] Prasetya Yoga. 2014. "Analisis Peningkatan Efisiensi Penggunaan Energi Listrik pada Sistem Pencahayaan dan Air Conditioning (AC) di Gedung Perpustakaan Umum dan Arsip Kota Malang". Malang: Universitas Brawijaya.
- [12] Karnoto. 2008. "Efisiensi Energi Listrik Kampus Undip Tembalang". Semarang: Jurusan Teknik Elektro Universitas Diponegoro (UNDIP).
- [13] Moh Rifki Binol, Sabhana Kanata. 2014. "Evaluasi Instalasi Listrik Gedung Di Hotel Maqna Gorontalo". Gorontalo: Jurusan Teknik Elektro Universitas Ichsan Gorontalo.
- [14] Suswanto Daman. 2009. "Sistem Distribusi Tenaga Listrik". Padang: Universitas Negeri Padang.
- [15] Badan Standardisasi Nasional, "Persyaratan Umum Instalasi Listrik 2000 (PUIL 2000)", Yayasan PUIL, Jakarta, 2000.
- [16] <http://www.slideshare.net/juliusbua/operasi-sistem-tenaga>
- [17] [http://www.academia.edu/10554597/PROSES_DAN_SISTEM_PENYALURAN_TENAGA LISTRIK_OLEH_PT.PLN_Persero](http://www.academia.edu/10554597/PROSES_DAN_SISTEM_PENYALURAN_TENAGA_LISTRIK_OLEH_PT.PLN_Persero)
- [18] <http://power-grounding.blogspot.co.id/2009/12/beban-beban-listrik.html>
- [19] https://id.wikipedia.org/wiki/Lampu_pijar
- [20] <http://www.kesimpulan.com/2009/09/eropa-mulai-era-baru-mewajibkan-pakai.html>
- [21] <https://sakasakti.wordpress.com/tag/air-conditioner/>
- [22] Amr.O. Elsayed dan Abdulrahman S. Hariri, 2011, Jurnal Low-Energy Architecture, World Renewable Energy, Saudi Arabia
- [23] ASHRAE Handbook. 2009. Refrigeration-Chapter 30 Thermofisical Properties of Refrigeran. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc, Atlanta
- [24] Dossat, R.J. Principles of Refrigeration. 1978 second Edition, John Wiley & sons, New York
- [25] Lippsmeier Georg. 1994. Bangunan Tropis. Jakarta. Erlangga
- [26] Peraturan Menteri Energi dan Sumber daya Mineral No 14 Tahun 2012
- [27] Piter Silitonga, Rio Jon. Peralatan Monitoring dan Instrumentasi Audit Energi, PT Energy Management Indonesia (Persero)
- [28] Soegijanto, 1999. Bangunan di Indonesia dengan Iklim Tropis Lembab Ditinjau dari Aspek
- [29] Standar Nasional Indonesia (SNI-03-6390-2000) "Konservasi energi sistem tata udara pada bangunan gedung
- [30] Stoecker, Wilbert F. 1996. Industrial Refrigeration Handbook.

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A stand-alone Photovoltaic System Design and Sizing: a Greenhouse Application in Sabha City: Case study in Libya

K. Sopian^{1*}, A.M Elbreki^{1,2**}, M.H. Ruslan¹, Ali Najah Al-Shamani^{1,3}, B. Elhub¹, Azher M. Abed¹, HusamAbdulrasool Hasan¹, M. M. S. Dezfouli⁴

¹Solar Energy Research Institute (SERI), Universiti Kebangsaan Malaysia, 43600 Bangi, Malaysia

²Electrical and Electronic Technical College, Benghazi, Libya

³Al-Musaib Technical College, Al-Furat Al-Awsat Technical University, 51009 Babylon, Iraq

⁴Institute of Product Design & Manufacturing (IPROM), Universiti Kuala Lumpur, 56100 Kuala Lumpur, Federal Territory of Kuala Lumpur

* Corresponding authors: [*ksopian@ukm.edu.my, ** nasirburki@yahoo.com]

Abstract During the last decade, there has been an increased interest to develop renewable energy technologies that could contribute to our ever-increasing energy needs. This concern was due mainly to the rising price of conventional energy sources and their limited supply. Renewable energy technologies were becoming, if not immediately at least for the close future, as technically and economically viable and environmentally friendly. In this study, a design of a stand-alone system for supplying the electrical load for a greenhouse in Sabha city at remote desert areas in Libya was presented. Sizing each component used in the stand-alone system that will power all electric appliances at a medium-energy-consumption greenhouse in Sabha city based on Watt-hour demand were presented. This paper elaborates early research works in this area. In addition, the costs of all system parts are included and the total cost is estimated. From the results, the most important conclusion is the cost of running these generators can be quite expensive when factoring in fuel availability and transportation costs. It is currently not economically feasible to extend the grid to such locations. The power must be generated locally. The purpose of this work was to analyze the feasibility of PV power generation for such a remote setting. It is shown that the PV generation system can be competitive compared to current diesel powered installations.

Keywords: greenhouse: stand-alone PV systems: PV sizing: cost evaluation.

1. Introduction

The sun provides the energy to sustain life in our solar system. In one hour, the earth receives enough energy from the sun to meet its energy needs for nearly a year [1]. Photovoltaic is the direct conversion of sunlight to electricity. It is an attractive alternative to conventional sources of electricity for many reasons: it is safe, silent, and non-polluting, renewable, highly modular in that their capacity can be increased incrementally to match with gradual load growth, and reliable with minimal failure rates and projected service lifetimes of 20 to 30 years [2]. It requires no special training to operate; it contains no moving parts, it is extremely reliable and virtually maintenance free; and it can be installed almost anywhere. A photovoltaic system is a complete set of interconnected components for converting sunlight into electricity by photovoltaic process including array, balance-of-system, and load. Over the last three decades, steady advances in technology and manufacturing have brought the price of photovoltaic modules down significantly to about \$4-\$5 per peak watt [3]. The intensity of the sunlight that reaches the earth varies with time of the day, season, location, and the weather conditions. The total energy on a daily or annual basis is called irradiation and indicates the strength of the sunshine. Irradiation is expressed in Wh.m⁻² per day or for instance kWh.m⁻² per day. Photovoltaic panels collect more energy if

they are installed on a tracker that follows the movement of the sun; however, it is an expensive process. For this reason they usually have a fixed position with an angle called tilt angle (β). This angle varies according to seasonal variations.

1.1 Literature review

Photovoltaic systems represent a silent, safe, not pollutant and renewable source of electrical energy [4]. Harnessing solar energy to power electrical appliances starts by converting the energy from the sun to electricity. Photovoltaic (PV) is the direct conversion of solar energy into electricity. PV systems can be used to exploit the solar energy in almost all applications. With fossil fuel resources expected to be depleted this century, PV Power systems provide a means of providing electricity to the developing world without concern for fuel supply security [4]. Today, more than 1.4 billion people all over the world lack access to electricity. About 42% of the people are from Sub-Saharan African, with over 76 million in Nigeria and some 69 million in Ethiopia and most of the rest in developing Asia [5]. Furthermore, 85% of these people live in rural areas. To improve access to electricity in the rural areas in Libya, a decentralized off-grid extension is considered in form of solar PV. An Off-grid PV systems are systems which use photovoltaic technology only and are not connected to a utility

grid. The systems use the DC output of the PV modules to power DC loads, while a bank of battery is used to store energy for use when there is demand. The DC output of the batteries can be used immediately to run certain low DC Voltage loads such as lighting bulbs or refrigerators or it can be converted by an inverter to AC voltage to run AC-loads that constitutes most appliances. Stand-alone PV system provides affordable electricity in area where conventional electricity grids are unreliable or non-existing [6]. In addition, there are also other applications to assess PV in cathodic protection (CP) has been made by Saleh et al. [7]. In such cases, the cathodic protection (CP) stations are usually far away from electric grid. CP station may be located more than 2Km from 11KV transmission line. The total PV system in this field was around 300 systems by the end of 2005, with total installed PV systems of 540 kW_p. The second study conducted in 2006 by Saleh et al. on PV systems was on rural electrification source to electrify rural areas consisting of electrifying scattered houses, and water pumping, which was done in several sites in Libya, some of these villages are: MrairGabis village, Swaihat village, etc. The installation of photovoltaic systems started in the middle of 2003. The total number of systems installed by General Electricity Company of Libya (GECOL) was 340 with total capacity of 220 kW_p. A review of PV technology was carried out by Jadi et al. [6] in which a survey on photovoltaic systems, its installation and applications in Libya between 1976 and 2005 were presented. The review provides a comprehensive analysis of experience on rural electrifications, social impacts, and future prospects of photovoltaic in Libya. PV system was first put into use in 1976 to supply electricity for a cathodic protection (CP) station. Since then; the use of photovoltaic systems is widely used in size and applications such as (rural electrification, and water pumping) and a very high reliability was recorded. The total peak power installed in Libya was developed from less than 20 kW_p by the end of the 1970's to about 1.5 MW_p by the year 2005. The study concluded that here is a good potential of PV systems which can be used in different applications at very low running cost or even no cost at all most especially the solar energy based PVS. When compared with the diesel generators in terms of ease of operational technicalities and power delivery, the PVS is the preferred option.

Al-Shamani[8]presented thecomponents required for the design of a stand-alone photovoltaic system that will power all electric appliancesat a medium-energy-consumption residence in Hilla City. One of the initial studies on the applications of PV presented by Eljrushi, Zubia[7] had introduced a proposal and recommended the construction of a photovoltaic power plant (PVPP) near Sebha city, this is due to the fact that Libya has limited fossil fuel resources in

addition to an expected enormous increments in demand for electricity, GEC is planning to install a new PV plant of 476 MW at Jabal Al-Hasouna, north of Sabha, as a large-scale power plant for electricity generation. Technical analysts have shown that the construction of a PV plant introduced new technologies, created more jobs, reduced pollution and promoted even more investment in solar energy. On the basis of the rival plants' lifetime of 20 years, the PV plant was more economic, due mainly to requiring no fuel and having low operating and maintenance costs. It is obvious that it was the best option available to the country when considering future utilities.

1.2 Area of Study

Libya is an oil exporting country located in the middle of North Africa, with 6 million inhabitants distributed over an area of 1,750,000 Km². The daily average of solar radiation on a horizontal plane is (7.1 kWh/m²/day) in the coastal region, and 8.1 kWh/m²/day in the southern region, with average sun duration of more than 3500 hours per year. The national electric grid consists of a high voltage network of about 12,000km, a medium voltage network of about 12,500 km and 7,000 km of low voltage network. The installed capacity is 5600 MW with a peak Load of 3650 MW, for the year 2004 [9]. Despite; there are many villages and remote areas located far away from these net- works. Economically these areas cannot be connected to the grid, owing to its small population, and small amount of energy required. In the past these facts dictate the use of diesel generators as a power supply. For these reasons we are pushed to look into some other sources like renewable energy.

1.3 Problem statement

Sabha floats on sea of water and in some areas we can obtain the water at low depth. For this reason we plan to build a greenhouse in Sabha city in order to get benefit from the advantage of the water to cool these greenhouses and can be using for Irrigation as well. Sabha located in an area rich by solar and wind energy resources; so, we can get the benefit from these resources to produce electricity at these remote areas.

1.4 Objectives of the study

The main objectives of this study can explain as follows:

1. Aiming to design a power system that will produce electricity for greenhouse in the country, such as greenhouses in Sabha as a part of solving the problem of electricity in different desert regions of the country.
2. To determine the optimal configuration of power sources relevant to greenhouse.
3. To sizing each components used in the stand-alone system based on Watt-hour demand.

- To design of a stand-alone photovoltaic system that will power all electric appliances at a medium energy consumption greenhouse in Sabha city.

2. Material and Method

The electrical greenhouse (loads) available at the proposed greenhouse in Sabha city were first itemized with their power ratings and time of operation during the day to obtain the total energy demand in Watt-hour per day. The total energy demand obtained was then used to determine the proposed stand-alone photovoltaic system components sizes.

2.1 Basic design elements of greenhouse in Sabha city

The greenhouse is assumed to be located in Sabha Libya with optimum tilt angle is 30°. Photo of the 39 m x 9.0 m with an area 351m² with its long dimension or ridge a long a north-south line. The greenhouse constructed of metal framing and fiberglass covering while the fan and pad evaporative cooling system was used for cooling. Ventilation was achieved by two exhaust fans located on the south-end of the greenhouse, and incoming air was forced through 12 m² (2m*6m) of 10 cm thick cooling pads set on the north end of the greenhouse. The rated ventilation rate for each of the two fans was 36000m³/hr. The geographical location of the Sabha city makes it one of the relatively sun-rich regions in the globe. It is located in southern region of Libya; it has a geographic coordinate that reads 27°01' North latitude and 14°26' E East longitude with an annual average incident solar irradiance of about 5.49kWh/m²/day. The available global horizontal radiation on the North Western Africa is shown in Fig.1[10].

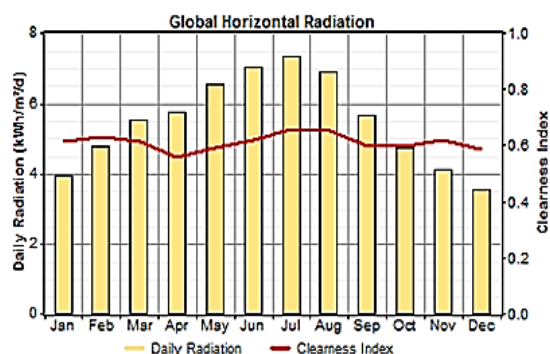


Fig.1 Insolation Map of North Africa[10]

2.2 Determining the power consumption demands

The first step in designing a solar PV system is to find out the total power and energy consumption of all loads that need to be supplied by the solar PV system by adding the Watt-hours needed for all appliances together to get the total Watt-hours per day which must be delivered to the appliances [11].

2.3 Sizing the PV solar array

To calculate the array size needed to meet our predicted energy consumption, divide the daily kWh consumption by the average daily peak sun-hours to get the approximate array size in Kw. That value is then divided by the system's efficiency factor:

$$\text{Peak Power} = \frac{\text{Daily energy consumption}}{\text{Peak sun hours}} \quad (1)$$

$$P_{PV \text{ array required}} = \frac{\text{Average daily energy required}}{\text{Overall efficiency factor}} \quad (2)$$

The total DC current (I_{dc}) needed can be calculated by dividing the peak power by the DC- voltage of the system [12].

$$I_{dc} = \frac{\text{Peak power}}{\text{System DC voltage}} = \frac{P_p}{V_{dc}} \quad (3)$$

Modules must be connected in series and parallel according to the need to meet the desired voltage and current in accordance with:

- First the number of series modules which equals the DC voltage of the system divided by the rated voltage of each module V_r [13].

$$N_s = \frac{\text{System DC voltage}}{\text{Module rated voltage}} = \frac{V_{DC}}{V_r} \quad (4)$$

- Second, the number of parallel modules which equals the whole modules current divided by the rated current of one module I_r [13].

$$N_p = \frac{\text{Whole module current}}{\text{Rated current of one module}} = \frac{I_{DC}}{I_r} \quad (5)$$

Or we can calculate the N_p by using equation (6) [14].

$$N_p = \frac{P_{pv \text{ array}}}{N_{ms} * P_{\text{module}}} \quad (6)$$

- Finally, the total number of modules N_m equals the series modules multiplied by the parallel ones:

$$N_m = \text{No of series modules} \times \text{No of parallel modules} = N_s * N_p \quad (7)$$

2.4 Sizing of the Battery Bank

The battery type recommended for using in solar PV system is deep cycle battery. Deep cycle battery is specifically designed for to be discharged to low energy level and rapid recharged or cycle charged and discharged day after day for years. The battery should be large enough to store sufficient energy to operate the appliances at night and cloudy days [15]. The amount of rough energy storage

required is equal to the multiplication of the total power demand and the number of autonomy days [15]. The term days of autonomy means the number of days a battery bank can provide the appliances you have connected to the system without a recharged by the solar panels.

$$E_{\text{rough}} = \text{Energy storage required} * \text{No of autonomy days} = E * D \quad (8)$$

For safety, the result obtained is divided by the maximum allowable level of discharge (MDOD) [15]:

$$E_{\text{safe}} = \frac{\text{Energy storage required}}{\text{Max depth of discharge}} \\ = \frac{E_{\text{rough}}}{\text{MDOD}} \quad (9)$$

At this moment, we need to make a decision regarding the rated voltage of each battery (V_b) to be used in the battery bank. The capacity of the battery bank needed in ampere-hours can be evaluated by dividing the safe energy storage required by the DC voltage of one of the batteries selected [15]:

$$C = \frac{\text{Safe energy storage required}}{\text{Battery voltage}} \\ = \frac{E_{\text{safe}}}{V_b} \quad (10)$$

According to the number obtained for the capacity of the battery bank, another decision has to be made regarding the capacity (C_b) of each of the batteries of that bank. The battery bank is composed of batteries that are connected in series and in parallel according to the selected battery voltage rating and the system requirements. The total number of batteries is obtained by dividing the capacity (C) of the battery bank in ampere-hours by the capacity of one of the battery (C_b) selected in ampere-hours [11]:

$$N_{\text{batteries}} = \frac{\text{Capacity of the battery bank}}{\text{Capacity of one battery}} \\ = \frac{C}{C_b} \quad (11)$$

The connection of the battery bank can be then easily figured out. The number of batteries in series (N_s) equals the DC voltage of the system divided by the voltage rating of one of the batteries selected [11]:

$$N_s = \frac{\text{The system DC voltage}}{\text{Battery voltage}} \\ = \frac{V_{\text{DC}}}{V_b} \quad (12)$$

Then number of parallel paths (N_p) is obtained by dividing the total number of batteries by the number of batteries connected in series [11]:

$$N_p = \frac{\text{The total number of batteries}}{\text{Number of batteries in series}} \\ = \frac{N_{\text{batteries}}}{N_s} \quad (13)$$

2.5 Sizing the voltage regulator

According to its function on controls the flow of current. A good voltage regulator must be able to withstand the maximum current produced by the array as well as the maximum load current. Sizing of the voltage regulator can be obtained by multiplying the short circuit current of the modules connected in parallel by a safety factor (F_{safe}). The result gives the rated current of the voltage regulator (I) [15]:

$$I = N_p * I_{\text{sc}} * F_{\text{safe}} \quad (14)$$

The factor of safety is employed to make sure that the regulator handles maximum current produced by the array that could exceed the tabulated value. And to handle a load current more than that planned due to addition of equipment, for instance. In other words, this safety factor allows the system to expand slightly.

2.6 Sizing the inverter

An inverter is used in the system where AC power output is needed. The input rating of the inverter should never be lower than the total watt of appliances. The inverter must have the same nominal voltage as your battery. For stand-alone systems, the inverter must be large enough to handle the total amount of Watts that will be using at one time. The inverter size should be 25-30% bigger than total Watts of appliances [15]. In case of appliance type is motor or compressor then inverter size should be minimum 3 times the capacity of those appliances and must be added to the inverter capacity to handle surge current during starting.

2.7 Demand loads

Table 1 presents the AC loads used by the proposed greenhouse with their power ratings and time of operation during the day to obtain the average energy demand in Watt-hour per day as follows:

Table 1 Greenhouse Loads and Daily Energy

Appliance	K ₁	K ₂	K ₃ =(K ₁ *K ₂)	K ₄	K ₅ =(K ₃ *K ₄)
	Rated Power (Watt)	Quantity	power (W)	Hours per day used	Energy per day
Fluorescent Lamps	15	10	150	10	1500
TV and Recorder	150	1	150	16	2400
Refrigerator	100	1	100	24	2400
Computer with accessories	125	1	125	10	1250
Heater	2500	1	2500	8	20000
Circulation Pump (0.75Hp)	59	1	59	16	944
Air Fans (1.5Hp)	1000	2	2000	16	32000
Water pump	350	1	350	4	1400
Total energy demand per day (sum of K5)					61,894kwh/day
Maximum AC power requirement (sum of K3)					5434W
Total summer					2934W
Total winter					5334

3. Consumption

Case Study: Build a Greenhouse in Sabha-City

3.1 Sizing the PV array

For sizing the PV array we have to find the following factors: the total daily energy required in Watt-hours (E) which is equal to 61,894KWh/day from table 1, the minimum peak sun-hour per day $T_{min}=5.5$, and the dc-voltage of the system $V_{DC}=24v$. Once these factors are available we move to the sizing process starting from Eq (1-7). To avoid under sizing, losses must be considered by dividing the total power demand in (Wh/day) by the product of efficiencies of all components in the system to get the required energy. To calculate the array size needed to meet our predicted energy consumption, divide the daily kWh consumption by the average daily peak sun-hours to get the approximate array size in (kW). That value is then divided by the system's efficiency factor:

$$\text{Peak Power} = \frac{\text{Daily energy consumption}}{\text{Peak sun hours}} = \frac{61,894}{5.5} = 11.253\text{KW}$$

To calculate the power needed from the PV array we have to divide the average daily power consumption by the overall system efficiency factor as follows: The efficiency factor can be obtained based on the following assumptions: average solar access of 95% (shading derate factor); inverter efficiency of 96%; module temperature derate factor of 0.88; DC and

AC wiring derate of 0.98 and 0.99; module soiling derate = 0.95; module mismatch derate = 0.98; system availability derate = 0.99.

Overall system efficiency factor = $0.95 * 0.96 * 0.88 * 0.98 * 0.99 * 0.95 * 0.98 * 0.99 = 0.72$

Then,

$$P_{PV \text{ array}} = \frac{\text{Average daily energy required}}{\text{Overall efficiency factor}} = \frac{11.253\text{KWh}}{0.72} = 15.629 \text{ KW}$$

The total current needed for a DC- voltage of 24 is:

$$I = \frac{P_p}{\text{system DC voltage}} = \frac{15629}{48} = 326\text{A}$$

According to the selected panel Mitsubishi PV-MF180UD4 poly-crystalline 180W, 24V, 7.45A, the number of panels connected in series are:

$$N_s = \frac{\text{system DC voltage}}{\text{module rated voltage}} = \frac{48}{24} = 2 \text{ module}$$

The numbers of panel connected in parallel are:

$$N_p = \frac{P_{array}}{N_s * P_{module}} = \frac{15269}{2 * 180} = 42.4 \cong 43 \text{ modules}$$

So, the number of panels needed is:

$$2 * 43 = 86 \text{ modules}$$

With total cost:

$$\text{Total cost} = 86 * 120\$ = 10320\$.$$

3.2 Sizing of battery bank

The minimum number of days of autonomy that should be considered is taking as 3.5 days and the maximum allowable depth of discharge is taken as 75%. Batteries used in all solar systems are sized in ampere hours under standard test condition of 25°C. Battery manufacturers usually specify the maximum allowable depth of discharge for their batteries. The depth of the discharge is a measure of how much of the total battery capacity has been consumed. The amount of energy storage required is:

$$E_{\text{rough}} = \text{total energy demand} \\ \times \text{number of days of autonomy} \\ = 15.629\text{KWh} \times 3.5 = 54.702\text{KWh}$$

$$E_{\text{safe}} = \frac{\text{Energy storage required}}{\text{Max depth of discharge}} = \frac{E_{\text{rough}}}{\text{MDOD}} = \frac{54702}{0.75} \\ = 72.936\text{KWh}$$

The capacity of the battery bank in ampere-hours required assuming we select a battery voltage of 12 V is:

$$C = \frac{72936}{12} = 6078\text{Ah}$$

According to the selected battery type (Rolls series 4000 batteries, 12MD410P) as shown in Fig.2 and the price of each one is \$165).



Voltage: 12V
Capacity (c20): 410 Ah
Dimensions: 310H x 337W x 552L (mm)
Weight: 105kg.

Fig. 2 Rolls 12EHG375P Series 4000

The number of batteries needed is:

$$N_{\text{batteries}} = 6078/410 \cong 16 \text{ batteries.}$$

With DC-voltage of 48 V, the number of batteries in series is:

$$N_{\text{sbatteries}} = V_{\text{System}}/V_{\text{battery}} = 48/12 = 4 \text{ batteries.}$$

$$N_{\text{parallel branch}} = N_{\text{batteries}}/N_{\text{series}} = 16/4 = 4 \text{ batteries.}$$

So, With DC-voltage of 48 V, four parallel branches are established according to the equation $N_p = 4$ each branch contains 4 series batteries. The storage batteries price amounts to \$2640.

3.3 Sizing of the Voltage Regulator

The voltage regulator as shown in Fig.3 is typically rated against amperage and voltage capacities. The voltage regulator is selected to match the voltage of

PV array and batteries. A good voltage regulator must have enough capacity to handle the current from PV array.



Fig.3 Xantrex C Series - C35, C40 & C60 Charge Controllers

In our design, the safety factor F_{safety} is taken to be=1.25 and the short circuit current for the selected module is $I_{\text{sc}}=8.03\text{A}$. The rated current (I) of the regulator is given by:

$$I = N_{\text{mp}} * I_{\text{sc}} * F_{\text{safe}} = 4 * 8.03 * 1.25 = 41\text{A}$$

Based on the selected regulator type (Xantrex C-60, 24-V, 60-A, and a price of \$140) [33]. The number of regulators required is:

$$N_{\text{reg}} = 41/60 = 0.68 \cong 1 \text{ voltage regulator.}$$

In this case we need eight regulators connected in parallel with a total cost

$$\text{Total cost} = 1 * \$140 = \$140.$$

3.4 Sizing of the Inverter

In sizing the inverter, the actual power drawn from the appliances that will run at the same time must be determined as first step. Secondly, we must consider the starting current of large motors by multiplying their power by a factor of 3. Also to allow the system to expand, we multiply the sum of the two previous values by 1.25 as a safety factor [11].

The power of appliances running simultaneously:

$$P_{\text{rs}} = (10*15+150+100+59+125) = 584\text{W}$$

And the appliances with large surge currents that include motors are:

$$P_{\text{Lsc}} = [2500+2000 +350] * 3 = 14550\text{W}$$

The input rating of the inverter should never be lower than the total watt of the appliance.

$$P_{\text{tot}} = (584 + 14550) * 1.25 = 18.918\text{kW} \\ = 18.92\text{KVA.}$$

The inverter to be used for this system should be able to handle about 18.92KVA and nominal voltage of 48VDC, and the list price for this inverter is 2200\$ [35].

3.5 Sizing of the system wiring

By selecting the perfect size and type of wire this will improve the performance of the system and reliability as well. The DC wires linking between the PV modules and the batteries through the voltage regulator must be handle the maximum current produced from these modules.

Calculating of cable size for PV modules through the batteries voltage regulators

The max current can be calculated as following:

$$I_{max} = N_p * I_{sc} * F_{safe} = 4 * 8.03 * 1.25 = 41A$$

The cross sectional area of the cable is given by the equation [14]:

$$A = \frac{\text{resistivity of copper wire} \times \text{length of the cable}}{\text{maximum voltage drop}} * 2$$

Where,

The resistivity of copper wire ρ is taken as $1.724 \times 10^{-8} \Omega m$ according to American wire gauge (AWG) and the cable length assumed to be 1m. The maximum voltage drop for the Dc wiring is taken not to exceed the 4% [14]. And can be calculated by the following formula:

$$V_d = \frac{4}{100} * 24 = 0.96V$$

$$A = \frac{1.724 * 10^{-8} * 1 * 41}{0.96} * 2 = 1.47mm^2$$

This means any copper cable of cross sectional area $1.47mm^2$, 41A and resistivity $1.724 * 10^{-8} \Omega m$ can be used for the wiring between PV modules and batteries through the voltage regulator.

Calculating of cable size between the battery bank and the inverter

In case of calculating the size of the AC- wire from the inverter to the electric panel of the greenhouse we have to make sure that it will withstand the maximum current produced by the inverter output. The current is given by the following formula for a rated AC voltage of 220Vac at power factor of 80% [17].

$$I_{max} = \frac{\text{inverter power}}{\eta_{inverter} \times V_{system}} = \frac{18.92KVA}{48 * 0.9} = 438A$$

The maximum voltage drop (V_d) for the AC wiring is taken not to exceed the 4%:

$$(V_d) = \frac{4}{100} * 48 = 1.92V$$

By assuming the cable length $L=5m$ we can determine the cable size as follows:

$$A = \frac{1.724 * 10^{-8} * 5 * 438}{1.92} * 2 = 39.33mm^2$$

This means any copper cable of cross sectional area $39.33mm^2$, 438A and resistivity $1.724 * 10^{-8} \Omega m$ can be used for the wiring between the battery bank and the inverter.

Calculating of cable size between the inverter and the load

Let the maximum length of cable $L_{cable}=20m$. The maximum current from inverter at full load on the phase (line) is given by [14]:

$$I_{Phase} = \frac{\text{inverter KVA}}{V_{output} * \sqrt{3}} = \frac{18920}{220 * \sqrt{3}} = 50A,$$

and the maximum voltage drop $V_d = \frac{4}{100} * 220 = 8.8V$

$$A = \frac{1.724 * 10^{-8} * 20 * 50}{8.8} * 2 = 4mm^2$$

This means any copper cable of cross sectional area $4mm^2$, 50A and resistivity $1.724 * 10^{-8} \Omega m$ can be used for the wiring between the inverter and the load. The whole system wiring configuration simulated as shown in Fig.4 for the designed proposed system.

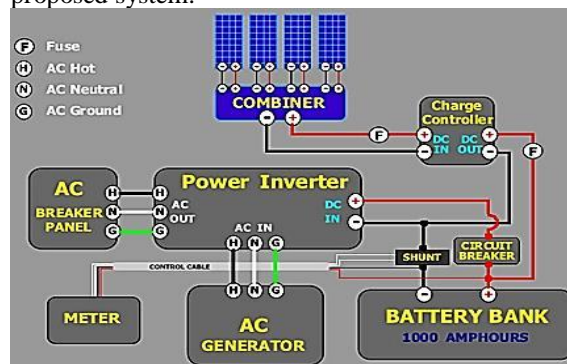


Fig.4 Wire configuration

4. Summary to the system components

The results obtained from the sizing of the proposed stand-alone system can be summarized as shown in Table 2.

Table 2. Summary to the system components

Component	Description of the component	Result
Load estimation	Total load estimated	61,894kwh/day
	Capacity of PV array	15.629kW
	Number of modules in series	2
PV array	Number of modules in parallels	43
	Total number of modules	86
	Battery bank capacity	6078Ah

Voltage regulator	Number of batteries in series	4	Inverter	Capacity of the inverter	18.9KVA
	Number of batteries in parallel	4		Wires	Between the PV modules and the batteries through voltage regulators
	Total number of batteries required	16	Between the battery bank and inverter		39.33mm ² , 438A
	Capacity of voltage regulator	41A	Between the inverter and the load		4mm ² , 50A
	Number of voltage regulators required	1			

The equipment's used to build up the stand-alone photovoltaic system for the suggested greenhouse described above are summarized with some details and specifications in Table

Table 3 Summarized of the equipment's used

Component	Type	Component Rating			Size	Unit price US\$	Weight	Warranty Year
		W/Ah	A	V				
PV panel	Mitsubishi MF180 UD4 poly-crystalline Rolls	180W	7.45	24	1658 *834 * 46mm	120	17kg	25
Batteries	12EHG375P Series 4000	410Ah	-	12	310H *337W* 552L (mm)	165	105kg	1
Regulator	Xantrex C Series - C60	-	60	24	25.4 cm *12.7 cm * 6.35 cm	140	1.4kg	2
Inverter	Pan power SSI20KVA	20KW	-	48/220/380	670*330*695mm	2200	39kg	3

Cost estimated of the designed system

The cost estimate of the system's components is summarized in Table 4 and has been calculated as follows:

Cost per Component = Quantity * Unit price
From Table 4 other Balance of System Component (BOS) can be calculated as follows:

$$\text{BOS Cost} = 20\% \text{ of total price} = 20\% * 15300 = 3060\$$$

The operating costs for solar PV installations are negligible, but the annual maintenance cost may amount to 0.5% to 1% of the capital cost of the system.

$$\text{Maintenance cost of the PV system} = 0.5\% * 18454\$ = 93\$ \approx 100\$$$

Table 4. Cost Estimate of the System's Components

Component	Type	Quantity	Unit price \$	Cost per component (\$)
PV panel	Mitsubishi MF180 UD4 poly-crystalline	86	120	10320
Batteries	UB-8D Absorb Glass Mat (AGM)	16	165	2640
Regulator	Xantrex C Series - C60	1	140	140
Inverter	Panpower SSI20KVA	1	2200	2200
	Total price			15300
	Other BOS costs such as (Wires, fuses, circuit breakers, etc.)			3060
	PV system Maintenance cost			100
	Overall cost			18460\$

Estimated Cost of the Fuel (Diesel) Generator used by Greenhouse in Sabah City

The greenhouse has a 4KW diesel generator used to charge the batteries when no sun is available. The hours used estimated to be equal to 5 hours.

- The total estimated hours used per annum = $5 * 365 = 1825$ hours
-
- The total estimated fuel (diesel) consumptions per hour = 3 liters per hour
- The total estimated fuel (diesel) consumptions per annum = $3 * 1825 = 5475$ liters
- Cost of diesel with transportation = 0.5\$
- The total estimated cost of fuel (diesel) used per annum = 0.5 * 5475 = 2738$$
- The total estimated cost of maintenance per annum = 200\$
- The total running cost per annum = $2738 + 200 = 2938$$
- Cost of purchase of generator = 800\$.

So, the total estimated cost of the diesel and the generator for the first year is

$$= 2938 + 800 = 3738 \$$$

Payback period calculation

The payback calculation is calculated using the following equation:

$$\begin{aligned} & \text{Payback energy period} \\ &= \frac{\text{overall cost of the PV system}}{\text{Total estimated cost of the diesel generator for the first year}} \\ &= \frac{18894}{3738} = 5 \text{ years} \end{aligned}$$

5. Discussions

The daily electrical energy demand (load) for a greenhouse in Sabha city was estimated based on the watt-hour rating of the appliances considered. The results of the estimated daily energy demand are shown in Table 1. The estimated load is 61,894kWh/ day. The proposed stand-alone PV system was designed based on the estimated load. The results as shown in Table 2 show that greenhouse requires 86 panels type Mitsubishi MF180 UD4 Poly-crystalline, 180W, 24V to produce a PV array capable of generating 15.6kW of electrical energy for the greenhouse. The parallel and series configurations of the resulted PV array are 43 modules and 2 modules to produce the required current and voltage respectively (Table 2). For storage of energy for use when there is demand, the greenhouse requires 16 of Rolls 12EHG375P Series 4000 batteries of battery bank capacity 6078Ah which comprises 4 batteries in parallel and 4 batteries in series. To safely charge the batteries and to maintain longer lifetime for them, the greenhouse requires a voltage regulators of capacity 41A. The capacity of the inverter required by the proposed system to convert its DC current to AC current is 18.9kVA. The resistivity of the copper wire selected for this design is $1.724 \times 10^{-8} \Omega \cdot \text{m}$. The DC wires between the PV modules

and batteries through the voltage regulators must withstand the maximum current produced by these modules. This current is 41A, and the optimum wire type for this current is any copper wire of cross sectional area 1.47mm^2 . The DC wire between the batteries and the inverter must withstand the maximum current from battery at full load supply. This current is 438A, and any copper wire of cross sectional area 39.33mm^2 can be used. The AC wire from the inverter to the load must withstand the maximum current produced by the inverter. This current is 50 A, and the optimum wire type for this current is any copper wire of cross sectional area 4mm^2 . It can be observed from Table 4 that the modules, the batteries and the inverter are the most costly components of an off grid photovoltaic system. Increasing the size of these components will increase the overall cost of the system. A cost estimate of the system provides the payback period of the system is estimated to be 5 years.

6. Conclusion

In this study, the electrical energy demand (load) of greenhouse at Sabha city in Libya was estimated. The estimated load is 61,894kWh/ day. System sizing and specifications were provided based on the estimated load. There results show that a 15.6kW PV array capacity of 86 modules, 16 (12V, 375Ah) batteries, 18.9KVA, 48V inverter and 60A, 24V voltage regulator are needed to supply the electrical load of the greenhouse. The proposed off grid PV system requires copper wires of cross-sectional area 1.47mm^2 , 39.33mm^2 and 4mm^2 for its installation. The cost of the system estimated is relatively high but when we compared to the lifespan of the selected PV modules which is 25 years it would be satisfied. The recommendation would be that the system can be made utility-interactive to enable the purchase of surplus solar energy from users. The most important conclusion is the cost of running these generators can be quite expensive when factoring in fuel availability and transportation costs. It is currently not economically feasible to extend the grid to such locations. The power must be generated locally. The purpose of this work was to analyze the feasibility of PV power generation for such a remote setting. It is shown that the PV generation system can be competitive compared to current diesel powered installations.

7. References

- [1] Messenger R, Abtahi A. Photovoltaic systems engineering: CRC press; 2010.
- [2] Markvart T. Solar electricity: John Wiley & Sons; 2000.
- [3] Patel MR. Wind and solar power systems: design, analysis, and operation: CRC press; 2005.

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- [4] Bockris JOM, Reddy AK. Modern Electrochemistry 2B: Electrode in Chemistry, Engineering, Biology and Environmental Science: Springer Science & Business Media; 2001.
- [5] Ishaq M, Ibrahim U, Abubakar H. Design Of An Off Grid Photovoltaic System: A Case Study Of Government Technical College, Wudil, Kano State. International Journal of Technology Enhancements and Emerging Engineering Research. 2013;2:175-81.
- [6] Al-Jadi ISI, EKhlal M, Krema N. PHOTOVOLTAIC IN LIBYA APPLICATIONS, AND EVALUATION. The International Conference on Renewable Energy for Developing Countries-20 Available: [http://www.udcedu/docs/cere/PHOTOVOLTAIC% 20IN% 20LIBYA pdf](http://www.udcedu/docs/cere/PHOTOVOLTAIC%20IN%20LIBYA.pdf).
- [7] Eljrushi GS, Zubia J. Photovoltaic power plant for the southern region of Libya. Applied energy. 1995;52:219-27.
- [8] Al-Shamani AN, Othman MYH, Mat S, Ruslan M, Abed AM, Sopian K. Design & Sizing of Stand-alone Solar Power Systems A house Iraq. 2015.
- [9] Saleh IM. Prospects of renewable energy in Libya. Solar Physics and Solar Eclipses (SPSE 2006)2006. p. 153-61.
- [10] Nizam M, Anwar M, Salema AA, Baieka MM, Esmαιο AE, Atia HM. Optimization of surface orientation angles to receive maximum solar radiation at Sabha city, Libya. Proceedings of the Joint International Conference on Electric Vehicular Technology and Industrial, Mechanical, Electrical and Chemical Engineering (ICEVT & IMECE): IEEE; 2015. p. 206-11.
- [11] Almansuri A, Dowdle D, Curwell S. The Effects of Passive Design and Renewable Energy in Producing Low Energy Efficiency Architecture and Special Identity–(Case Study Libyan Desert Zone–Ghadames).
- [12] www.solarexpert.com.
- [13] Strong SJ, Scheller WG. The Solar Electric House: Energy for the Environmentally Responsive. Energy-Independent Home Sustainability Press, Massachusetts. 1993.
- [14] Almansuri A, Dowdle D, Curwell S. The Effects of Passive Design and Renewable Energy in Producing Low Energy Efficiency Architecture and Special Identity–(Case Study Libyan Desert Zone–Ghadames). 2015.
- [15] Abu-Jasser A. A stand-alone photovoltaic system, case study: a residence in Gaza. Journal of Applied Sciences in Environmental Sanitation. 2010;5:81-91.

B 003

The Effect of Gas Flowrate on CO₂ Absorption through Super Hydrophobic Hollow Fiber Membrane Contactors

Sutrasno Kartohardjono^{1*}, Kevin Stevanus Sembiring¹ and Juan¹

¹Department of Chemical Engineering, Faculty of Engineering, Universitas Indonesia, Kampus Baru UI, Depok 16424, Indonesia.

* Corresponding authors: [sutrasno@che.ui.ac.id]

Abstract This study aims to see the effect of gas flow rate on CO₂ absorption through super hydrophobic hollow fiber membrane contactors using water and diethanolamine (DEA) %% solution as absorbents. The absorption process of carbon dioxide from the gas stream can be applied to reduce emissions of carbon dioxide into the atmosphere and to increase the calorific value of natural gas. During the experiment, the CO₂ gas and the absorbent were sent into the shell side and the lumen side of the contactor, respectively. The gas flow rates as well as the number of fibers in the membrane contactor are the variables observed to see their effects on the overall mass transfer coefficient, the flux and the absorption efficiency in the membrane contactor. The experimental results for the overall mass transfer coefficient and the flux showed a different characteristic for both absorbents. The overall mass transfer coefficient and the flux for DEA solution increased with increasing gas flow rate and decreasing the number of fibers in the membrane contactor. Meanwhile, for water absorbent the overall mass transfer coefficient and the flux increased with increasing the gas flow rate and the number of fibers in the membrane contactor. The amount of CO₂ absorbed and absorption efficiency for both absorbents showed similar characteristic, which is increased with increasing the gas flow rate and the number of fibers in the contactors.

Keywords: Flux; hollow fiber; mass transfer coefficient; absorption efficiency.

1. Introduction

Today, the absorption of carbon dioxide gas can be done with various techniques. There are many techniques have been applied for the absorption of carbon dioxide gas such as the chemical and physical absorption, solid adsorption, carbon molecular sieve adsorption, cryogenic distillation, membrane separation. Among these methods, the most widely used method for separating carbon dioxide from a gas stream using a solvent alkanolamine is absorption through conventional contactors equipment such as packed or tray columns (Yan et al., 2007). However, this technology consumed high energy and subject to flooding, foaming and entrainment.

Hollow fiber membrane contactor (HFMC) is a promising alternative. The absorption of carbon dioxide gas occurs at the membrane contactor when the gas in contact with the liquid phase flowing in the opposite side of the membrane. Contacts between the two phases is separated by the membrane, so that the carbon dioxide gas that is absorbed passes through the membrane pores to the flow of the liquid phase. The modular form causing membrane contactors can easily scale-up and can effectively eliminate the problems that occur in conventional equipment (Li & Chen, 2005). On the other hand there is a shortage of membrane contactors i.e. additional mass transfer resistance in the membrane itself. Membrane also experience fouling, although this tends to occur on process in which pressure is the driving force. In

addition, the membrane has a limited life service so that the necessary costs for periodic replacement

should be taken into account (Gabelman & Hwang, 1999). Hollow fiber membrane contactor has attracted many researcher in the recent years and can be applied in many processes such as in ammonia removal from wastewater (S. Kartohardjono, M. I. Fermi, et al., 2015), (S. Kartohardjono, G. M. Damaiati, & Rama, 2015) and CO₂ absorption (S. Kartohardjono, R. Darmawan, M. F. Karyadi, & Saksono, 2016) processes.

The addition of the mass transfer resistance depends on the membrane material, absorbent solution, and the pressure between the two phases. The gas absorption through the membrane system needs to avoid increasing the mass transfer resistance due to the membrane being filled with a liquid absorbent. Good absorption will occur if the membrane is filled by the gas during absorption. Prevention of liquid absorbent entering the membrane pore is done by remarking the interaction between membrane material used and the liquid absorbent. In the case of absorption of carbon dioxide gas, non-wetted mode is desirable to maximize the efficiency of the absorption process. If the membrane pore wetted by liquid, the membrane resistance will increase, resulting in a small flux (R. Wang, Zhang, Feron, & Liang, 2005). Membrane wetting usually occurs on micro porous hydrophobic membrane materials (Lv, Yu, Tu, Yan, & Dahlquist, 2010). This research utilizes super hydrophobic

hollow fiber membrane contactor to absorb CO₂ using water and diethanolamine (DEA) solution as absorbents. It is expected that with this properties, a highly resistant membranes to not wetted by liquid absorbent. The objective is to see the effects of gas flow rates and the number of fibers in the membrane contactor on the mass transfer performance.

2. Material and Methods

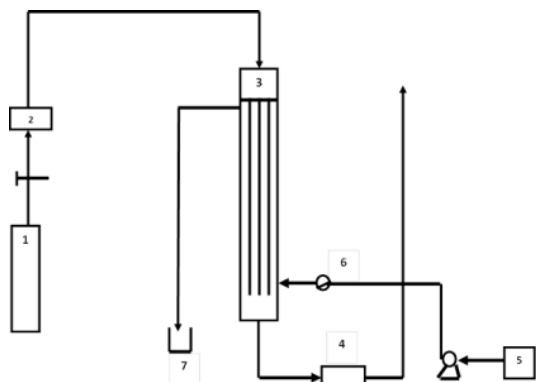


Figure 1 Schematic diagram of experimental set up: 1. Feed gas, 2. Mass flow meter, 3. Super hydrophobic hollow fiber membrane contactor, 4. Mass flow meter, 5. Absorbent reservoir, 6. Flow meter, 7. Absorbent reservoir

Schematic diagram of experimental set up for CO₂ absorption through the membrane contactor has been presented elsewhere (S. Kartohardjono et al., 2016) and is shown in Fig. 1. Super hydrophobic hollow fiber membrane contactors used in this study were provided by PT GDP Filter Bandung Indonesia. The hollow fiber membrane used is polypropylene-based with outer and inner diameter of about 525 and 235 μm, respectively. The contactors used were 7.6 and 25 cm in diameter and length, respectively, which consist of 2000, 4000 and 6000 fibers. Meanwhile, the CO₂ gas (99%) and DEA were purchased from BOC Gases and Merck, respectively. During the experiment the absorbents, water or DEA solution (5% vol in water) flowed through the lumen side of the membrane fiber, while CO₂ gas flowed through the shell side of the membrane contactor. The liquid flow rate in the contactor was kept constant at 300 CC/sec. The absorbents flow rate was measured using liquid flow meter Krohne, whilst inlet and outlet gas flow rate was measured using mass flow meter Sierra Top Trak Instruments. The overall mass transfer coefficient, K_{OVL} , Flux, J , and Absorption efficiency, % R , from the experiment are calculated by Eq. 1 (D. Wang, Teo, & Li, 2004), Eq. 2 and Eq. 3 (S. Kartohardjono et al., 2016), respectively.

$$K_{OVL} = (Q_{Gin}/A_m) \ln(C_{in}/C_{out}) \quad (1)$$

$$J = (Q_{Gin} - Q_{Gout})RT/A_m \quad (2)$$

$$\%R = 100(Q_{Gin} - Q_{Gout})/Q_{Gin} \quad (3)$$

Q_{Gin} , Q_{Gout} , A_m , C_{in} and C_{out} are inlet and outlet gas flow rate, membrane area and inlet and outlet CO₂ concentration, respectively. Meanwhile, R and T are gas constant and temperature, respectively.

3. Results and Conclusions

Figure 2 shows the effect of the gas flow rate on the amount of CO₂ absorbed at various numbers of fibers in the membrane contactors for water and solution of DEA 5%. Figure 2 shows the similar effects for both absorbents where the amount of CO₂ absorbed increase with increasing gas the flow rate and the number of fibers in the contactor. The surface area and the gas flow rate has a great influence on the amount of CO₂ absorbed for the solution of DEA 5% especially at high gas flow rate. However, for water absorbent, the effects of the gas flow rate was inferior compare to the effects of the number of fibers in the contactor reflected that the surface area has a greater influence than the flow rate of gas.

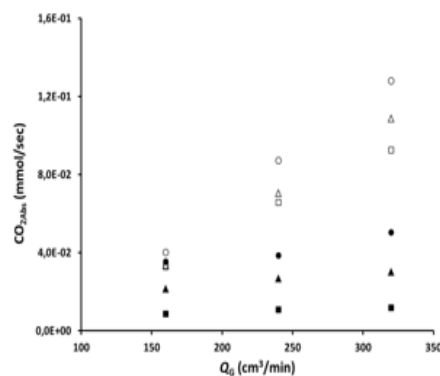


Figure 2 The effects of the gas flow rate, Q_{Gin} , on the amount of CO₂ absorbed at various numbers of fibers in the membrane contactors for water and solution of DEA 5%

Fig. 3 shows the effects of the gas flow rate and the number of fibers in the contactor on the overall mass transfer coefficients for water and solution of DEA 5%. Fig. 3 shows that for both absorbents the overall mass transfer coefficients increase with increasing the inlet gas flow rate. However, Fig. 3 shows the different effect on the number of fibers in the contactor for water and solution of DEA 5%, of which for the water the overall mass transfer coefficient increases with increasing the number of fibers in the contactor, whilst for DEA 5% solution the overall mass transfer coefficient decreases with increasing the number of fibers in the contactor. Based on Eq. 1, there are

three variables affecting the overall mass transfer coefficient namely the gas inlet flow rate, Q_{Gin} , the membrane surface area, A_m , and the logarithmic of ratio concentration, $\ln(C_{in}/C_{out})$. The overall mass transfer coefficient increases with increasing the gas flow rate and decreasing the number of fibers in the contactor as shown by the solution of DEA 5% but not with water. The increase in the number of fiber in the contactor will increase the membrane surface area and will enhance the amount of CO₂ absorbed as shown in Fig. 2, which lead to the increasing the overall mass transfer coefficient.

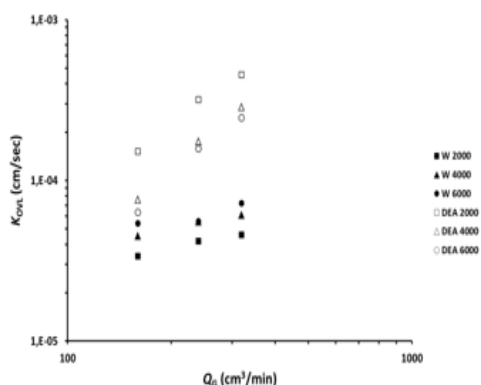


Figure 3 The effects of the gas flow rate, Q_{Gin} , on the overall mass transfer coefficient, K_{OVL} , at various numbers of fibers in the membrane contactors for water and solution of DEA 5%

On the other hand, the increase in the number of fiber in the contactor will decrease the flow rate of species in the lumen fiber where in this study water or solution of DEA 5%, which leads to the decrease in the overall mass transfer coefficient. Therefore, for the solution of DEA 5%, the effect solvent flow rate more dominant than the effect of the surface area, this leads to the decrease in the overall mass transfer coefficient as the number of fiber in the contactor increases. This is due to solution of DEA 5% is a good absorbent for CO₂ so that the decrease in flow rate can reduce the amount of CO₂ absorbed significantly. Meanwhile, for water the effect of the surface area for enhancing the absorption process more dominant than the solvent flow rate in the lumen fiber so that the overall mass transfer coefficient increases with increasing the number of fibers in the contactor. This is due to water is a poor absorbent for CO₂ so that the increase in the membrane surface area can increase the amount of CO₂ absorbed significantly as shown in Fig. 2.

Fig. 4 shows the effect of the gas flow rate and the number of fibers in the contactor on the flux for water and solution of DEA 5%. As for the overall mass transfer coefficient, the fluxes for both absorbents increase with increasing the initial gas flow rate. However, the flux only slightly increases for water as water is a poor absorbent for CO₂.

Meanwhile, the increase in the number of fibers in the contactor will reduce the flux of solution of DEA 5% but will increase the flux of water. Again, this was due to the effect of an increase in the flow rate of the solvent is more dominant than the increase in the surface area for good absorbent and vice versa.

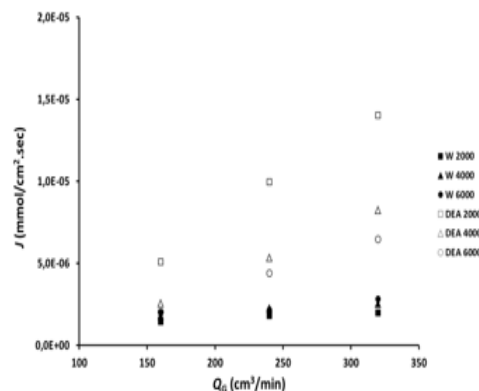


Figure 4 The effects of the gas flow rate, Q_{Gin} , on the flux, J , at various numbers of fibers in the membrane contactors for water and solution of DEA 5%

Fig. 5 shows the effect of the gas flow rate and the number of fibers in the contactor on the absorption efficiency for water and solution of DEA 5%. As expected, the increase in the flow rate and the amount of fibers in the contactor will increase the absorption efficiency due to an increase in the amount of CO₂ absorbed as shown in Fig. 2.

In conclusion, the increase in the gas flow rate will increase the amount of CO₂ absorbed, the overall mass transfer coefficient, the flux and the absorption efficiency for the both absorbents. The increase in the number of fibers in the membrane contactor will increase the amount of CO₂ absorbed and the absorption efficiency for the both absorbents. However, the increase in the number of fibers in the membrane contactor has different effects on the overall mass transfer coefficient and the flux for both absorbents. The increase in the number of fibers in the membrane contactor will decrease the overall mass transfer coefficient and the flux for the solution of DEA 5%, but will increase the overall mass transfer coefficient and the flux for water.

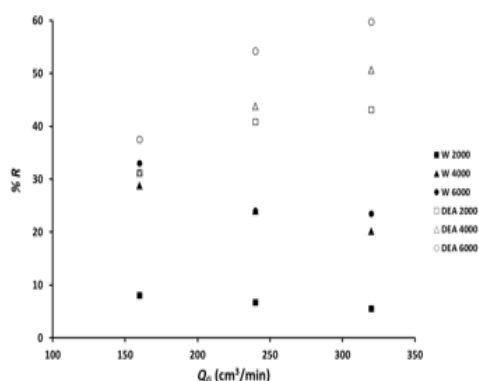


Figure 5 The effects of the gas flow rate, Q_{Gin} , on the absorption efficiency, %R, at various numbers of fibers in the membrane contactors for water and solution of DEA 5%

4. Acknowledgement

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5. References

- Gabelman, Alan, & Hwang, Sun-Tak. (1999). Hollow fiber membrane contactors. *Journal of Membrane Science*, 159(1), 61-106.
- Li, Jing-Liang, & Chen, Bing-Hung. (2005). Review of CO₂ absorption using chemical solvents in hollow fiber membrane contactors. *Separation and Purification Technology*, 41(2), 109-122.
- Lv, Yuexia, Yu, Xinhai, Tu, Shan-Tung, Yan, Jinyue, & Dahlquist, Erik. (2010). Wetting of polypropylene hollow fiber membrane contactors. *Journal of Membrane Science*, 362(1), 444-452.
- S. Kartohardjono, G. M. Damaiani, & Rama, C. T. (2015). Effects of Absorbents on Ammonia Removal from Wastewater Through Hollow Fiber Membrane Contactor. *Journal of Environmental Science and Technology*, 8(5), 225-231.
- S. Kartohardjono, M. I. Fermi, Yuliusman, K. Elkardiana, A. P. Sangaji, & Ramadhan, A. M. (2015). The Removal of Dissolved Ammonia from Wastewater through a Polypropylene Hollow Fiber Membrane Contactor. *International Journal of Technology*, 6(7), 1146-1152.
- S. Kartohardjono, R. Darmawan, M. F. Karyadi, & Saksono, N. (2016). CO₂ Absorption Through Super-hydrophobic Hollow Fiber Membrane

Contactors. *Journal of Environmental Science and Technology*, 9, 214-219.

- Wang, Dongliang, Teo, WK, & Li, K. (2004). Selective removal of trace H₂S from gas streams containing CO₂ using hollow fibre membrane modules/contactors. *Separation and Purification Technology*, 35(2), 125-131.
- Wang, R, Zhang, HY, Feron, PHM, & Liang, DT. (2005). Influence of membrane wetting on CO₂ capture in microporous hollow fiber membrane contactors. *Separation and Purification Technology*, 46(1), 33-40.
- Yan, Shui-ping, Fang, Meng-Xiang, Zhang, Wei-Feng, Wang, Shu-Yuan, Xu, Zhi-Kang, Luo, Zhong-Yang, & Cen, Ke-Fa. (2007). Experimental study on the separation of CO₂ from flue gas using hollow fiber membrane contactors without wetting. *Fuel Processing Technology*, 88(5), 501-511.

B 004

Production of Cellulase By *A. Niger* and *T. Reesei* Under Solid State Fermentation Using Bagasse As Substrate

Abdullah, Hamid, Hadiyanto

Chemical Engineering Department, Engineering Faculty, Diponegoro University
Jln. Prof. Sudharto, Tembalang, Semarang, 50239, Telp/Fax: (024)7460058
*abd_busairi@yahoo.com

Abstract Cellulase is a very important enzyme for ethanol production from lignocellulose and others. Bagasse is very good to be chosen as lignocellulosic material for cellulase production because it is cheap and already available in huge amount. Solid-state fermentation has advantages than submerged fermentation because of its higher yield and activity. Cellulase production using solid-state fermentation has been researched by many people, but for different substrate, different pretreatment and different fungi producer, it is likely to have a different condition. It is very important to perform specific study to optimize cellulase production with specific substrate and specific fungi which available in Indonesia. Because large amount of fungi strains available so it is wise if they are screened using effective and efficient methods. This research is started by initial screening of three strain of *Trichoderma reesei* and five strain of *Aspergillus niger* using Congo red dye staining on CMC agar plate. It is shown that a strain of *Trichoderma reesei* and two strains of *Aspergillus niger* has better activity than the others. Further screening is performed by conducting solid-state fermentation using bagasse by three best strains for five days. The activity of the cellulase is measured every 24 hour using Ghose method by dinitrosalicylic acid as reagent. The highest activity is shown by *A.niger ITBCC L74* on third day at 0.525 Unit/gram

Keywords: *A. niger*; *T.reesei*; bagasse; cellulose; solid state fermentation.

1.Introduction

Commercial enzymes or industrial importance are obtained from three main sources namely plants, animals and microorganisms. In the past, plants and animals served as main source of enzymes but today microbial sources of enzyme are becoming more popular for obvious reasons [1].

The recent thrust in bioconversion of agricultural and industrial wastes to chemical feedstock has led to extensive studies on cellulolytic enzymes produced by fungi and bacteria. Large quantities of lignocellulosic wastes are generated through forestry, agricultural practices and industrial processes, particularly from agro-allied industries such as sugar cane, breweries, paper pulp, textile and timber industries. These wastes generally accumulate in the environment thereby causing pollution problem. Lignocellulose is a major renewable natural resource of the world and represents a major source of renewable organic matter. The plant biomass regarded as “wastes” are biodegradable and can be converted into valuable products such as enzymes, biofuels, chemicals, cheap energy sources for fermentation, improved animal feeds and human nutrients [2].

Industrially important enzymes have traditionally been obtained from submerged fermentation (SF) because of the ease of handling and greater control of environmental factors such as

temperature and pH. However, solid state fermentation (SSF) technique can improve the yield and reduces the cost of enzyme production. Filamentous fungi are the most commonly used microorganisms in SSF because they are able to grow on solid materials with low water contents. The other advantages of SSF include superior productivity, simple technique; low capital investment, low energy requirement and less water [3].

The aim of this study is to find the best strains in producing cellulase enzyme under solid state fermentation using bagasse as substrate media among eight strains of *Aspergillus niger* and *Trichoderma reesei*

2. Material and Methods

A. Chemicals

All chemicals used were of analytical grade. Media and chemicals used in this study were purchased from Merck, Indonesia.

B. Cellulosic materials

Bagasse was obtained from Sugar Factory, Mojo Panggung Tulungagung, Indonesia and characterized using Chesson-Data method [4] to determine of cellulose, hemicellulose, lignin, and ash.

C. Microorganism

The micro-organism used in this study were *Aspergillus niger* ITBCC L51, L74, L76, and L161 obtained from Bandung Institute of Technology, and *Aspergillus niger* FNCC 6114, *Trichoderma reesei* FNCC 6012, 6013, and 6131 obtained from Gajah Mada University and maintained at 4^oC on Potato Dextrose Agar (PDA) slants.

D. Cellulase Production with Congo Red Staining

Eight strains were inoculated aseptically on a PDA plate for 2 hours, then PDA cut with a diameter of approximately 1.5 cm and removed to a petri dish that contains agar (20g/l), sodium CMC and Mandels nutrients and stored for 4 days. The samples were then treated with a solution of 10 ml congo red (2.5g/l) for 10 minutes. Samples were washed with NaCl solution (10g/l). Orange colour of colony diameter than measured [5].

E. Solid state fermentation (SSF)

Ten grams of bagasse with water content of 80% was incubated with 2 ml inoculum in a 250 ml Erlenmeyer flask. Nutrients are added in accordance with nutrients Mandels. After reaching the specified time the enzyme was extracted with a solution of sodium citrate buffer pH 4,5 in the ratio of dry bagasse against buffer 1:10 w/v. The enzyme activity was tested by the Ghose method [6].

3. Results and Conclusions

A. The characteristic of bagasse

The bagasse was obtained from sugar industry, the characteristic of this waste is important in order to know the actual composition which definitely affects the results of the fermentation process. The result was shown in Table 1.

Table 1 The characteristic of bagasse

Element	Content (%)
Cellulose	57,76
Hemicellulose	12,94
Lignin	21,34
Others	7,96

B. Selection of Strains

Eight strains were tested by congo red staining to find enzymatic index and are presented in Table 2. The result shows that three strains of *A. niger* ITBCC L74, *A. niger* ITBCC L161 and *T. reesei* UGM 6131 were higher than the four other strains with enzymatic index of 1.945, 1.608, and 1.875, respectively.

Table 2 Enzymatic index for eight strains

Strains	Colony diameter (D _k)	Effect of enzyme cellulase (D _e)	Enzymatic index (IE) = D _e /D _k
<i>A. niger</i> FNCCC 6114	2,23	-	-
<i>A. niger</i> ITBCC L51	2,21	3,36	1,520
<i>A. niger</i> ITBCC L74	1,63	3,17	1,945
<i>A. niger</i> ITBCC L76	1,91	2,17	1,136
<i>A. niger</i> ITBCC L161	1,94	3,12	1,608
<i>T. reesei</i> FNCC 6131	1,84	3,45	1,875
<i>T. reesei</i> FNCC 6012	1,88	2,23	1,186
<i>T. reesei</i> FNCC 6013	1,85	2,47	1,335

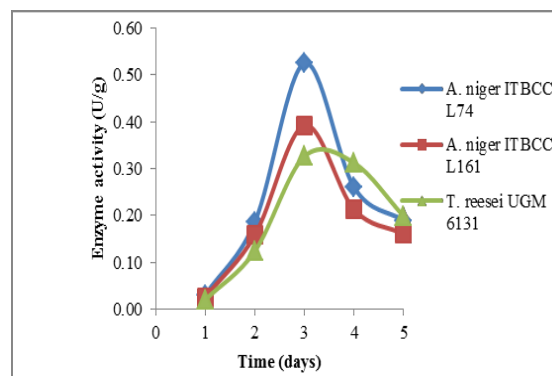
C. Time course of cellulase production

SSF was carried on bagasse with initial moisture content of 80 % at 30^oC. Time course of cellulase production were given in Table 3 and Figure 1. As shown in Fig.1, after 72 hours incubation the enzyme activity of CMCase for *A. niger* ITBCC L74, *A. niger* ITBCC L161 and *T. reesei* UGM 6131

reached the maximum of 0.5251, 0.3927 and 0.3264 U/g, respectively. Incubation beyond 72 hours resulted in decreased enzyme activity; this might be do to the denaturation of the enzyme caused by interaction with other compound in the medium. Similar trend also reported by Sun et al [7].

Table 3 Enzyme activity (unit/gram) vs time

Time (day)	<i>A. niger</i> ITBCC L74	<i>A. niger</i> ITBCC L161	<i>T. reesei</i> UGM 6131
1	0,0311	0,0264	0,0208
2	0,1868	0,1585	0,1246
3	0,5251	0,3927	0,3264
4	0,2602	0,2129	0,3122
5	0,1892	0,1608	0,1986



Bagasse have been used in production of cellulase by *Aspergillus niger*. The results highlight the potentials of the substrates as possible raw materials for cellulase production using *Aspergillus niger* ITBCC L74.

4. Acknowledgment

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5. References

- [1] Abubakar FA and Oloyede OB. (2013), Production and activity of cellulose from *Aspergillus niger* using rice bran and orange peel as substrates, International Journal of Scientific Research and Management, Vol 1(5),pp. 285-291.
- [2] Acharya PB., Acharya DK and Modi HA. (2008), Optimization for cellulase,"African Journal of Biotechnology, Vol. 7 (22),pp.4147-4142.
- [3] Mrudula S and Murugammal R. (2011), Production of cellulase by *aspergillus niger* under submerged and solid state fermentation using coir waste as a substrate, Brazilian Journal of Microbiology, Vol 42, pp. 1119-1127.
- [4] Chessson A. (1981), Effect of sodium hydroxide on cereal straws in relation to the enhanced degradation of structural polysaccharides by rumen microorganism," J.Sci. Food Agric., Vol32,pp.745-748.
- [5] Florencio C., Couri S and Farinas CS. (2012), Correlation between agar plate screening and solid state fermentation for the prediction of cellulase production trichoderma strains, Enzyme Research.
- [6] Ghose TK (1987), Measurement of cellulase activities, Pure & Appl.Chem, 59(2),pp.257-268.
- [7] Sum HY., Li. , Zhoo P and Peng M. (2011),Banana peel: A novel substrate for cellulase production under solid state fermentation, African Journal of Biotechnology, Vol.10(77),pp. 17887-17890.

B 007

Optimization Inulin Of Dahlia Tuber From Biaro, West Sumatra Through Multi Stage Extraction Process

Elmi Sundari, Erti Praputri, Ellyta Sari, Puji Agenta

Chemical Engineering Department, Faculty of Industrial Technology, Bung Hatta University
Kampus III - Jln. Gajah Mada No. 19 Olo Nanggalo – Padang 25143, Telp. (0751) 54257

*elmisundari@yahoo.com

Abstract In West Sumatra, Dahlias have been knowing for a tourism destination because of the beautiful and captivating of blossoms. People don't know yet that Dahlia tubers have a high economic value since it contains inulin in a range from 69.50 to 75.48%. Inulin is a polymer of high-fiber food fructose and prebiotics savour for health. Information about the content of inulin in dahlia flowers still vary, and inulin yield were successfully extracted between 3.8 to 4.3% by using a hot water solvent. It was alleged that the planting site also determines the yield of inulin from dahlias. It is necessary to re-investigate on the yield of inulin that can be extracted from the flowers of dahlias located in West Sumatra. The success of extraction is not only determined by the type of solvent, but also there are several others variables that must be tested such as the water content of the material to be extracted, harvest time, the material size, extraction temperature, and extraction time. This study was aimed to find maximum yield of inulin through the extraction method by varying the method. Research was carried out in the laboratory of Chemical Engineering Department Bung Hatta University with inulin extraction method using a solvent of water and inulin precipitation using water. The tools were used to support this research the balance sheet, glass beaker, stirrer, water bath, thermometer, filter, buchner, oven, and filter paper, hot plate, and a cutter. Materials were used dahlia tubers obtained from Bukit Tinggi. The yield of inulin was observed through a variety of extraction methods (the direction, the opposite direction, and cross), the extraction time was 4 hours, and mass ratio of material to volume of solvent of 1: 2. From the research that has been done can be concluded that quality of tuber greatly affect the levels of inulin obtained and the multi-stage extraction process will increase the yield of inulin.

Keywords : Inulin; extraction; dahlia tuber.

1. Introduction

Dahlia flower is well known to people in Indonesia, especially in West Sumatra. Dahlia flower thrives in some regions in West Sumatra such as Bukit Tinggi, Matur, and Biaro because due to suitable climate. Statement of Dekranas chairman in West Sumatra, Nevi, 2012, launced Bukit Tinggi as the City of Dahlia for the inulin production. Until now public has not yet motivated to cultivate Dahlia flower due to people don't know how to get inulin.

Inulin is a polymer of fructose units with dietary fiber, which reached 90% which serves as a prebiotic food supplement beneficial in the gut (At Tachorirotul , M , 2011) Inulin contained as an additive in some products of food in Indonesia is still largely imported. Inulin is derived from artichoke tubers with levels of 80% and 75% chicory levels. Dahlia tuber from Indonesia contains inulin about 72% and the quality is equivalent to the inulin import (At Tachorirotul , M , 2011).

Research on the content of inulin from Dahlia tuber have been conducted by several researchers since 2006 until today. Suleman et al, 2008, using ethanol and ether Dietyl obtained inulin content of 7.5%. Other researchers, Thelma A, (2010) obtained inulin content of 5%. S., Elmi, et al, (2014) using alcohol and water solvent obtained crude inulin yield around 20% and 16.65% respectively. Some LIPI

researchers in collaboration with Bandung Chemical Research Center continue to develop the production of inulin from Dahlia tubers. Yield of inulin from Dahlia tubers is influenced by several parameters such as methods of contacting, temperature, and type of solvent. Generally, to get inulin from Dahlia tuber is done through the one stage solid-liquid extraction process. Method of contacting the extraction of one stage generally do not get the maximum yield of inulin, because there is inulin carried dregs.

This study aims to find the optimum conditions to get inulin from Dahlia flower tuber through a variety of methods of contacting the solvent and the tuber.

2. Material and Methods

A. Material

The main material for inulin- making is the Dahlia tuber taken from Biaro, West Sumatra. The water is used as solvent, while the material used for identification of inulin is resorcinol.

B. Equipment.

The equipments used were a beaker serves as an extractor, a water bath to maintain the temperature of the extraction, the oven to measure water content of the material, juicers to separate the

fiber and starch, glassware, and other ancillary equipment.

C. Research design

Intake of inulin from Dahlia tubers is done with multistage extraction through a variety of methods of contacting between the solvent and dahlia tubers, namely contacting in the same direction, the opposite direction, and cross flow as shown in Figure 1, 2, and 3.

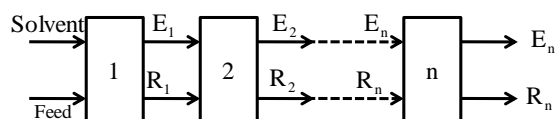


Figure 1. The multi-phase extraction with directional flow

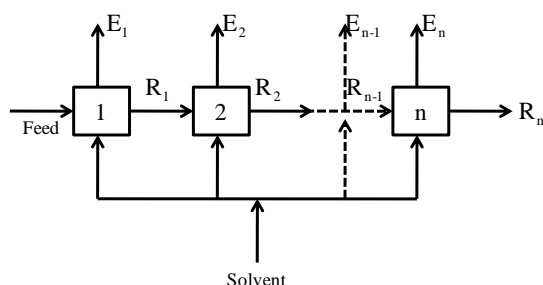


Figure 2. The multi-phase extraction with cross flow method

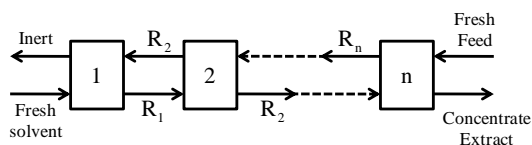


Figure 3. The multi-phase extraction with the flow in opposite directions

3. Results and Conclusions

Inulin levels that can be extracted from the dahlia tubers from West Sumatra are still vary. This is caused by the condition of the raw material and the process of extraction and purification of inulin (separation). The result of the inulin-extraction study using dahlia tubers taken from West Sumatra show that multi-phase extraction with cross-flow method gives highest achievement of inulin only in phase 1, namely 0.68%, while the second phase gives only 0.03%. Meanwhile, phases 3 and 4 give no inulin. Total yield of cross flow method was 0.71%. For multi-phase extraction flow in opposite directions, inulin can still be obtained through stage 3 with the highest achievement in stage 2 at 1:15% and a total

return of 2.54%. At the direction of inulin extraction method can be obtained up to four stages with a total of 0.59% inulin. Difference level of Inulin achieved at each stage of extraction caused by difference quality of dahlia tubers used. The quality of this tuber is affected by soil conditions, harvesting of tubers and flower color. Inulin identification results (Fig. 4) to the tubers taken from four kinds of dahlia colors show that the highest inulin content obtained in dahlia tubers of orange color by 6.9%. S, Elmi, et al (2014) inulin content analysis results by the single stage extraction is 8.5%.

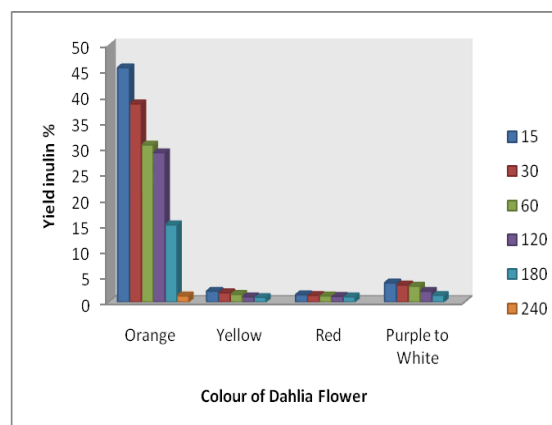


Figure 4. the Influence of Color of Dahlia Flower Against Inulin Content

In theory, a multi-stage extraction process will provide a higher yield than the single-stage extraction process. but in this study, the results are lower. Low levels of inulin content obtained in this study due to the raw material (dahlia tubers) used taken randomly.

In general, the extraction process is influenced by several factors such as solvent, temperature, time and method of contacting the solvent extraction and material to be extracted. Comparison on the same operating conditions show that percent inulin gained on single stage extraction is lower than that on the multi-stage extraction, because there is inulin left in the residue. In cross-current flow contacting method, the material to be extracted in step 2 is raffinate from stage 1, while the solvent used are fresh solvent. For cross-current-flow method, total yield should higher than the other two methods (R.S.Rajian, 2015)

In the counter-current flow method, mutual extraction done by extract and raffinate, so the result is higher as shown in Table 2. Likewise, on unidirectional flow contacting method, the results obtained are smaller than the flow in the opposite direction (Table 3). Figure 5 shows that the method of contacting the counter-current flow provides the highest gain of 2.54%.

Table 1. Cross-current Flow Extraction Method

Stage	Mass of tuber (gr)	Inulin (gr)	Yield of inulin (%)
1	3000	20.4	0.68
2	3000	1	0.03
3	3000	0	
4	3000	0	

Tabel 2. Counter-current flow Extraction Method

Stage	Mass of tuber (gr)	Inulin (gr)	Yield of inulin (%)
1	3000	22.5	0.75
2	3000	34.6	1.15
3	3000	19.1	0.64
4	-	-	

Tabel 3. Co-current Flow Extraction Method

Stage	Mass of tuber (gr)	Inulin (gr)	Yield of inulin (%)
1	3000	8.4	0.28
2	3000	4.6	0.15
3	3000	4.1	0.14
4	3000	0.7	0.02

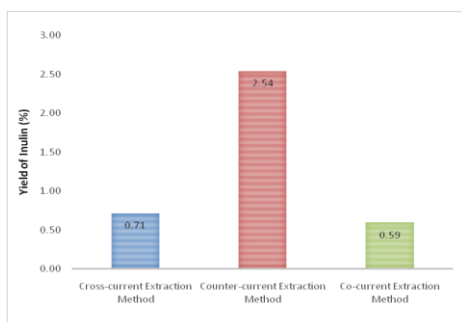


Figure 5. The Influence Contacting Method to Inulin Content

Identification of inulin performed by using a solution of recorsinol in HCl show that all of the samples tested contained inulin. It is characterized by discoloration of inulin from white to red. The test results can be seen in Figure 6.



Figure 6. Identification of inulin quality

4. Conclusion

From the research that has been done can be concluded;

1. Quality of tuber greatly affect the levels of inulin obtained.
2. The multi-stage extraction process will increase the yield of inulin.

5. References

1. At Tachrirotul, M, “Inulin : Nutrisi Bakteri Baik dan Musuh Bakteri Patogen”, <http://attadotcom.wordpress.com>, 27/04/2013
2. R.S.Rajian, dkk (2015) Ekstraksi Multi tahap kurkumin dari kunyit (*Curcuma domestica* Valet), menggunakan pelarut etanol, Jurnal Teknik Kimia USU, Article in Press.
3. Sundari, E., dkk (2014), “Identifikasi dan Kondisi Ekstraksi Inulin dari Umbi Dahlia di Sumatera Barat, Prosiding Seminar Nasional Sains dan Teknologi Lingkungan (SNTL), Volume 1, Jurusan Teknik Lingkungan, Universitas Andalas.
4. Nevi, (2013), *Sumbang Berpeluang Kembangkan Bunga Dahlia Bernilai Ekonomis*, Berita Terkini Sumatera Barat, 26 April 2013.

B 011

The Effect of The Addition of Alkanolamide on Cure and Tensile Properties of Unfilled Polychloroprene Rubber Compounds

I. Surya^{1*}, S. F. Siregar¹, H. Ismail²

¹ Department of Chemical Engineering, Engineering Faculty, University of Sumatera Utara, Medan, 20155, Sumatera Utara, Indonesia

² School of Materials and Mineral Resources Engineering, Universiti Sains Malaysia, Engineering Campus, Nibong Tebal, 14300, Penang, Malaysia

* indradanas@yahoo.com

Abstract The effect of the addition of Alkanolamide (ALK) on cure characteristics, tensile properties and crosslink density of unfilled polychloroprene rubber (CR) compounds was investigated. The ALK was prepared from Refined Bleached Deodorized Palm Stearin (RBDPS) and diethanolamine and -together with magnesium and zinc oxides- incorporated into the unfilled CR compounds. The ALK loadings were 0.5, 1.0, 1.5 and 2.0 phr. It was found that ALK enhanced the cure rate, torque difference and crosslink density of the unfilled CR compounds. ALK also enhanced the tensile modulus and tensile strength; especially up to a 1.5 phr loading. Scanning Electron Microscopy (SEM) proved that the 1.5 phr of ALK exhibited the greatest matrix tearing line and surface roughness, due to the highest degree of crosslink density.

Keywords: Alkanolamide; polychloroprene rubber; cure characteristics; tensile properties; crosslink density

1. Introduction

In rubber science and technology, polychloroprene rubber (CR) is conventionally cured by both magnesium oxide (MgO) and zinc oxide (ZnO), at satisfactory loadings of 4 and 5 phr, respectively. Besides MgO and ZnO, ethylene thiourea (ETU) is widely used as the vulcanisation accelerator for CR (Akiba and Hashim, 1997).

Recently, newer curing agents, including thiophosphoryl disulphides, dimethyl l-cystine, and cetyltrimethylammonium maleate, have been reported (Das et al., 2004; Ismail et al., 2003). Although there are many published works on various curing agents for CR, the most practical curing agents are still ETU, MgO and ZnO, due to the superior mechanical properties of the cured products. ETU is a toxic material and is suspected to be carcinogenic (Chhabra et al., 1992; Smith, 1984). Therefore, the appearance of an alternative vulcanisation accelerator for CR, which is capable of

providing CR products/vulcanisates equivalent or superior to those provided by the ETU and both metal oxides, has been in demand.

This study reports the utilisation of Alkanolamide (ALK) as an additive ingredient for CR. The study is focused on the effect of addition of ALK on the cure characteristics, crosslink density and tensile properties of the unfilled CR compounds.

2. Material and Methods

2.1. Laboratory Preparation of Alkanolamide

The reaction was carried out at atmospheric pressure, in a one liter reaction vessel fitted with a stirrer. Typically 1.0 mol RBDPS and 1.86 mol of liquid diethanolamine were placed in the reaction flask. The mixture was stirred and heated at 70 °C for 5 hours. Through a sequence of purification operations, ALK was produced and then used as an additive ingredient in unfilled CR compounds. The reaction equation was as shown in Figure 1.

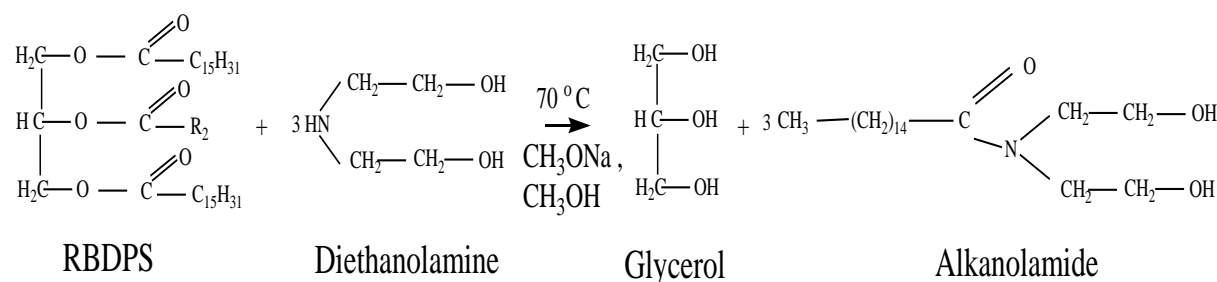


Figure 1. Chemical reaction of the preparation of Alkanolamide.

Table 1. Composition of the unfilled CR compounds

Ingredients	Content (phr)*
CR	100.0
MgO	4.0
ZnO	5.0
Stearic acid	1.0
S	2.0
ALK	0.0; 0.5; 1.0; 1.5; 2.0

* parts per hundred parts of rubber

2.2. Materials

Polychloroprene rubber (CR) [Skyprene B-30] was used. Other compounding ingredients were sulphur (S), ZnO, MgO, stearic acid and ALK.

2.3. Compounding

A sulphur-accelerated vulcanization system was used for compounding. The recipe for the preparation of the CR compound is given in Table 1. The compounding procedure was done in accordance with the American Society for Testing and Material (ASTM) – Designation D 3184 – 80. Compounding was done on a two-roll mill

2.4. Cure Characteristics

Compound cure characteristics were measured using a Monsanto Moving Die Rheometer (MDR 2000), which was used to determine the scorch time (t_{s2}), cure time (t_{90}) and torque difference ($M_H - M_L$) according to ASTM 2240-93. Samples of the respective compounds were tested at 150 °C.

The compounds were subsequently compression moulded using a stainless steel mould at 150 °C with a pressure of 10 Mpa using a laboratory hot-press based on the respective curing times.

2.5. Tensile Properties

Dumbbell-shaped samples were cut from the molded sheets according to ASTM D 412-93. Tensile tests were performed at a crosshead speed of 500 mm/min. Tensile tests were carried out with a universal tensile machine Instron 3366 to determine the tensile properties in terms of tensile strength (TS), stresses at 100% and 300% elongations (M100 and M300) and elongation at break (EB).

2.6. Swelling Test

Swelling test was done in toluene in accordance to ASTM: D471-12a. Vulcanised test pieces of dimension 30 mm x 5 mm x 2 mm were weighed using an electrical balance and swollen in toluene until equilibrium, which took 72 h at room temperature. The samples were taken out from the liquid, the toluene was removed from the samples

surface, and the weight was determined. Calculation of the changes in mass is as follows:

$$Swelling = \frac{W_2 - W_1}{W_1} \times 100$$

Where W_1 is the initial mass of specimen (gram) and W_2 is the mass of specimen (g) after immersion in toluene.

2.7. Scanning Electron Microscopy (SEM)

The tensile fractured surfaces of the CR vulcanisates were examined using a Zeiss Supra-35VP scanning electron microscope (SEM) to obtain information regarding the possible presence of micro-defects. The fractured pieces were coated with a layer of gold to eliminate electrostatic charge build-up during examination.

3. Results and Conclusions

3.1. The effect of ALK on cure characteristics and crosslink density

Table 2 shows the cure characteristics, swelling and tensile properties of unfilled CR compounds with and without ALK. The addition of up to 2.0 phr of ALK into the unfilled CR compound produced CR with ALK compounds with shorter scorch (t_{s2}) and cure (t_{90}) times, compared to the control compound (CR-0.0). The ALK functioned as a curative additive since it increased the cure rate and can be considered as an accelerator. Any rubber ingredient that enhances the action of a curing or vulcanising agent to speed up the resultant cure, even though it constitutes a very small part of a rubber compound, is classified as an accelerator (Long, 1985). Amine is an accelerator substance of rubber compounds (Long, 1985) and hence, amine constituent of ALK caused the cure enhancement (Surya and Ismail, 2016; Surya et al., 2015).

The higher the ALK loading, the longer were the scorch and cure times. This can be attributed to ALK functioning as an additional vulcanising agent (discussed later).

Table 2. The cure characteristics, swelling and tensile properties of unfilled CR compounds

Compounds*	Cure characteristics			Swelling (%)	Tensile properties			
	ts ₂ , min.	t ₉₀ , min.	M _H -M _L , dN.m		M100, MPa	M300, MPa	TS, MPa	EB, %
CR-0.0	11.29	28.28	7.91	370.81	0.72	1.30	13.7	1612
CR-0.5	3.74	25.31	14.90	366.67	0.78	1.31	15.5	1590
CR-1.0	6.68	27.09	15.56	350.70	0.82	1.37	17.2	1537
CR-1.5	7.16	27.43	15.59	311.21	0.83	1.38	18.9	1487
CR-2.0	7.58	27.96	12.63	340.53	0.78	1.29	17.8	1516

* CR-ALK

The torque difference of the CR-A0.5 compound was higher than that of the control compound. Theoretically, torque difference is an indication of the crosslink density of a rubber compound (Boonstra et al., 1975; Cochrane and Lin, 1993; Surya and Ismail, 2016; Surya et al., 2013; Surya et al., 2014; Surya et al., 2015). The higher the torque difference value, the higher is the degree of crosslink density. The addition of 0.5 phr of ALK enhanced the torque difference of the unfilled compound significantly. Enhancement in torque difference has the same meaning as enhancement in crosslink density and hence, ALK can be considered as an additional vulcanising agent for the unfilled CR system.

As discussed earlier, increasing the ALK loading up to 2.0 phr increased the scorch and cure times. Simultaneously, the torque difference value increased with up to 1.5 phr, but decreased beyond this loading. These phenomena can be attributed to the function of ALK as an additional vulcanising agent. The higher the loading, the more was the amount of ALK presented as a reactant, and the more pronounced was its function as a vulcanising agent over that of as an accelerator and hence, a longer time was needed to complete the crosslink process.

The reduction of torque difference value beyond the 1.5 phr of ALK was most probably attributed to the excessive amount of ALK which

reduced the crosslink density. The torque difference result corresponds well with the result of swelling test.

3.2. The effect of ALK on tensile properties

As presented in Table 2, the incorporation of up to 1.5 phr of ALK into the unfilled CR compound increased the M100, M300 and TS. However, further loading increases decreased those properties. The tensile properties of a rubber vulcanisate are dependent mainly on the degree of crosslink density (Hertz Jr and INC, 1984; Ismail and Chia, 1998a). Again, the enhancements of M100, M300 and TS up to 1.5 phr were attributed to ALK functioning as an additional vulcanising agent, which increased the degree of crosslink density of the unfilled CR compounds. This explanation is in line with the swelling result trend shown in Table 2 and the SEM micrographs shown in Figure 2. It is widely accepted that the swelling result is directly correlated to the crosslink density of a rubber vulcanisate, with less solvent uptake or penetration into the compounds indicating higher crosslink density (Hayeemasae et al., 2016). The micrograph of CR-A1.5 exhibited the greatest matrix tearing and surface roughness. This indicates the highest degree of crosslink density, which altered the interactions between CR segments into the strongest ones and thus, caused an increase in tensile strength.

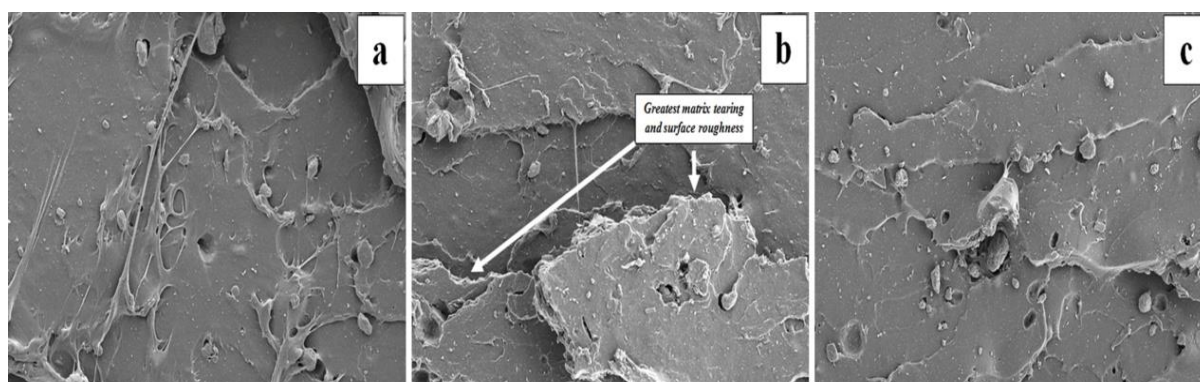


Figure 2. SEM micrographs of the unfilled CR vulcanisate failed fracture at a magnification of 200X; (a) CR-A0.0, (b) CR-A1.5, and (c) CR-A2.0.

The deterioration of properties beyond 1.5 phr can be attributed to the excessive loading of ALK, which lowered the total crosslink density. Presumably, the excessive amount of ALK formed a boundary layer, which dissolved and coated a part of the curatives (MgO, ZnO, S) and hence, reduced the formation of crosslinking of CR by those curatives. This explanation is again in line with the result of swelling test shown in Table 2.

The ALK reduced the EB by up to 1.5 phr, and then increased it slightly as the ALK loading further increased. EB depends mainly on the degree of crosslink density (Ismail and Chia, 1998b). The reduction of EB by up to 1.5 phr was simply attributed to the higher degree of crosslink density; which immobilised the CR segments freely. However, beyond the 1.5 phr of ALK loading, EB was found to increase. An explanation for this is again given by the excessive effect of ALK, which lowers the crosslink density and causes a more free movement of the CR segments.

4. Conclusions

The addition of Alkanolamide into unfilled polychloroprene rubber compounds enhanced the cure rate of magnesium-zinc oxides vulcanised polychloroprene rubber compounds. Alkanolamide also enhanced the tensile properties and crosslink density of unfilled polychloroprene rubber compounds especially up to 1.5 phr loading. The enhancements of the cure rate, crosslink density and tensile properties were due to the function of ALK as a curative additive in unfilled polychloroprene rubber compounds.

5. Acknowledgements

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6. References

1. Akiba M., Hashim A. (1997) Vulcanization and crosslinking in elastomers. *Progress in Polymer Science* 22:475-521.
2. Boonstra B., Cochrane H., Dannenberg E. (1975) Reinforcement of silicone rubber by particulate silica. *Rubber Chemistry and Technology* 48:558-576.
3. Chhabra R., Eustis S., Haseman J., Kurtz P., Carlton B. (1992) Comparative carcinogenicity of ethylene thiourea with or without perinatal

- exposure in rats and mice. *Fundamental and Applied Toxicology* 18:405-417.
4. Cochrane H., Lin C. (1993) The influence of fumed silica properties on the processing, curing, and reinforcement properties of silicone rubber. *Rubber Chemistry and Technology* 66:48-60.
 5. Das A., Naskar N., Basu D.K. (2004) Thiophosphoryl disulfides as crosslinking agents for chloroprene rubber. *Journal of Applied Polymer Science* 91:1913-1919.
 6. Hayeemasae N., Surya I., Ismail H. (2016) Compatibilized natural rubber/recycled ethylene-propylene-diene rubber blends by biocompatibilizer. *International Journal of Polymer Analysis and Characterization*:1-12.
 7. Hertz Jr D.L., INC S.E. (1984) *Theory & Practice Of Vulcanization*. Elastomerics, November.
 8. Ismail H., Chia H. (1998a) The effects of multifunctional additive and vulcanization systems on silica filled epoxidized natural rubber compounds. *European Polymer Journal* 34:1857-1863.
 9. Ismail H., Chia H. (1998b) The effects of multifunctional additive and epoxidation in silica filled natural rubber compounds. *Polymer Testing* 17:199-210.
 10. Ismail H., Ahmad Z., Mohd Ishak Z. (2003) Effects of cetyltrimethylammonium maleate on curing characteristics and mechanical properties of polychloroprene rubber. *Polymer Testing* 22:179-183.
 11. Long H. (1985) *Basic Compounding and Processing of Rubber*, Rubber Division, American Chemical Society Inc. The University of Akron, Ohio, USA.
 12. Smith D.M. (1984) Ethylene thiourea: thyroid function in two groups of exposed workers. *British Journal of Industrial Medicine* 41:362-366.
 13. Surya I., Ismail H. (2016) The effect of the addition of alkanolamide on properties of carbon black-filled natural rubber (SMR-L) compounds cured using various curing systems. *Polymer Testing* 50:276-282.
 14. Surya I., Ismail H., Azura A. (2013) Alkanolamide as an accelerator, filler-dispersant and a plasticizer in silica-filled natural rubber compounds. *Polymer Testing* 32:1313-1321.
 15. Surya I., Ismail H., Azura A. (2014) The comparison of alkanolamide and silane coupling agent on the properties of silica-filled natural rubber (SMR-L) compounds. *Polymer Testing*.
 16. Surya I., Ismail H., Azura A. (2015) The effect of alkanolamide loading on properties of carbon black-filled natural rubber (SMR-L), epoxidised natural rubber (ENR), and styrene-butadiene rubber (SBR) compounds. *Polymer Testing*.

B 012

An Evaluation of the Establishment New Core for Fiber Optic Backbone Network in Syiah Kuala University

Rizal Munadi¹⁾, Musfira²⁾, Syahrial¹⁾ Elizar, Ernita Dewi Meutia

Wireless and Networking Research Group (Winner)¹⁾

Electrical Engineering Department, Engineering Faculty, Syiah Kuala University^{1,2)}

Jalan Tgk. Syech Abdurrauf No. 7, Darussalam, Banda Aceh 23111, Indonesia

*e-mail: {rizal.munadi, syahrial, elizar, dewi.meutia}@unsyiah.ac.id, musfira.te08@yahoo.co.id

Abstract Transmission capacity using fiber optic has a prominent choice for backbone infrastructure to deliver communication services to customers in any technology platform. To ensure its services, technology and service planning have played a key role to provide the quality service to existing users. Even though this has been calculated and maintained in well fashion, some factors have to consider while the growing number of users could force the quality of service to downgrade. This service and planning using fiber optics as its transmission line case is proposed to be evaluated in Syiah Kuala Network for internet. Enhancement in implementing new network equipment and technology capacity to replace the old one has to evaluate and analyze. This research was conducted by using two optical measuring instruments, namely Optical Time Domain Reflector (OTDR) and power meter. Point measurements were made of the port core switch / server in ICT center building in Syiah Kuala University. The findings obtain that the installation of new cores have reduced many point of connector which cause network performance quality. Results show that the establishment new core has overcome transmission attenuation and failure.

Keywords: Transmission capacity; fiber optic; attenuation; quality of service; performance.

1. Introduction

Fiber optics is a transmission medium of optics communication that carries information from one point to another in the form of light. As huge and its wide spread spectrum fiber optic, for many application. Fibre optics are optical cables that carry light, and receivers that receive light signals and then convert it back into an electrical signal. Capacity with bandwidth and low attenuation characteristics make it ideal for transmitting optical fiber gigabit and beyond [1].

In the implementation, a network that uses fiber optic technology is also used at the University of Syiah Kuala (Unsyiah) to meet Internet and information services on campus. To improve services , since 2007 Unsyiah has started building a network using fiber optic media. At first stage, laying the core switch/server based in the rector (old) Unsyiah and are channeled to other buildings next to the user. Multimode type of cable used with an installation capacity of six cores.

In 2011 Unsyiah cooperate with the service provider to fix the network by removing the core switch to building Information and Communication Technology (ICT) center , which is assistance from the government of Taiwan for rehabilitation Unsyiah damaged by the earthquake and tsunami in 2004. The replacement of existing connection has been made as the changes of Computer and Information System Center (PUKSI) to be ICT Center at new building. At this

moment, the type of fiber optic used are singlemode and multimode with an installation capacity of 48 core. To conduct the measurement of the network, optical node in current network are examined using Optical Time Domain Reflector (OTDR) and Power Meter to collect its value and quality.

2. Fiber Optics Fundamental

Fiber Optics (FO) is a thin glass with a diameter of approximately less than 120 μm . FO is used to deliver higher numbers of signals in the form of light pulses, and can reach a distance of 50 km without the help of the signal amplifier [2].

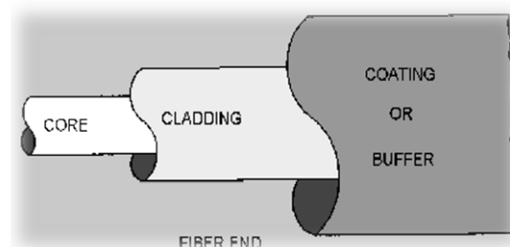


Figure 1 Structure of Fiber Optics Cable [3]

A. Cable Optics Structure

Fiber Optic is consists of three parts: core, cladding and coating. Figure 1 below is the basic structure of a fiber optics.

The core are in the form of a cylindrical rod made of dielectric material (silica material (SiO_2), usually with Germanium Oxide (GeO_2) or

Phosphorous Penta Oxide (P2O5) doped to increase the refractive index that does not conduct electricity. The core has a radius of about 8-200 μm and the refractive index (n_1) of approximately 1.5. It also layered with a kind of material called skins, which are made of dielectric material (non-silica or less doping), the skin has a radius of about 125-400 μm and refractive index (n_2) slightly lower than (n_1) [3].

Basically, Fiber optics can be is classified into three types, singlemode step index, multimode step index and multimode graded index [4]:

1. Singlemode Step Index

Singlemode step index can transmit above average of 50 times more longer than multimode. These type of fiber have smaller cores compare to multimode. The small core and a single light wave can reduce the distortion caused by the overlap of light, less signal attenuation and high-speed transmission [4]. Figure 2 shows the form of singlemode step index fiber.

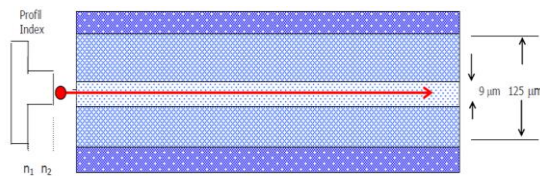


Figure 2 Singlemode Step Index Fiber Optics [5]

2. Multimode Step Index

Multimode step index contains a bigger core with a diameter greater than 100 microns. As a result, some of the light makes the digital signal passing through the main route (direct route). The other signals are bended when the light is bounced the cladding, this leads to an alternative different light grouping known as a mode, it arrived separately at a receiving point. The need to leave a distance between both signals to prevent overlap bandwidth will limit the amount of information that can be sent to the receiving point. As a consequence, this type of fiber are more suitable for short-distance application [4]. Figure 3 shows the form of multimode step index fiber.

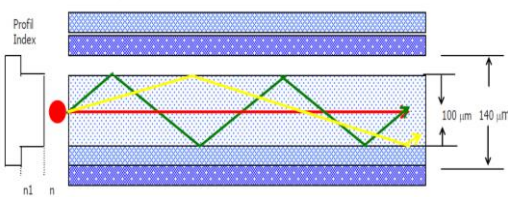


Figure 3 Multimode Step Index Fiber Optics [5]

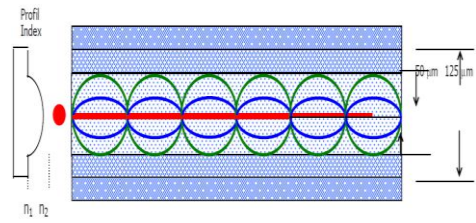


Figure 4 Multimode Grade Index Fiber Optics [5]

3. Multimode Grade Index

Multimode grade index contains a core with gradually reduced refractive index from its center of core to the outer cladding. The highest refraction index are at the center makes the light moves more slowly on its axis compare to the light that closer to the cladding [4]. Figure 4 shows multimode grade index fiber.

B. Optical Time Domain Reflector

Optical Time Domain Reflector (OTDR) identify and specifically display the events in the span of optical fiber between the connector and the splice. OTDR transmits light signals emitted throughout the range of the fiber, where light scattering may occur due to discontinuities in some part of optical fiber such as connectors, splices, and bendings. It then detected and analyzed part of the signal returned by Fresnel reflections and Rayleigh backscattering. Fresnel reflection is a little part of light signals that is reflected back when the light travels through materials with different reflection index. Rayleigh backscattering is a reflection resulting from light scattering due to the fiber impurities [6].

C. Power Meter

Power Meter is used to measure the total loss of an optical link either during installation or maintenance process. The measurement must be performed in accordance with the wavelength of its transmitting. When the device works at a wavelength of 1550 nm, the light sources used must also be at 1550 nm [5].

3. Research Methodology

The research was conducted by firstly doing field surveys to examine the structure of installed fiber in the network, it the performing two stages measurements using OTDR and power meter devices. OTDR is used when measuring and testing the installed FO to make sure its working, both in terms of wavelength and OTDR other parameters from the cable connector end to Optical Terminal Block (OTB). Power meter is used when measuring the total attenuation of installed FO from the beginning and the end part of the cable. OTDR will provide measurement results in the form of insertion loss distance,

reflection, and loss arising at any point of cable, and display this information on the display screen. Analytical study is conducted using the measurement results data. The measurement results then will be compared with the results of previous measurements that have been done before the transfer process of core switch / server of Unsyiah fiber optic network

A. Optical Fiber Network Measurement Result.

1. Measurement Result Using OTDR

The measurement of optical fiber network between nodes at Unsyiah using OTDR Yokogawa AQ 7260 is tabulated on table 1. The data shows the core number, distance, CUM loss and SLOPE at every measuring point. CUM loss is cumulative loss along the path, while SLOPE is the link path attenuation per km. The measurement on some cores could not be done due to there were transmission came from reverse direction.

4. Results and Analysis

Table 1 Optical Fiber Network of Unsyiah Measurement Data

<i>Event</i>	<i>Core</i>	<i>Distance (km)</i>	<i>CUM Loss (dB)</i>	<i>SLOPE (dB/km)</i>
Law Faculty	3	0,65428	2,481	1,536
	4	2,02461	-6,847	-3,382
Library	5	0,72517	0,944	8,863
	6	2,02461	-3,797	-1,876
FKH	10	0,97129	4,412	1,666
Chemical Eng. Dept.	11	1,29843	3,456	9,558
	12	0,97129	1,153	0,690
Integrated Lab.	13	2,02461	7,887	3,895
Teaching and Education Science Faculty	18	1,40781	2,073	0,276
Social Science and Politics Faculty	19	0,41930	-0,660	-1,737
	20	1,16372	2,096	0,462
Chemical Dept. of Mathematics and Basic Science Faculty	21	1,52530	2,672	1,514
	22	0,42032	-1,336	-3,472
Medical Faculty	23	1,4179	2,840	0,140
MIPA (Dean Office)	25	0,97534	2,569	1,330
	26	0,42336	-0,151	-0,390
MIPA Faculty	28	1,20322	2,541	0,456
Auditorium	31	1,20423	2,417	0,347
	32	1,20322	1,710	0,344
Agriculture Faculty	33	0,42234	-0,592	-1,535
	34	1,27817	8,561	-4,376
Economics Faculty	35	0,42133	1,444	4,243
	36	0,76467	-0,119	-1,095
Pasca Sarjana	37	0,4223	-0,041	-0,106
	38	1,26298	13,133	-33,452
Lab School	39	0,42336	-0,058	-0,151
	40	0,70796	0,564	-0,438
Engineering Faculty	45	0,76467	1,822	0,457
	46	1,20322	0,990	0,257

Table 2 Optical Power Meter Measurement Result

Core	λ (nm)	Transmit Power (μ W)	Received Power (dBm)
1	1310	1.17	-29.28
2	1310	1.17	-43.94

2. The Result of Measurement Using Optical Power Meter.

The measurement was conducted on the link between ICT center to Fakultas Teknik building. The parameters recorded at calibration process are:

- Transmit*: wavelength: 1310 nm and output frequency 0 Hz.
- Receive*: wavelength 1310, received power: 32,90 μ W. Calibration value: -13,55 dBm

B. The Measurement Result Analysis of Optical Fiber at ICT – FT Link

There are two cores that are used on ICT – FT link, core 45 and 46. The path for this link is connected to old bureau building and passes MIPA’s device. The measurement results for this link with core 45, is shown on Figure 5 below.

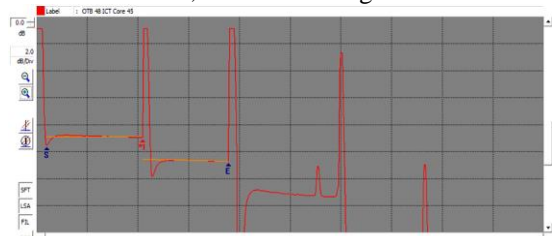


Figure 5 Graphic of Optical Fiber FT Link Core 45 Measurement

At core 45 FT, there is a connector as shown on the graph of figure 6 marked as ‘1’. The connector is located at 0.42234 km with connector loss of -0.016 dB. From the red color shown at OTDR monitor, it is known that the connector loss is below tolerable value. This bad connection decreased the quality of signal propagation as shown on the graph. The measurement result data is shown on table 3.

Table 3 The Result of Measurement of Optical Fiber FT Link Core 45

Event	Link FT
Jarak	0,76467 km
Loss	1,822 dB
Atenuasi	0,457 dB/km

Next is the measurement of optical fiber on FT link core 46. The measurement result is shown on figure 6.

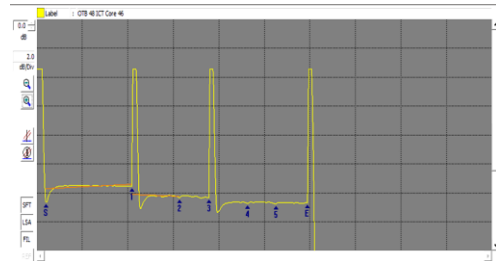


Figure 6 The Measurement of Optical Fibre on FT Link Core 46 Graph

As shown on the graph, there are five connectors along the path. However, the light can still go through all of these connectors. The connector loss is 0.687 dB at 0.42234 km for the first connector, -0.085 dB at 0.63503 km for the second one, 0,056 dB at 0,76467 km, -0.092 dB at 0.92685 km for the fourth one and -0.031 dB at 1.06244 km for the fifth one. Signal propagation line is almost straight but with many ripple along the transmission as the effect of bad cable quality. A report from technicians at ICT building Unsyiah mentioned that complains arose quiet frequently on this link. This complaint triggered further measurement using optical power meter to investigate the factors that may disrupt signal transmission on this link. The data collected from the measurement are received power measured at ICT -FT link. At the first core, received power is -29.28 dBm and at the second one is -43.94 dBm. The transmitted power at both cores is 1.17 μ W or -29.32 dBm. The first core of this link is used as a back-up and is not connected to the device. It proves that the transmission link between ICT and FT has a bad quality, since it received -49.94 dBm, from -29.32 dBm transmitted. It produced losses on the transmission link as big as -20.62 dBm. The simple diagram of ICT _FT link is depicted on figure 7.

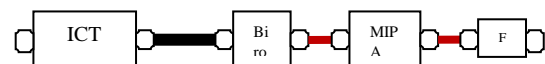


Figure 7 Simple Diagram

ICT as core switch center sends signal using single mode cable (black line on figure 8) and force it to go through converter device at old Biro building. From old Biro building, the signal continues to travel to the device at MIPA which is multimode old cable (red line on figure 8) that has already existed before the core switch is relocated. There are four connecting terminals that are passed by the signal. Each terminal has two connectors. So there are totally eight connectors that used to send the signal.

Maximum standard loss value for a connector is 0.5 dB. This value is achieved if the quality and the splice of the connector are good. However, there is always possibility that this value is not achieved due to the factors such as the connector

is not properly connected to the terminal, the cable bent, and the dirt on connector at each terminal. These factors increase the attenuation and connector loss.

C. The Comparison of Result of Measurement Before and After Core Switch Removal

Along with the relocated of core switch optical fiber network at Unsyiah, some changes took place. The changes are mainly on upgrading the network to increase the quality of service. The changes in the network is shown on Table 4.

Table 4 The Changes on Unsyiah Optical Fiber Network Before and After Core Switch Removal

No	Changed Aspect	Before Core Switch Removed	After Core Switch Removed
1.	Number of Core Used	12 core	48 cores
2.	Cable type	Multimode	Singlemode and multimode
3.	Building/Faculty core usage:	Internet access has been moved to Engineering Faculty and seat available are have extend a week.	Setiap gedung/fakult as masing-masing 2 core kecuali untuk programmer PUSKOM yaitu 4 core

Even though the changes have been made, transmission cable and network topology to connect the cable to indoor devices at faculty or building are still the same old one. The star topology centered at old Biro building and connected to buildings/faculty is still used. However, the core switch that has been removed to ICT center, and the use of single mode cable to take 48 cores passing the topology will surely affect the loss value and optical fiber total attenuation.

The comparison of the result of measurement before and after core switch removal are shown on table 6. The data of measurement before core switch removal were taken from 2010 data [7]. But, since the location of the core has changed, then the comparison is made based on transmission link that connect five main locations to other buildings.

Tabel 5 The comparison of the result of measurement before and after core switch removal

No	Link	Loss (dB)			Total α_f (dB)		
		Before	After		Before	After	
			core I	core II		core I	core II
1.	Economics Faculty	2,73	1,444	-0,119	0,925	1,788	-0,837
2.	Mathematics and Basic Science Faculty	1,42	-	2,541	0,123	-	0,549
3.	Veterinary Medicine Faculty	3,15	-	4,412	1,536	-	1,618
4.	Library	2,16	0,944	-3,797	0,103	6,427	-3,798
5.	Auditorium	2,04	2,417	1,71	0,113	0,419	0,414
6.	Law Faculty	1,98	2,481	-6,847	0,085	1,005	-6,847

D
ata on Table 5 shows that at Economics Faculty-Library link, the quality of network increased as the loss value decreased, after core switch removed. Considering the addition of network device after the core switch was removed, the attenuation on both link also increased. Besides, there are other factors that may increase the attenuation such as: the imperfect joint of connector that may cause Fresnel reflection, the use of two different FO cable modes that cause core size variations and the addition of device that increase the attenuation due to micro bending on the cable connected to it.

The quality of network at Mathematics and Basic Science Faculty, Veterinary Medicine Faculty, Auditorium and Law Faculty link decreased as the transmission and attenuation loss increased. The comparison graphs of transmission

and attenuation loss before and after removal are depicted on figure 8(a) and (b) subsequently.

As can be seen on the graph, after core switch removal, the network quality improves. The use of two cores for every faculty building may reduce and overcome disruption that happened on one of the cores which has transmission cable of bad quality. However, since the network design needs the signal to go through additional devices, the occurrence probability of link attenuation also increases.

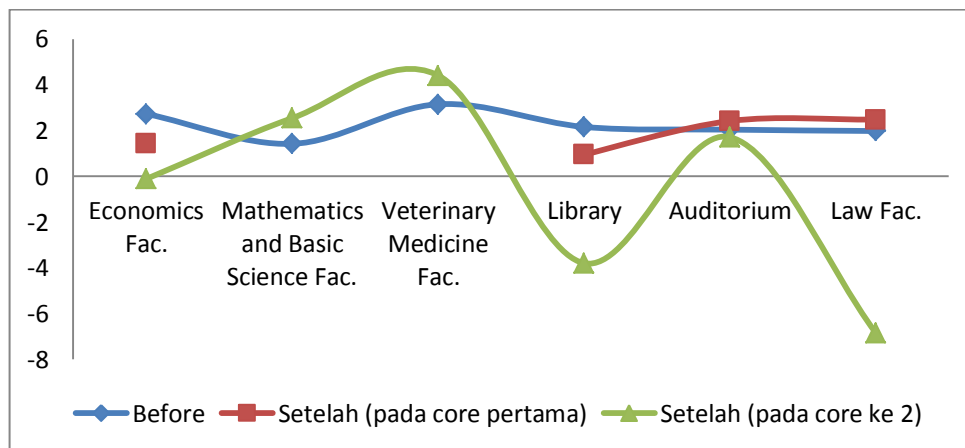


Figure 8(a) Transmission Loss Comparison

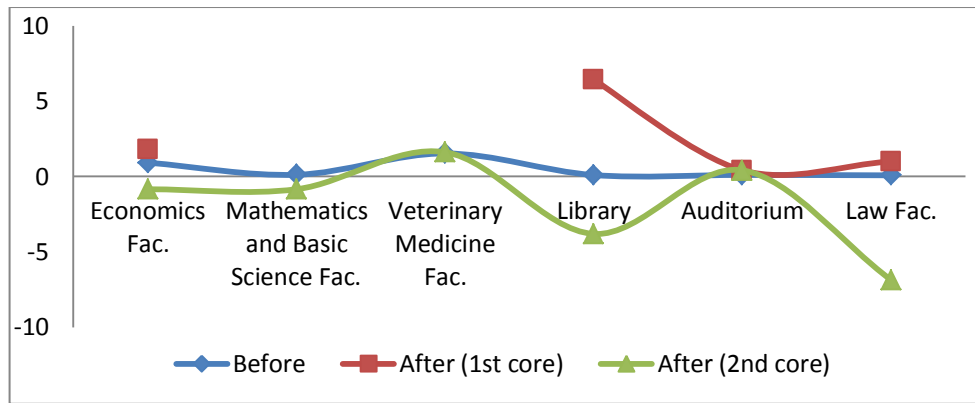


Figure 8(b) Total Attenuation Comparison

Figure 8 The Comparison Graph of the Measurement Result Before and After Core Switch Removal

The lower the graph the better the link transmission is. Minus value on the attenuation and losses means there is gain on the signal transmitted. However, the second core at Library and Law Faculty link is an unused link, so the gain occurred due to the absence of connector at the end of the terminal that cause the signal to propagate straightly along the path. Attenuation excess happens when the signal pass through few terminals.

D. The Result of Evaluation on Performance Comparison of Optical Fiber Network at Unsyiah.

From the research on performance comparison of optical fiber network, it is found that there are advantages and disadvantages on the network after core switch/server removing. The advantage includes the decreasing of loss value on the link. Unfortunately, the network structure that forced the signal to additional device will increase the attenuation on the link. This phenomenon is a disadvantage for the network after the core switch removing.

5. Conclusions

Based on the measurement data and analysis, it can be concluded that losses can be appeared caused by many connection along the link between nodes and degraded quality and network performances. Result analysis shows that attenuation along the transmission lines are decreased after replacing core switch server and the network quality improves.

6. References

1. Massa, Nick. (2000), 'Fiber Optic Telecommunication' thesis, University of Connecticut, USA.
2. Mutiarawati, Fadila. (2003), *Fiber Optik, Kabel Masa Depan*, PC Media, Jakarta.

3. Palais, Joseph C. (2005), *Fiber Optic Communications*.
4. Harte, Lawrence & Eckard, David. (2005), *Introduction Optical Communication*, ALTHOS Publishing, USA.
5. Kristianto, Endi Dwi, *Fiber Optik Atas Tanah*, viewed 12 April 2013, Available:<http://IlmuKomputer.com>
6. Talbot, B. Eng, Pierre, Hamel, B. Eng, Caroline, Michel, B. Eng, M. Sc & Marie Claude. (2005), *OTDR And OLTs Two Different Tools For Specific Needs*, pp. 1.
7. El Sera, Nona. (2010), *Evaluasi Jaringan Serat Optik Unsyiah Menggunakan Optical Time Domain Reflector (OTDR)*, Jurusan Teknik Elektro, Fakultas Teknik, Universitas Syiah Kuala, Banda Aceh.

B 013

Production of Glycerol from *Crude Palm Oil* Using Crude Lipase of Rice Bran as Biocatalyts

Efri Mardawati*, Fitri Astutiningsih¹, Yana Cahyana¹, Sarifah Nurjanah¹
Mimin Muhaemin¹, Handarto, Totok Herwanto, Rosalinda, Ade M. Kramadibrata¹.

¹) Faculty of AgroIndustrial Technology
Padjadjaran University, West Java, Indonesia
*efri.mardawati@unpad.ac.id

Abstract The utilization of crude palm oil as a feedstocks for biodiesel and glycerol synthesis utilize crude lipase from rice bran was investigated. The transesterification can be carried out chemically or enzymatically to produce fatty acid methyl esters (FAME's) and glycerol. Glycerol is by product of this potential biodiesel. Lipase-catalyzed transesterification of oils to FAME's gives a very high-purity product that can be easily separated from glycerol. This article describes the study of transesterification process using crude lipase extract produced by rice bran. The study focused on the optimization process in terms of concentration of crude lipase and transesterification time. The optimization was done based on Response Surface Methodology (RSM) to give either the optimum glycerol.

Keywords : Biodiesel; glycerol; lipase; and rice bran.

1. Introduction

Glycerol is one of the important materials in chemical industries. It is a potential raw material that can be converted into high value products such as glycerol trihepanoat (Sears & Darbey , 1982), glycerol monostearate (Kirk - Othmer, 1994), glycerol monooleate (Griffin, 1979), lecithin and tritetrabutyl glycerol (Kiatkittipong et al., 2010), glycerol triacetin (Pagliaro M, Rossi M. 2010)., glycerol tribenzoat and glycerol ester resin (Kern, 1966) .

Indonesia meet the needs of glycerol by imports from abroad which tends to increase from 2011-2014 (BPS 2014), as shown in Table 1

Table 1 Import of Glycerol Indonesia

Year	Import (Ton/year)
2011	1.963
2012	2.327
2013	2.208
2014	2.448

Source: BPS, 2014

Given the high growing import of glycerol, Indonesia needs to decline the import and produce its own glycerol while there are a lot of raw materials from Indonesia's own natural resources. One of the important efforts of making glycerol is to produce biodiesel as fuel oil (Mittlebach and Claudia, 2004) through transesterification reaction using vegetable oils, e.g., Crude Palm Oils (CPO).

The transesterification reaction is a process of reacting triglycerides in vegetable oils or animal fats with short-chain alcohols. The reaction is usually

added by a catalyst to accelerate the reaction rate and its conversion products. The catalysts that are often used in the transesterification reaction is a homogeneous alkaline catalyst (KOH, NaOH).

However, the reaction using chemical catalysts are not environmentally friendly, since their chemical wastes pollute the environment

Another alternative catalyst is to use an enzyme, in this case, lipase. The type of lipase used for the synthesis of vegetable oil is generally a microbial one which is relatively expensive due to its complicated production process (extraction, isolation etc). Therefore, efforts to obtain a cheap source of lipase is needed.

One of the natural ingredients that are known to have lipase activity is rice bran (Elizabeth *et al* , 1998).

So far there has been no research on the production of glycerol through transesterification reaction using crude rice bran lipase. Hence, it is necessary to study the use of crude rice bran lipase in producing glycerol through the transesterification reaction of vegetable oils .

Factors of enzyme concentration and reaction time greatly affects the product resulted from transesterification of vegetable oils . Long reaction time is directly proportional to the percentage of glycerol obtained, while the higher the concentration of the enzyme the faster the reaction takes place. In other words, the enzyme concentration is directly proportional to the speed of the reaction and conversion products. (Knothe, G. 2002) where the desired amount of glycerol should be high. The research herewith will be focused on the enzyme concentration and reaction time .

The purpose of this study was to determine the optimal conditions of transesterification reaction in glycerol production of crude palm oil using lipase rice bran and the physico-chemical properties of glycerol resulted from optimization using response surface method (RSM) .

2. Material And Method

A. Materials

Raw materials used in this study was obtained from the CPO palm processing factory of PTPN VIII Cikasungka Bogor , West Java Crude bran rice enzyme was supplied by a rice mill in Tanjungsari Sumedang that was stored in glass bottles which was sealed by silica gel to ensure its moisture content remained constant..

Chemicals used during the study was 0.1 N KOH , 0.05 N KOH , 95% ethanol , H₂C₂O₄ 0.1 N , acetone NaH₂PO₄ . H₂O , Na₂HPO₄ , alcohol 95 % , buffer pH 7.4 , a solution benedict , H₂O₂ , FeCl , methanol , isopropyl alcohol , amyl alcohol , sodium citrate , anhydrous Na₂CO₃ , K₂Cr₂O₇ 0.1 N , 6N H₂SO₄ , distilled water and 1 % PP indicator , the indicator bromtimol blue , ethylene glycol .

B. Methods

A. Research Methode

Optimization of this research is to find the concentration of enzyme crude rice bran and the optimal reaction time in order to produce the highest glycerol conversion of the CPO substrate. Concentration variable of crude rice bran enzyme and reaction time was selected for the enzyme has concentration and optimum reaction time on any substrate . In addition, the optimum temperature and pH of the enzyme of crude rice bran have been known based on preliminary research and literature studies and being used as a fixed variable.

The determination of the optimum condition of enzymatic transesterification reaction was carried out by experimental design of Response Surface Method (RSM) of Central Composite Design (CCD) type. Each experimental design is shown in Table 2 and Table 3, as follow:

Tabel 2 Value of Each Variable for CPO Enzymatic Transesterification Reaction

Treatment	(-α)	(-)	(0)	(+)	(+α)
Concentration of Lipase Enzyme <i>crude</i> of Bran Rice (%)	6,27	10	19	28	31,73
ReactionTime (h)	1,06	5	14,5	24	27,94

Run in this experiment amounted to 21, including 5 replicates to the middle point (center point) while other points (star and factorial points) were repeated twice. The responsevariable is expected as the output destination of enzymatic transesterification reaction. In this case there is only one response variable that is the concentration of glycerol (%).

Table 3 Overall Run for Optimization of Enzymatic transesterification reaction of CPO

Treatment	Concentration of Crude Rice Bran Enzyme (%)	Reaction Time (h)	Response
1.	19	27,94	Concentration of Glycerol Percentage
2.	28	5	
3.	10	5	
4.	19	1,06	
5.	19	14,5	
6.	19	14,5	
7.	28	24	
8.	19	27,94	
9.	28	24	
10.	31,73	14,5	
11.	6,27	14,5	
12.	10	5	
13.	19	14,5	
14.	10	24	
15.	28	5	
16.	19	14,5	
17.	10	24	
18.	19	14,5	
19.	19	1,06	
20.	6,27	14,5	
21.	31,73	14,5	

Having obtained the optimum variables, then followed by model validation and testing of physicochemical glycerol with descriptive methods that include water content, density, viscosity, and qualitative test of methanol

B. Main Research Procedure

The main research objective was to determine the optimum conditions of glycerol production process, the effect of the catalyst of crude rice bran concentration of lipase and reaction time of the conversion products as well as the physico-chemical properties of glycerol resulted from CPO. The stages of research activities were performed as follows:

1. Weighing: Crude rice bran lipase enzyme is weighed according to variations of % w / w of the oil in a beaker glass.

2. Addition of Phosphate Buffer: Crude rice bran lipase enzyme was filled into a 250 ml- Erlenmeyer flask, added with phosphate buffer at pH 7.4 by 8 drops / gram of crude rice bran lipase. The addition of phosphate buffer intended to maintain the pH of the solution during the transesterification reaction taken place for the optimum pH of crude lipase is 7.4 .

3. Addition of CPO and methanol with a molar ratio of 1: 6 (v/ v) into a 250 ml Erlenmeyer flask, then closed.

4. Transesterification reaction

The mixture was reacted for variation $t = h$ at $55 \pm 2 \text{ }^\circ\text{C}$ with agitation of 350 rpm using a shaker incubator

5. Filtration

6. The results of the transesterification reaction is a mixture of FAME and glycerol and crude rice bran lipase. The mixture was then filtered using a vacuum filter to separate the crude enzyme lipase in solid form.

7. Sentrifuse

The mixture was then inserted into a centrifuge tube and centrifuged at a speed of 4100 rpm for 1 hour to form two distinct phases . The top layer is a fatty acid methyl ester (FAME), while the bottom layer is a mixture of glycerol and methanol.

8. Testing Concentration

Glycerol result of enzymatic transesterification reactions using crude rice bran lipase concentrations were then tested using the titration method. The procedure can be found in Appendix 2.

9. Data Processing of RSM

The concentration of glycerol used as a response to the factors of time and concentration of the enzyme in the crude glycerol production optimization process. Data concentration of glycerol is then inserted into the Design Expert software to be optimized. The results of data processing in form of optimum conditions of glycerol production to produce the highest concentrations of glycerol.

10. Optimization Model Validation of RSM

The model validation was performed by transesterification reaction in accordance with the optimum conditions resulting from software design expert

3. Results And Discussion

A. Characterization of Raw Materials

1) Rice Bran

Characterization of raw material of rice bran was conducted to review the potency of rice bran oil when used as a lipase enzyme, as shown in Table 4.

Table 4 Charakteristic of Rice Bran

Parameter	Characteristics of Rice Bran
Water contentr (%)	4,46 (wb)
Protein Content (%)	16,59
Fat Content (%)	15,71
Lipase Activity (U/ml)	8,14

The potential of rice bran can be used as a crude enzyme lipase as seen from the content of fat, protein and high value lipasenya activity. This indicates that in the rice bran contained the enzyme lipase

2). CPO

Characterization of raw materials was also made to the CPO to determine its quality . Here is the characterization data of CPO are:

Table 5 Crude Palm Oil Characterization

Parameter	Characteristic of Crude Palm Oi
Water Content (%)	0,42
Density (g/mL)	0,9068
Free Fatty Acid (%)	4,14
Jod Number (g/100 g oil)	10,44
Saphonification numbers (mg/g oil)	198,83
Glycerol Qualitative Test	Negative

B. Optimization of Transesterification Reaction

1) Glycerol Concentration

The results of the research to 21 randomized run are presented in Table 6 of the 21 runs , 5 runs a middle point (center point) for examination and estimation of experimental error reducibility. The concentration of glycerol as presented in the response and the rightmost column shows the average value of experiments in duplicate.

Table 6 Glycerol Concentration Resulted From Transesterifikasi Reaction

Treatment	Concentration of Crude Enzyme of Rice Bran (%)	Reaction Time (h)	Glycerol Concentration (%)
1.	28	5	2,52
2.	19	27,94	2,48
3.	28	24	3,28
4.	31,73	14,5	4,14
5.	19	14,5	7,43
6.	19	1,06	0,83
7.	6,27	14,5	4,54
8.	10	5	2,49
9.	19	1,06	2,1
10.	28	24	3,74
11.	19	14,5	6,16
12.	19	27,94	2,08
13.	10	24	3,75
14.	19	14,5	6,98
15.	10	24	2,91
16.	19	14,5	6,88
17.	10	5	2,1
18.	31,73	14,5	5,02
19.	19	14,5	6,33
20.	28	5	2,52
21.	6,27	14,5	5,39

According to the Table 6, the concentration of glycerol produced varies, ranging from 0.83 % to 7.43% . The concentration of glycerol generated from each of the transesterification reaction conditions CPO is still considered low when compared to the concentration of glycerol generated from the transesterification reaction of palm oil using a chemical catalyst. As reported in the studies Damayanti (2010) that the CPO transesterification reaction with methanol and a catalyst assisted KOH and NaOH 0.6%, 0.6 % , both will produce glycerol concentration of ± 35 %

A low concentration of glycerol is likely due to the enzyme lipase in rice bran including crude enzymes that have a low lipase activity. The statement in accordance with Yesiloglu and Kilic (2004) which states that the product formed is not perfect due to using a form of the enzyme lipase still rough so that the amount required to be able to run the activities of transesterification is still inadequate.

2) . Selection Model RSM

The election process this model was based on a summary of statistical models . Statistical parameters used for selecting the right model was focused on the roots of R -Square and predictions highest R squared.

The following is a summary table of statistical models Order 2, as shown in Table 7:

Table 7 Model Summary In Statistics Order 2

Source	R-Quadrate	Predicted R-Quadrate	
Linear	0,034139	-0,22005	
Two Factors Interaction	0,034153	-0,29578	
Quadratic	0,941714	0,884567	Recommended
Cubic	0,947328	0,856316	denied

Based on the Table 6 it can be seen that the chosen model can explain the response (concentration of glycerol) is a quadratic model with root R- Squared value and the highest prediction of R squared

3). Analysis of Variance (ANOVA)

To determine the response of the interaction between variables contained in the equation obtained, it is a need to refer to the results of the Analysis of Variance (ANOVA). Experiments carried out there are two factors that do the optimization process is the concentration of crude rice bran lipase (A) and the transesterification reaction time (B) . The model equations to be obtained has 5 terms with each term has one degree of freedom. Term consists of two linear effect (A & B) , one effect of the interaction (AB) and 2 quadratic effect . Here is the data Analysis of Variance (ANOVA) on glycerol production process, shown in Table 8.

Table 8 Analysis of Variance (ANOVA)

Source	p-value Prob > F	
Model	< 0.0001	Significant
A- Crude of Bran Rice Enzyme	0.8983	
B-Reaction Time	0.0097	
AB	0.9535	
A ²	< 0.0001	
B ²	< 0.0001	
Lack of Fit	0.3037	not significant
R-Squared	94,17%	

P value (Prob > F) for the model are significant at the 95% confidence level. This means that variables in the model have a significant effect on the response of the concentration of glycerol. Moreover,

the lack of fit is non significant also shows that both models to be applied . The value of $R^2 = 0.9417$ shows that the crude enzyme concentration and reaction time effect amounting to 94.17 % while 5.83% are influenced by other factors such as ratio of methanol : oil and temperature used in the transesterification reaction .

In the ANOVA analysis of glycerol concentration response , variable having a significant effect on the production process of glycerol through transesterifikasi enzymatic reactions include transesterification reaction time (B) , A2 and B2

Transesterification reaction time was significantly affected on the production of glycerol. The longer the reaction time, it will generate a large percent glycerol concentration. It was due to the possibility of contact between the substance increases. Glycerol concentration continues to increase at 1.06 hours to 14.5 hours.

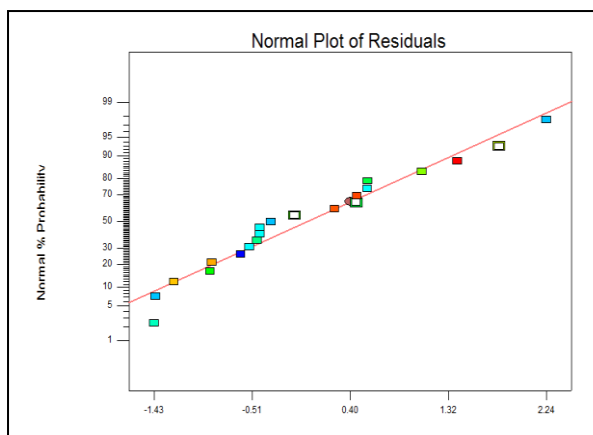


Figure 1 Plot of the normal probability and the residuals

However, if the reaction equilibrium has been achieved, then with time , it will not increase the product yield. The output of design experts , it was found that the reaction $t = 15.25$ hours is the time it will produce optimum glycerol concentration is equal to 6.77 % .

But then that at 15.25 hours to 27.92 hours decreased glycerol concentration results. This is because at $t = 15.25$ hours, the reaction has reached equilibrium . The reaction may be reversible (back and forth) so that when it reaches a point of equilibrium, then the reaction will shift to the left and far to the product (Suhendra *et al.*, 2005

Variable concentrations of crude rice bran lipase enzyme as well as its interaction with a variable time does not affect significantly the response of the glycerol concentration is indicated with a P value (rob > F) greater than 0.05 . The addition of crude enzyme with a concentration range from 6.27 % to 31.73 % were not sufficient to provide an increase in

the concentration of glycerol . This is because rice bran lipase activity of which is still very small

The accuracy of the model also can be seen from the comparison carried out using a normal probability plot of the residuals and residual plots against the prediction of response. Here's a curve of normal probability plot of the residuals and residual plots on a predicted response.

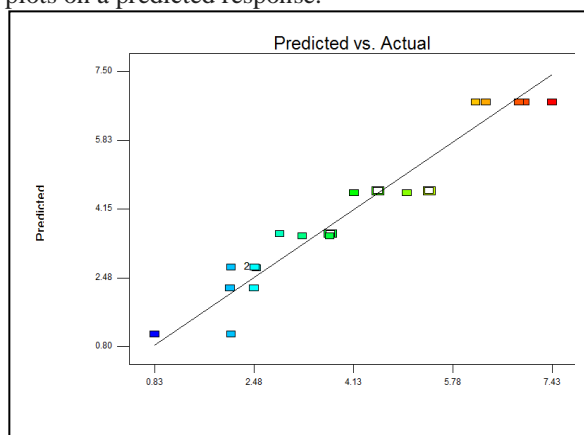


Figure 2. Plot of the residuals and the predicted response

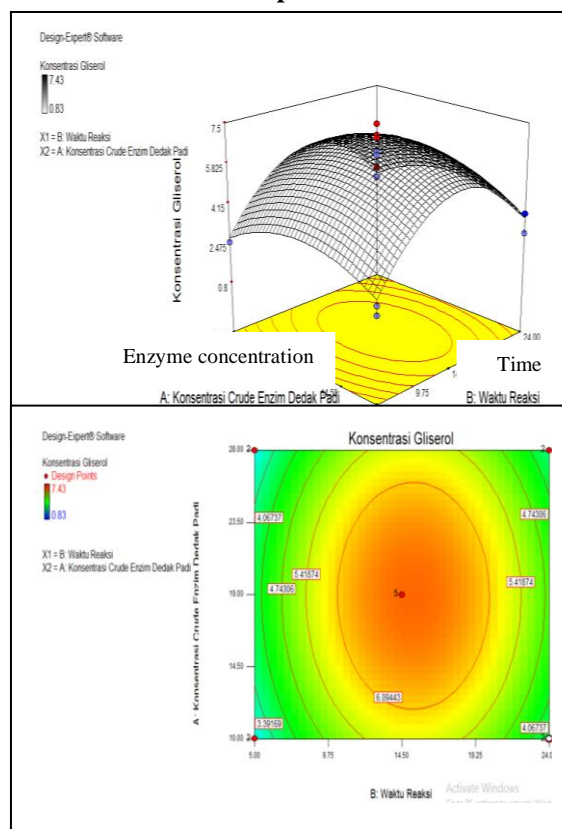


Figure 3 3D-Curve: Effect of Crude Enzym Concentration and time Reaction to Glycerol concentration.

Effect of crude enzyme concentration and reaction time on the concentration of glycerol, resulted from transesterification reaction – the profile and the 3D contour curves, as shown in Figure 3.

The influence of the concentration of crude enzyme (A) and reaction time (B) the concentration of glycerol as a result of transesterification reactions seen clearly in Figures 5 and 6 above. The concentration of glycerol will be maximum at a concentration of 18.92 % and a crude enzyme reaction time 15.25 hours with a concentration of glycerol to be gained by 6.77%

C. Validation Model RSM

The results of optimization using Response Surface Methodology in glycerol production through enzymatic transesterification using crude lipase can be seen in the following Table 9.

Table 9 Optimum Glycerol Production

No.	Run	Crude Enzyme of Rice Bran	Reaction Time	Gliserol Concentration
1	Predicted	18,92	15,25	6,771407
2	Actual	18,92	15,25	6,13165

AS can be seen in Table 9, there are differences in the concentration of glycerol predicted results of the optimization using the RSM and the actual results of the study. The accuracy of the results of RSM model validation based on the concentration of glycerol obtained amounted to 90.55 % , in other words acquired RSM models worthy to be a reference to the process of production of glycerol through the transesterification reaction .

Table 10 shows a comparison of the characteristics of glycerol resulted from transesterification reactions using crude glycerol with commercial lipase:

Tabel 10 Glycerol Characteristics

Physical Property	Commercial Gliserol	Researched Glycerol	Unit
Density	1,261	1,100	g/ml
Viskositas (20°C)	1499	1382	Cp
Water Content	0,5	0,24	%
Kualitative Methanol	-	+	-

4. Conclusion

1) Condition glycerol production process optimization using Response Surface Methodology is a crude enzyme concentration of 18.92 % , 15.25 hours reaction time will produce optimum concentration of glycerol amounted to 6.77% .

2) The results of the model validation RSM in glycerol production is crude enzyme concentration of 18.92 % , the reaction time of 15.25 hours to produce the optimum concentration of glycerol of 6.13 % .

3) The accuracy of the results of RSM model validation based on the concentration of glycerol obtained amounted to 90.55 % , in other words acquired RSM models worthy to be a reference to the process of production of glycerol by transesterification reaction .

4) Characteristics of glycerol results of the transesterification reaction is 0.24% water content , density of 1.1 g / mL , the viscosity of 1382 cp with methanol qualitative test positive , which means there is still a methanol in glycerol

5. Acknowledgement

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6. References

- [1] Badan Pusat Statistik (BSN). 2009. Statistik Impor Gliserol. Badan Pusat Statistik, Jakarta.
- [2] Elisabeth, J., A. Jatmika, dan K. Sinaga. (1998). “Lipase-Catalized Incorporation of N-3 PUFA into Palm Oil”. International Oil Palm Conference.
- [3] Griffin, W.C. 1979. Emulsions. Standen (ed) Kirk-Othmer Encyclopedia of Technology (3rd ed) 8 :117-154.
- [4] Kiatkittipong, W., Parinya, I. 2010, Glycerol ethers synthesis from glycerol etherification with tert-butyl alcohol in reactive distillation, Computers and Chemical Engineering, Elsevier Ltd. SciVerse ScienceDirect.
- [5] Sears, J., J. Darbey. 1982 . The Technology of Plasticizer, New York.
- [6] Kirk O, Christensen MW. 2002. *Lipases from Candida antarctica*: Unique Biocatalysts from a Unique Origin. Org Process Res Dev 6:446–451.
- [7] Kern. 1966. *Glycerol. Encyclopedia of Chemical Technology*. vol. 10. New York (US): Interscience Publishers.
- [8] Pagliaro M, Rossi M. 2010. *The Future of Glycerol*. Royal Society of Chemistry
- [9] Mittlebach, M. and R. Claudia. 2004. *Biodiesel The Comprehensive Handbook* Viema: Boersdruck Ges. M.bh.
- [10] Knothe, G. 2002. *Biodiesel: The Use of Vegetable Oils and Their Derivatives as Alternative Diesel Fuels*. Review. Agricultural Research Service, U.S. Department of Agriculture. United States of America

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A Role of Calcium on Leaching of Trace Elements from Coal Fly Ash

Farrah Fadhillah Hanum*, Akihiro Takeyama*, Shinji Kambara

*Environmental and Renewable energy Department, Gifu University, Gifu 501-1193, Japan
e-mail: v3815002@edu.gifu-u.ac.jp

Abstract Calcium has been known has a good decreasing in the leaching concentration of As. This study aims to provide the useful reference in controlling As leaching concentration into the environment through the effect of addition of suppressing material. Suppressing material, as the by-product of some industries which contains of high calcium, had been proven in decreasing of arsenic (As) leaching concentration from coal fly ash. There are three suppressing materials that have been tested, that are: paper sludge ash 3 and 4 (PS 3 and PS 4) and filter cake (FC). Calcium hydroxide (Ca(OH)₂) has been used as the standard for those three suppressing materials. Ca(OH)₂ and PS3 show almost 85-90% decreasing in As leaching concentration based on ICP analysis. Based on some instrumentation analysis, calcium oxide has been known as the almost calcium compound which is containing in PS 3 and also known has the best decreasing on As leaching concentration amongst the others calcium compound tested. Therefore, PS 3 is decided as the best suppressing material in controlling As leaching concentration in the environment.

Keywords: Coal Fly Ash; Calcium compound; Suppression material.

1. Introduction

Thermal power plant generates large amounts of fly ashes. Coal fly ash is powdery material leftover from burning ground or powdered coal. Presently, a substantial amount of these wastes is disposed in landfills and only 16% of total ash worldwide is potentially utilized for various applications such as cement production, synthesis of zeolite, mine backfill, and road-sub-base. If not properly disposed of, it can cause water and soil pollution, disrupt ecological cycles and pose environmental hazards.

The large volume of coal fly ash produced around the world is a potentially significant anthropogenic source of arsenic. Arsenic (As) is one of the most volatile and potentially toxic metals in coal. It is largely released into ambient as gas phase and/or associated with fine ash particulates during coal combustion. Even for the fine ashes which are captured in a power plant, the subsequent treatment through landfilling results in the mobilization of As into aquifer systems, which consequently causes damage to either surface water or groundwater.

Environmental quality standard is a value, generally defined by regulation, which specifies the maximum permissible concentration of a potentially hazardous chemical in an environmental sample, generally of air or water. The values vary from country to country in order to prevent health hazard and conserve the living environment. Related to the protection of human health, Japanese government established the permissible limit for As is 0.1 mg/L, and related to environmental quality standard for water pollution the As standard is 0.01 mg/L or less.

Understanding the leaching behavior of As

in coal fly ash is significant in evaluating its potential impact on the environment. Calcium is known to play an important role in the release of arsenic from coal fly ash. One hypothesis is that arsenic is reacting with calcium and precipitates as calcium arsenates. Suppressing material is by-products from industries which contains of high calcium contents.

In this research, leaching experiments have been done by the addition of some amounts of suppressing material into the coal fly ash sample. This addition is intended to decrease the arsenic leaching concentration, so that it can be used to control the leaching of arsenic into the environment. The role of suppressing materials onto arsenic leaching concentration will be verified in this study. Furthermore, the calcium compound that has influence in the process also will be investigated.

2. Methodology

A. Coal fly ash and suppressing materials

Coal fly ash sample H (FA H), is collected from a coal fired power plant (600MWe). It decided to use as the sample based on the low calcium contents (2.05% of CaO, measured by X-ray fluorescence; XRF), and high arsenic leaching concentration (48.66 µg/L, measured by ICP – AES/OES ULTIMA2, HORIBA Ltd).

Three kinds of suppressing material which have been tested in this research, they are papersludge ash (PS 3 and PS 4), filter cake (FC) and calcium hydroxide (Ca(OH)₂). The percentage of calcium oxide (CaO) which consists in PS3 and FC based on XRF analysis is 46.13% and 59.18%.

Paper sludge ash is waste generated by

the paper recycling industry. It is produced when dewatered waste paper sludge, a by-product of the de-inking and re-pulping of paper. It is combusted, to reduce waste volume and to produce energy. Filter cake (FC) comes from lime industry, which is waste in a CaCO₃ manufacturing process. Therefore, calcium hydroxide or Ca(OH)₂, is chemical compound that have been used to compare the results of both suppressing material above. Some pure calcium compounds also have been tested into FA H in order to investigating calcium compound which affect the leaching mechanism.

B. Sample preparation and leaching test

Coal fly ash was mixed with suppressing material in the mixed bag. The addition ratio of suppressing material is 5% and 10% of total mixture.

Leaching test No. 13 which notified by the Japanese Environment agency were basically employed as the leaching test in this work. Amounts of coal fly ash will was mixed with distilled water (the ratio 1:10) and it was shaken with the shaking speed 200 r.p.m for 6 hours in room temperature. Solid-liquid sample was separated by a filtration using membrane filter of 0.45 μm to obtain the filtrate. The arsenic concentration in the filtrate was measured by ICP-AES. The final pH of leachate was measured by pH/ION METER D-53, HORIBA.

C. Instrumentation

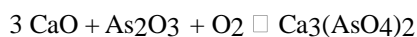
Ethylene glycol extraction insisted with ICP-AES analysis and thermogravimetric analysis has been carried out in the determination of calcium oxide and calcium hydroxide in coal fly ash and suppressing materials for the quantitative analysis.

X-Ray photoelectron spectroscopy (XPS Quantera SXM-G) analysis was applied into the investigation of calcium compound on the surface of coal fly ash and the XPS peak obtained were processed by using of MultiPak software.

3. Result And Discussion

A. The effect of suppressing material into As leaching concentration

Arsenic is reacting with calcium and precipitates as calcium arsenates, which is slightly soluble in water. The addition of suppressing material which contains high calcium contents could be enriched the calcium contents in coal fly ashes, so that the leaching of arsenic into the environment could be controlled.



Calcium hydroxide (Ca(OH)₂), as the standard calcium to compare the leaching results from the others suppression material shows almost 95% of decreasing compared with the leaching concentration of coal fly ash without suppressing material.

Paper sludge ash (PS3), shows the closest effect with Ca(OH)₂, with the decreasing percentage of arsenic leaching concentration is 85-90%, while the PS4 only shows 50% of decreasing. In the contrary with filter cake (FC) result. The effect of FC into As leaching concentration could not be detected.

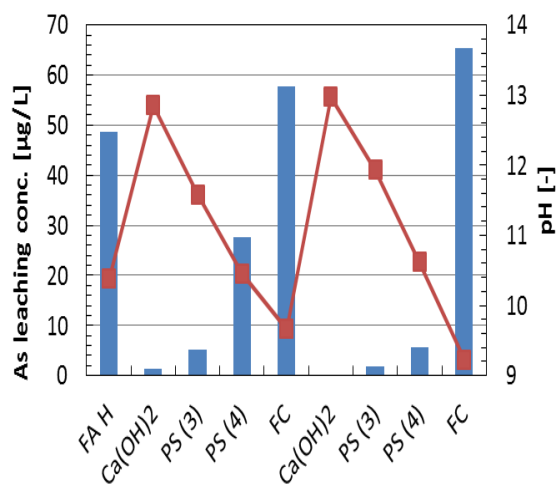


Fig 1. Suppressing material effect into trace elements As leaching concentration

This hypothesis has been insisted with the result from ion chromatography analysis as shown on Fig 2, which explained the relation between the concentrations of calcium ion in leaching solution and As leaching concentration. The effect of calcium into pH also was explained in the figure 1. The difference in pH could be an indicator of the calcium content amount in the leachate. In the next, the determination of pH leachate expected could be an indicator of the calcium role into As leaching concentration.

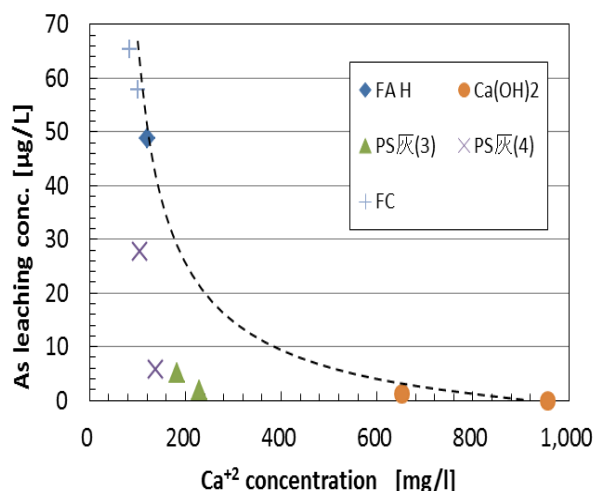


Fig 2. Correlation between Ca⁺² concentrations into As leaching concentration

B. Investigating calcium compounds in coal fly ash and suppression materials

Some calcium compounds have been tested as suppressing material into FA H in order to ascertain the effect of calcium into As leaching concentration. Based on the results have been known that calcium affects the As leaching concentration. Moreover, Fig. 3 explained that calcium oxide (CaO) and calcium hydroxide (Ca(OH)₂) gives better decreasing on As leaching concentration comparing with calcium carbonate (CaCO₃) and calcium sulphate (CaSO₄). Based on this results, could be hypothesized that PS3 and PS4 may contains CaO or Ca(OH)₂ and FC contains CaCO₃ or CaSO₄. Some analysis and instrumentation have been done to investigate the exact calcium compound in the suppression materials and coal fly ash itself. XPS analysis has been carried out into some pure calcium compounds and two suppressing materials, PS and FC, which showed the contrary effect each other.

Table 1 shows the XPS results of some pure calcium compound which will be used to compare the binding energy of coal fly ash and the both suppressing materials mentioned above.

Table 1. Binding Energy Data Of Pure Calcium Compounds

	Experimental Data	Data Base
CaO	346	346.2
Ca(OH) ₂	346.1	-
CaCO ₃	347	346.8
CaSO ₄	347.6	347.4

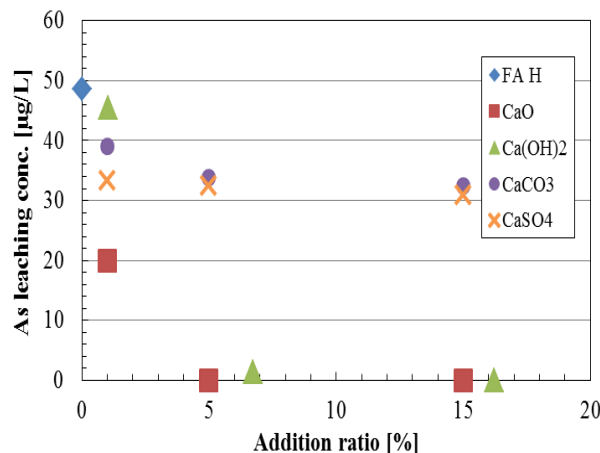


Fig 3. Calcium compounds effect into As leaching concentration

Table 2 shows the XPS analysis result of coal fly ash and the suppressing materials. Compared with the result from the Table 1, the estimated calcium which contain in PS3 and FC are CaO and CaCO₃. Could be said that PS3 is a good suppressing material because it is containing CaO and FC is not a good suppressing material because it is containing of CaCO₃.

Table 2. Estimated Calcium Compound In Coal Fly Ash And Suppression Materials

	Experimental Data	Estimated Ca compound
PS3	346.4	CaO
FC FA H	346.7	CaCO ₃
	347.1	-

The binding energy of coal fly ash sample (FA H) is in between the binding energy of CaCO₃ and CaSO₄. Therefore, XPS analysis had been carried out into the mixture of CaCO₃ and CaSO₄ in order to establish the calcium compound composition on FA H.

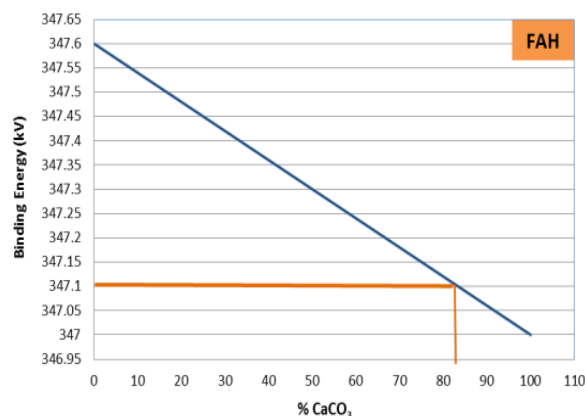


Fig 4. The XPS results of CaCO₃ and CaSO₄ mixture in CaCO₃ percentage

Figure 5 shows the calibration curve of CaCO₃ and CaSO₄ mixture. The composition of calcium compound in FA H was expressed in percentage of CaCO₃. By plotting the binding energy of FA H on the graph, estimated calcium compound in FA H have been investigated. The ratio of CaCO₃ and CaSO₄ in coal fly ash sample H in sequentially is 83% and 17%. Table 3 shows the comparison of calcium compound in FA H between calculation result and experimental result (XPS).

Calculation result is the results which produced by calculated the data from XRF analysis and ion chromatography analysis. Based on the FA H result from the both analysis, had been known that the percentage of CaCO₃ and CaSO₄ in FA H is almost same with the XPS analysis results.

Table 3 Comparison Between Calculation And Experimental Results

	Calculation Result (Wt%)	Xps Analysis Result (Wt%)
CaCO₃	81.45	8
CaSO₄	18.05	1

Based on the discussion above could be concluded that calcium which is consisting in coal fly ash is almost of CaCO₃ and material with high CaO or Ca(OH)₂ content is the best material for being suppressing material.

C. Quantitative analysis for calcium compound in coal fly ash and suppressing materials

The leaching experiment by ethylene glycol analysis has been conducted in order to know the amount of calcium oxide (CaO) and calcium hydroxide (Ca(OH)₂) content in leachate from the mixture of FA H and the three suppressing materials below. The results of this analysis will be measured by ICP analysis and insisted with thermogravimetric analysis.

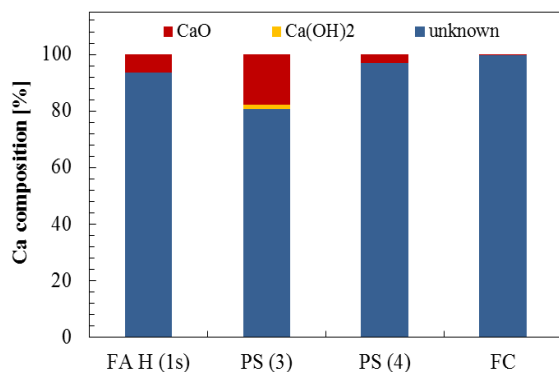


Fig 5. The calcium compounds ratio in coal fly ash and suppressing materials

Figure 5 shows that only PS 3 which is consisting of Ca(OH)₂ and PS 3 also content higher calcium oxide than the two others suppressing materials, 8.19%. FA H is containing 0.13% of CaO but based on the previous discussion, almost of the calcium contents in FA H is CaCO₃. Therefore, could be concluded that the unknown compound in the figure 5 is calcium carbonate (CaCO₃). Table 4 will show the CaO percentage each materials.

Table 4 Cao Composition For Coal Fly Ash And Suppressing Materials

Material	CaO composition (wt%)
FA H	0.13
PS 3	8.19
PS 4	0.57
FC	0.12

4. Conclusion

Based on this research has been known that suppressing material is affected on As leaching concentration. The most calcium compound which consists in FAH is CaCO₃ and that calcium compound did not give a good effect in As leaching concentration. CaO was known has a good decreasing in As leaching concentration. Paper sludge no 3 is containing high calcium oxide, therefore PS 3 is decided as the best suppressing materials for controlling As leaching into the environment.

5. References

- [1] Tian Wang, Jianmin Wang, Yulin Tang, Honglan Shi, and Ken Ladwig: Leaching characteristic of arsenic and selenium from coal fly ash: Role of calcium. *Energy and Fuel* 2009, 23, 2959-2966.
- [2] F. Jiao, L. Zhang, N. Yamada, A. Sato, and Y. Ninomiya: Role of calcium compounds on reduction of arsenic and selenium during fluidized bed coal combustion. *Chia Laguna, Cagliari, Sardinta, Italy, September 11-15, 2011.*
- [3] Tian Wang, Jianwang, Joel Burken, and Heng Ban: The leaching behavior of arsenic from fly ash. 2004.
- [4] Takatoshi Wako (2012): Industrial waste water management in Japan. Ministry of the environment. Government of Japan.
- [5] Misa Kato, Tatsuya Hari, Shingo Saito, and Masami Shibukawa: Determination of free lime in steelmaking slags by use of ethylene glycol extraction/ICP-AES and Thermogravimetry. *Tetsu-to-Hagane Vol. 100 (2014) No.3.*
- [6] Z.T. Yao, X.S. Ji, P.K. Sarker, J.H. Tang, L.Q. Ge, M.S. Xia, Y.Q. Xi: A comprehensive review on the application of coal fly ash. *Earth science reviews; 14-(2015)-105-121*

C006

Sand Adsorption Ability in Removing Metal Ion Dissolved in Solution With Batch Operation System

Bode Haryanto, Samuel Sitorus, Fransiscus R. Butarbutar, Aulia Chairunnisa, Michael J.C. Butarbutar

Chemical Engineering Department, Faculty of Engineering, University of Sumatera Utara
*haryanto_bode@yahoo.com

Abstract In this study, sand adsorption ability in removing cadmium ions dissolved in solution at pH 4.5, was investigated. The concentration variation of contaminant and size of sand and shaking rpm, were applied to measure the sand adsorption ability in removing Cadmium ions. The optimal of sand adsorption ability was 38%. The interaction model of the adsorbed on sand surface was investigated by using adsorption kinetics pseudo 1st and 2nd order. The interaction of sand surface was following the 1st order with slightly higher R^2 than 2nd order. The interaction type was occurred competitively in physical and chemical sorption. The contaminated sand was then remediated by using batch washing and column flushing without foam with SDS. The removal by batch was about 10.00% and by column flushing without foam is about 11.30%. Flushing in column without foam showed the domination of channeling effect in which the removal results were very low.

Keywords: Adsorption Ability; Sand Adsorbent; Contaminant; Remediation.

1. Introduction

Human activities in the production of various mining industries, agriculture, transport and others, can release large amounts of heavy metals into the environment. The main sources of metal pollution are the burning of fossil fuels, smelting of metal ores, the use of fertilizers and pesticides, and others [Sardar, et al, 2013]. Pollutants such as heavy metals are substances found in the environment that caused adverse effect by destabilizing. One of the hazardous metals is Cadmium (Cd^{2+}). Usually found in the form of mineral combined with other elements such as oxygen (cadmium oxide), chlorine (cadmium chloride) or sulfur (cadmium sulfate, cadmium sulfide). Cadmium can be toxic to almost every system of the animal's body, the environment, reduce quality of life and can ultimately cause death. (Duruibe, J. O., et al, 2007; Raikwar, Mukesh K., et al, 2008)

Sand can be a good choice as an adsorbent material, because the amount is abundant and easy to obtain in the environment. Many studies were done to evaluate the sand adsorption ability on heavy metal ions, other elements in the waste water, or soil (Shi, Shan, et al, 2014). To purify the contaminated water some methods already applied such as: adsorption process, coagulation and precipitation chemistry, electro-flotation, ion exchange and membrane separation (Da Mota, et al., 2014). Adsorption proses is more efficient and less expensive than other technology entrapment of heavy metals for water purification (Barros M. A. S. D., et al 2003).

Sand adsorption capacity is affected by pH, ionic strength, and the nature of divalent cations in the solution phase. Because sand is not porous, the

adsorption can only occur on the outer surface of the sand. The specific surface area and performance is an significant factor for its absorption capacity (Shi, Shan., et al, 2014; Thambavani dan Kavitha, 2014) evaluated the adsorption ability of sand to adsorb ion Cr without modifying the adsorbent. Gusain et al. (2013) modified the sand to adsorb ion Cu. Han et al. (2014) modified sand with FeS to adsorb the As metal with variation of pH and weight of adsorbent. Modified sand was possible to adsorb almost 100% As metal at pH lower than 7. Haryanto and Chang (2014) used natural sand to adsorb Cd and Cu then used bio-surfactant to remediate the contaminated sand. Shi, Shan et al. (2014) used sand adsorbent to remove dye contaminants.

This study is to evaluate the adsorption ability of the sand from Medan in removing Cd^{2+} metal ions from contaminated water with batch operation system. The interaction of metal ion and diffusion type were evaluated. Batch and column washing were applied to desorb the metal ion from the sand surface.

2. Material and Methods

The white sand was obtained from beach in the Tourism District Dolok Masihol, Serdang Bedagai regency, North Sumatra, Indonesia (Figure 1A). Every 1000 grams of white sand was washed with 1.2 L of deionized water (aquadestilator, W41 Water Still Favorit, Indonesia) by stirring with a propeller of 100 rpm for 1 hour. Effluent then discharged and a new washing water was added. It was done as much as 3-4 times and repeated until the pH of the washing water become constant (Figure 2.1.B).



Figure 2.1 (A) White Sand and (B) Propeller in Cleansing the Sand

The next step was the process of drying the adsorbent in the oven (Memmert UN, 55, Indonesia). The oven was turned on and waits until the temperature reached 60 ° C (Ansari, Et al, 2013). Every 10 minutes of drying time, the white sand was weighed until a constant mass achieved. The adsorbent was left up to cool to room temperature. Then the white sand was sieved to get mesh size variation: 10; 20 and 40 mesh size.

The solution provided was acid solution. Base solution is a solution of 0.1 M HCl 3 Liter and 0.1 M NaOH 3 Liter. The second solution was used as a pH solution control and as a metal solvent with pH 4.5 as much as 5 L. 5 L deionize water was put in a sterile

bottle. Then into the water were added HCl and NaOH to reach out pH 4.5 the materials were purchased from Mallinckrodt Baker, Inc, Paris and from Merck KgaA, Darmstadt, Germany, respectively. Solvent solution of pH 4.5 is taken out about 2.5 L. Then the solution is put into a sterile bottle. Then the solution was added with solid Cd (CH₃COO)₂ 2H₂O as much as 125 mg, purchased from Merck KgaA, Darmstadt, Germany. The mixture was stirred until the solid metal ions were dissolving. The solution was analyzed by AAS to confirm the content (ppm) Cd²⁺ in solution.

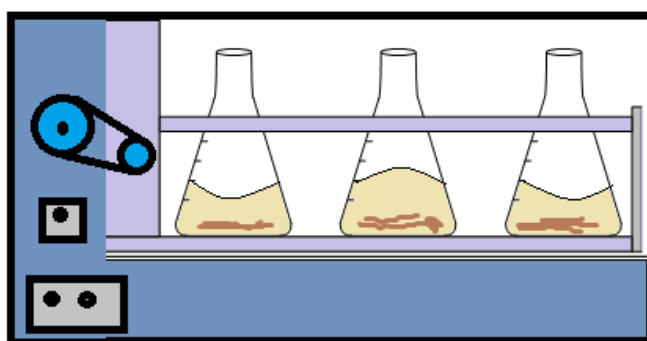


Figure 2.2 the orbital shaker for adsorption process and batch washing

Metal ion concentration Cd²⁺ + 50 ppm solution in 100 ml taken from the 2.5 L bottle, then inserted into every each of 10 bottles Erlenmeyer. Then 100 gram white sand adsorbent with size fit to a particular adsorbent is added to each of the solution within the 10 Erlenmeyer. Then all the bottles were the mixture is stirred with a shaker at stirring speed of 100 rpm at room temperature for 2 hours (Figure 2; d72379, Hechingen Edmund Buhler GmbH, KS 15A, Germany). Then all the erlenmeyers were allowed to stand without stirring for 24 hours to reach equilibrium adsorption of Cd²⁺ into the sand. The entire solution and sand accumulated 1000L and 1000 gram are to uniform the concentrations of Cd.

Then 50 mL samples were taken for analysis. Cd²⁺ ion concentration in the solution after adsorption were analyzed by Atomic Adsorption Spectroscopy (AAS), AA-7000 Series, Shimadzu Corporation, Japan. Then the 930 ml of fluid was taken and then dried in an oven. Then the concentration of (ppm) Cd²⁺ contained in the sand were calculated. Equation (1) is the amount of metal ion adsorbed in sand at equilibrium (q_e); q_t is the amount of metal ion adsorbed in sand at time t, when one run on contact time (Equation 2). Equation 3 (%R) is to calculate the percentage of metal ion removed from solution and when using the remediation by batch and column flushing from the sand contaminated. Equation 4 was

the accumulation amount of metal ion adsorbed in sand during adsorption process at equilibrium and residual left in sand after put in oven. Where: q_e , q_t and q_r is (mg/g); C_0 is the initial metal concentration (mg/L), C_t is the metal concentration at time t (mg/L) and C_e is the metal concentration at equilibrium (mg/L). V is the volume of solution (L) and m_{ads} is the mass of adsorbent (g). (Liuchun, Z., et al., 2010; Liu, W., Et al., 2013; Liu H., Et al., 2013; Vafakhah, S., et al., 2014; Arshadi, et al., 2014; Qinghai, H., et al., 2014).

$$q_e = \frac{(C_0 - C_e)V}{m_{ads}} \quad (1)$$

$$q_t = \frac{(C_0 - C_t)V}{m_{ads}} \quad (2)$$

$$R\% = \frac{(C_0 - C_e)}{C_0} \cdot 100\% \quad (3)$$

$$q_r = \frac{(C_0 - C_e)V_0}{m} + \frac{(C_e)V_r}{m} \quad (4)$$

Shown in Figure 2.2 The flushing column operation was as shown in Figure 2.3.

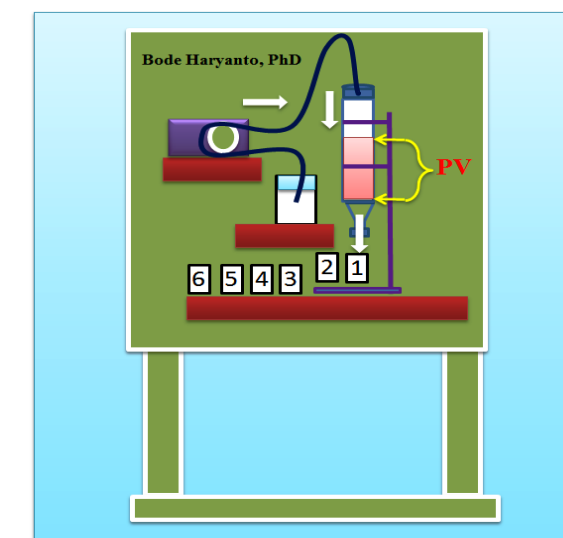


Figure 2.3 Flushing in Column Without Foam

In remediating with batch system, the 13 grams of contaminated Cd^{2+} sand was added to the Erlenmeyer. The remediation operations have been done with variation of SDS concentration and rotation speed of shaker (Haryanto, B., et al, 2014). Then the sample is taken timely up to 24 pore volumes. Cd^{2+} ion concentration in the effluent was analyzed by AAS. In flushing column, the 13 grams of contaminated Cd^{2+} sand was added to the remediation columns. Then it was remediated with 0.5 cmc surfactant, by controlling the solution flow rate of 2ml/min into the column (Haryanto, B., et al, 2014). Then effluent of surfactant accumulated on a beaker glass. Then the sample is taken up to 24 pore volumes. Cd^{2+} ion concentration in the effluent was analyzed by AAS. Then the value of %R was calculated by equation 3. Pore Volume (PV) was calculated as the free space of the inter area of the sand in the column. PV then was used as a parameter to collect the volume of effluent flushing from the column and for the volume of surfactant solution used in batch system.

Model for adsorption kinetic can be evidenced by the coefficient correlation (r^2). The equations of first order (5) and second order (6)

respectively expressed as follows (Chen S., Et al., 2011; Liu H., et al., 2013; Arshadi, et al., 2014):

$$\log(q_e - q_t) = \log q_e - \frac{k_1}{2,303} t \quad (5)$$

$$\frac{t}{q_t} = \frac{1}{k_2 q_e^2} + \frac{1}{q_e} t \quad (6)$$

Liu H., et al. 2013 has reported that the adsorption process was understood as a process of migration of a substance from the solvent to penetrate the surface of the adsorbent. The diffusion of an ion is referred to as an external diffusion and can be described using the following Equation 7:

$$\ln \frac{C_t}{C_0} = -z \cdot t + C \quad (7)$$

$$\text{with: } z = \frac{k_f A}{V} \text{ and } \frac{A}{V} = \frac{3m}{\rho d}$$

C_0 , C_t , and A/V are respectively the initial concentration of the solution, the concentration at time t , and the ratio between the total particle surface

areas to volume of solution. Liu H., et al. (2013) compared the sample to A/V. Where m is the mass of adsorbent (g), d is the particle diameter (m), and ρ is the density of adsorbent (g/cm³). External diffusion coefficient, k_f (cm/s), can be determined from the slope of the line from the plot of ln (C_t/C₀) versus t.

Internal diffusion can be described by experimental data using the following Equation 8 (Chen S., et al., 2011):

$$q_t = k_{id}\sqrt{t} + C \quad (8)$$

Where q_t is the adsorption capacity at time t (mg/g), the k_{id} is a diffusion coefficient (mg/g.min^{0.5}) and t is the time of adsorption. To confirm the present of metal ion on the sand surface area, was analyzed by BET micrometric Instrument Laboratory, PT. Indonesia Asahan Aluminium (PT. INALUM).

3. Results and Conclusions

3.1. Results

In investigation on the variation of adsorbent size, from analysis it can be seen that the current size of 40 mesh adsorbent has the best

removal of Cd²⁺ with the (R%) is 43.47% for 2 hour sorption process with shaking and 45.62% for 24 hour sorption process without shaking. Meanwhile, when the size of the adsorbent is 10 mesh, has the smallest removal of Cd²⁺ in solution for 2 hours and 24 hours sorption process which are 36% and 39.35%. Sand 40 mesh size has larger surface area that possible to increase the adsorption capacity in removing the metal ion compared with 10 and 20 mesh size.

Confirmation by BET method, this sand surface area is large enough. It was found that the specific surface area of the 40 mesh white sand adsorbent is 368 cm²/gram. The sand surface area was greater than the surface area of the specific river sand in India which is 76.75 cm²/gram (Thambavani, 2014). When an adsorbent has a larger surface area, the width of the contact area between the adsorbent and adsorbate will be greater, so that the process will provide higher adsorption ability (Widihati, et al, 2012).

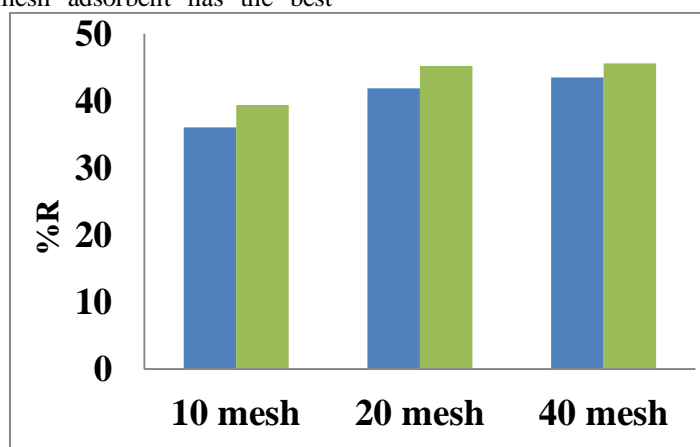


Figure 3.1 %R of metal ion Cd verse variation of mesh size of sand

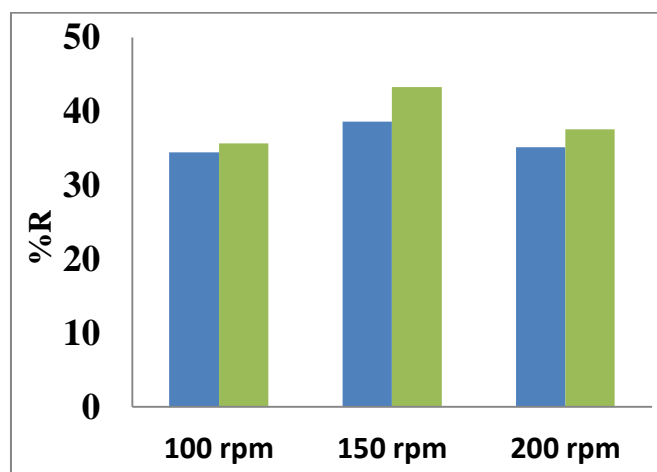


Figure 3.2 %R of metal ion Cd verse variation of rotation speed

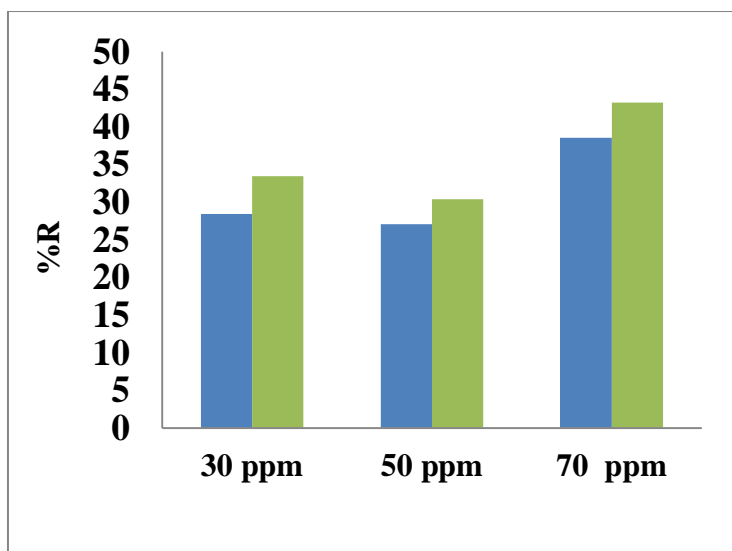


Figure 3.3. %R of metal ion Cd versus initial concentration

Variation of Shaker's Rotation Speed is shown in Figure 3.2. From the analysis above, it can be seen that the stirring speed of 150 rpm provides the largest percentage of adsorption. In the removal percentage that is: at the time $t_0 = t_1 = 0$ minutes to 120 minutes and $T_{max} = 24$ hours, the %R was increase from 38.61% to 43.28% respectively. While the smallest removal percentage is on the stirring speed of 100 rpm when, $t_0 = t_1 = 0$ minutes to 120 minutes and $T_{max} = 24$ hours with the %R : 34.48% and 35.63%.

Stirring speed is also one important factor that can affect the ability and adsorption capacity of an adsorbent. Higher rotation speed can encourage the mass transfer of the solution to diffuse the ions in large amount onto the intra surface area of the adsorbent. It is caused by a layer of film on the adsorbent that thinning the adsorbent which make it able to penetrate the layer film (Drastinawati and Zultiniar, 2013). But the stirring speed if too fast will cause desorption then the adsorption capacity will decrease (Thambavani, et al., 2014). It was shown in

this result, which increasing the speed at 200 rpm, decreased the %R.

Variations of initial concentration, of contaminant in solution are shown in Figure 6. From the result, it can be seen that the solution concentration of 70 ppm Cd^{2+} has the largest removal percentage. For the adsorption process at the time $t_0 = t_1 = 0$ minutes to 120 minutes and $T_{max} = 24$ hours, %R were 38.61% and 43.28% respectively. While the smallest removal percentages of Cd^{2+} concentration 50 ppm at the time, $t_0 = t_1 = 0$ minutes to 120 minutes and $T_{max} = 24$ hours are 27.11% and 30.45%.

The above experimental results show that the removal is proportional with the concentration of the metal ions. In other words, the interaction between the metal ions and adsorbent will increase concurrently with the increasing concentration of the metal. The reason is because the greater the concentration of the metal ion in the solution will cause more amount of adsorbate absorbed on to the active sites of the adsorbent (Haryanto and Chang, 2014).

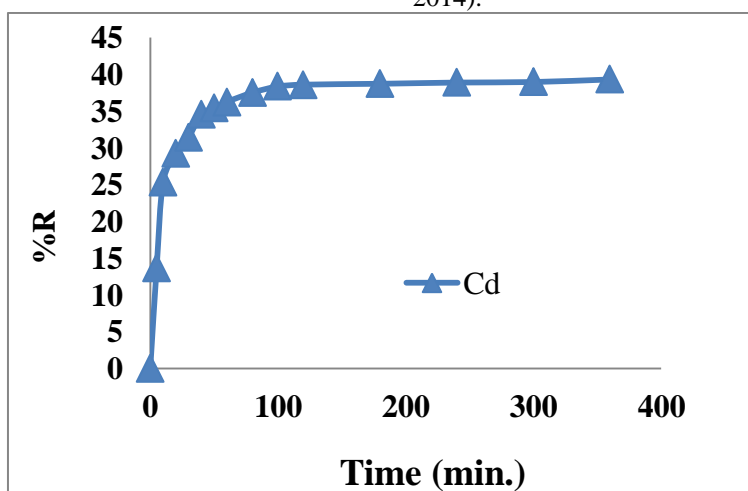


Figure 3.4 %R of metal ion Cd verse contact time of adsorption kinetic

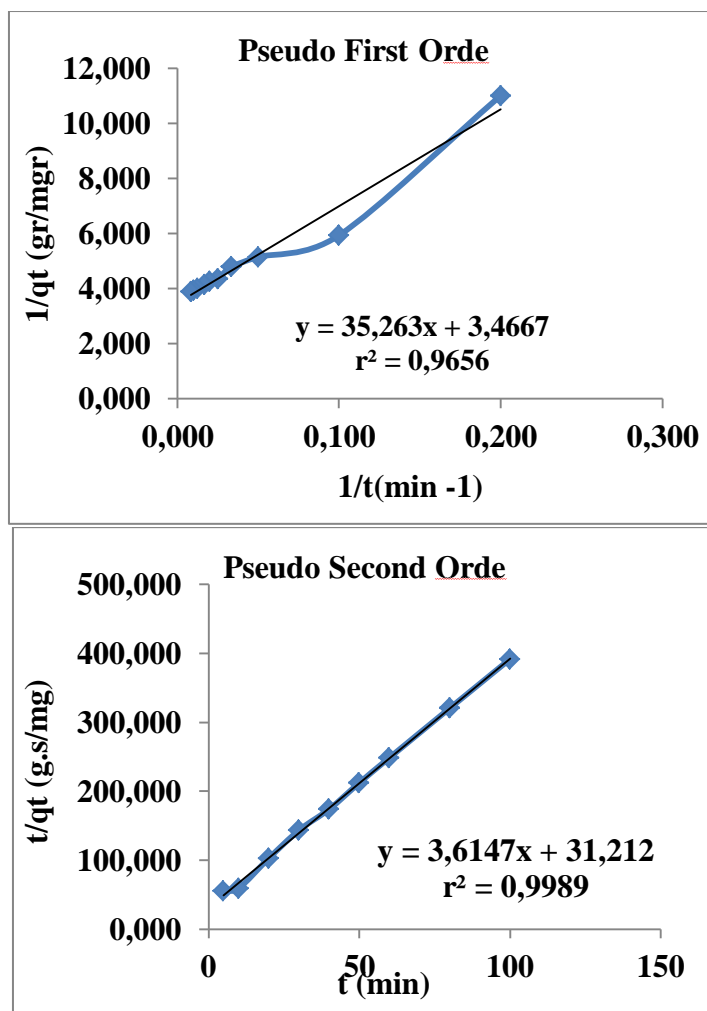


Figure 3.5 Pseudo First Order and Second Order

Adsorption Kinetics is demonstrated at Figure 3.4. The adsorption equilibrium can be achieved by measuring the contact time between the adsorbate with the adsorbent. From the results, in the first 5 minutes, the amount of metal ions Cd²⁺ adsorbed was only 13.66%. Cd²⁺ adsorbed achieves optimum point in the minute-200, where the %R adsorbed was 39.31%.

At the beginning of the adsorption process, many adsorbent surfaces not yet absorbed the Cd²⁺ ions which makes adsorption is low. Adsorption capacity continues to increase to adsorb Cd²⁺ ion until the time of 200 minutes with the concentrations of adsorbate Cd²⁺ consecutively 25.35%, 29.22%, 31.44%, 34.55%, 35.41%, 36.25%, 37.51%, 38.35%, 38.61%, 38.72%, 38.89%, and 38.96%. After 100 minutes operation, adsorption interaction of Cd²⁺ by white sand had approached a constant point. This show, that the adsorption process has achieved an equilibrium state (Thambavani and Kavitha, 2014). The equilibrium time is to find out when an adsorbent already reached saturation so that the adsorption process has been completed.

From the results of theoretical calculations, the correlation coefficient (r²) for first order is lower

than second order as shown at Figure 3.5. The equation of first order has a value of r² = 0.965 and equations of second order has a value of r² = 0.998. This shows that the pseudo second-order modeling makes more presentative of the adsorption data. From these data it can be concluded that the adsorption process is involving a chemical reaction (chemisorption) between the adsorbate and adsorbent (Thambavani and Kavitha, 2014).. With both r² was very close it may be concluded that the interaction on the surfaces occur together with physical sorption.

The correlation coefficient (r²) for external diffusion was lower than internal diffusion as shown at Figure 9. The value of external diffusion is r² = 0.6818 and the value of internal diffusion is r² = 0.7956. These show that the internal diffusion is more presentative of the data. From these data they are shown that the adsorption process was dominant by as internal diffusion. With both r² figures were close it may be concluded that the diffusion on the surface occurs together with external diffusion. The internal diffusion was at inter particle area of sand.

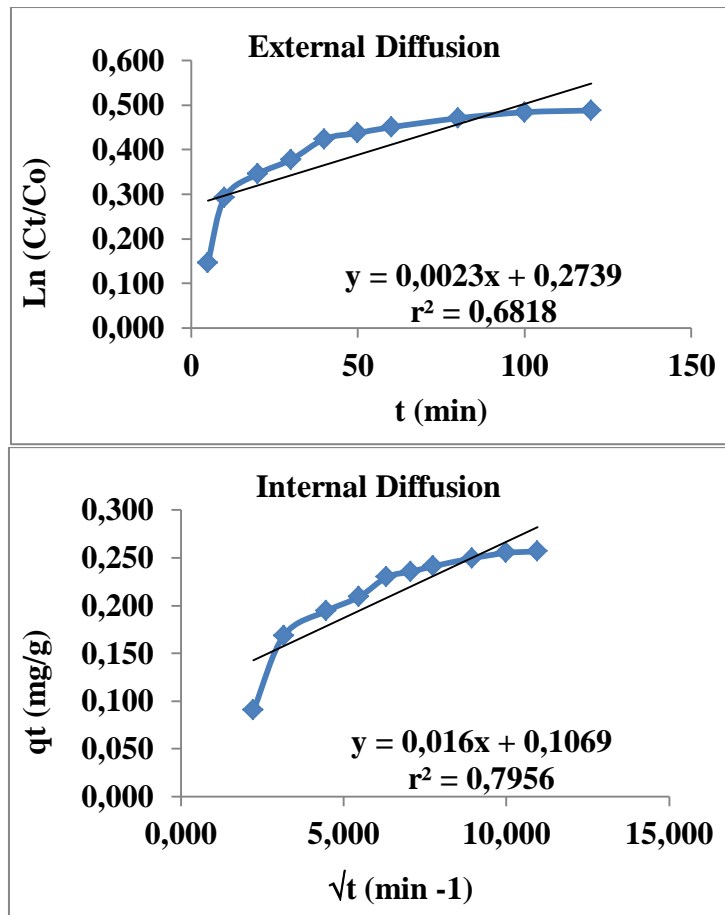


Figure 3.6 Internal and External Diffusion

In this study the contamination was 37.7817 mg/kg of Cd²⁺ on sand. The result in remediation by flushing with batch system is shown in Figure 10. The concentration removal efficiency is at 2 CMC of SDS concentrations and with stirring speed of 100 rpm, the result is 1.39 ppm. For percentage removal efficiency is 10.01%. While the removal efficiency of the lower concentration of SDS is 0.4371 ppm with the percentage of removal efficiency (%RE) is 3.1464%.

In theory, the shaking speed is directly proportional to the results of removal efficiency. The greater the speed of shaking will increase the metal removal efficiency. According to Haryanto, et al., 2014, the surfaces of the sand has fractions on their outer surface and inter surface area. By doing the shaking, the surfactant monomer may diffuse further to interact with the Cd²⁺ ions that possible to increase the removal efficiency. Surfactant concentration is one important factor in increasing the removal efficiency.

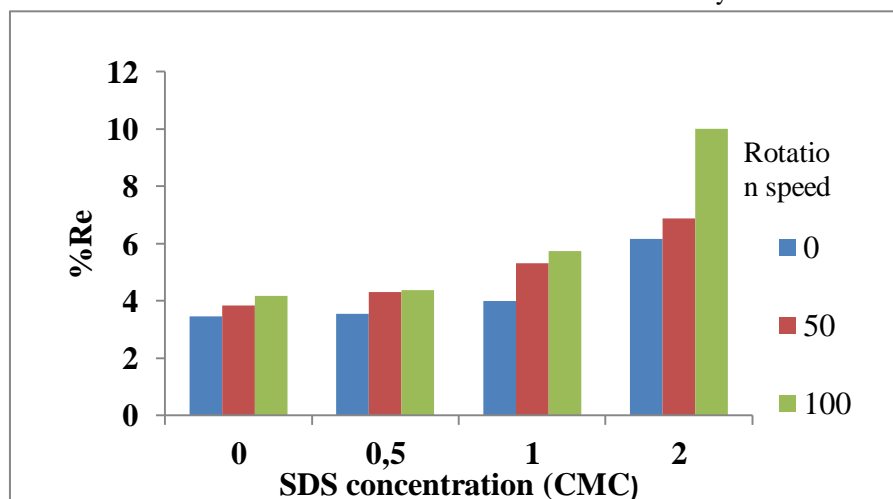


Figure 3.7. %R of metal ion Cd to desorb verse SDS concentration with batch system

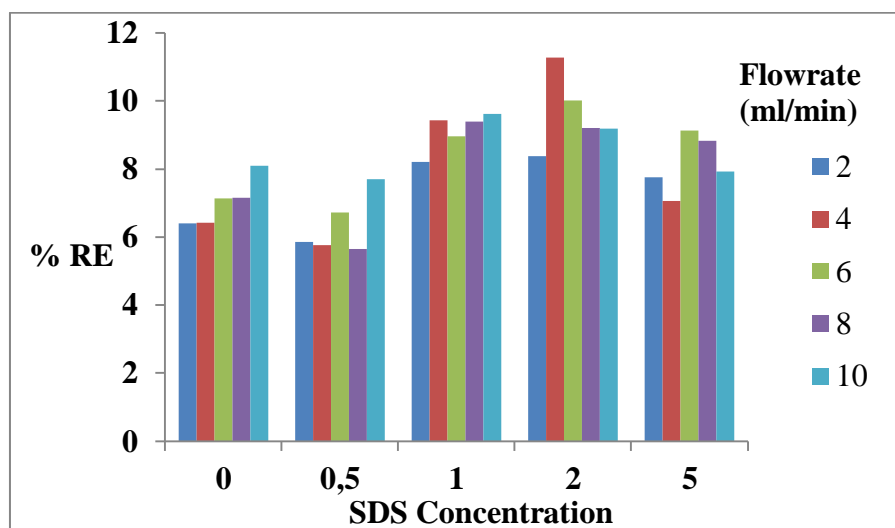


Figure 3.8 %R of metal ion Cd to desorb verse SDS concentration in column remediation

Figure 3.8 demonstrates the removal efficiency over metal ion with the variation of SDS concentrations. From the analysis above, it can be seen the effect of SDS concentration and flow rate on the SDS removal efficiency. The results show comparisons between washing with water and washing using surfactants. It can be seen that washing with water (0cmc) with an increased rate of SDS water also increases the removal efficiency.

The result obtained was fluctuated about 0,5x cmc. This is due to the addition of SDS molecules only on the surface of the water, so that the interactions to the metal ion onto the sand surface is low. Because the sulfur-containing on the molecule of SDS, SDS can bind with heavy metals and facilitate and initiate desorption of heavy metals from the soil (Anhua long, et al 2013).

Using 1x cmc, micelle is formed; it is enough to add the ability to interact with the metal ions on the surface of the sand. When the surfactant molecules are increased, the micelles begin to form what is called: the critical micelle concentration (CMC). Interactions of micelles with a hydrophilic surface further enhancing desorption of contaminants from the sand (Xuhui, Mao, Et al, 2014).

For 2 x cmc, the number of micelles is increased, the interaction with metal ions Cd (II) is possible to increase. This further enhance the interaction to desorb metal ion Cd (II) contaminants on the sand surface. But the results were fluctuating against the increase in flow rate. The channeling effect cannot be controlled at a certain flow rate of SDS. Channeling effect on the flow of washed solution leads to lower contact area between the washing solution and the surface of the sand. Channeling effect is a key factor that limits the achievement of efficiency in the removal or washing without foam technique (Haryanto, Bode, et al, 2014).

At the time of the surfactant solution with a concentration of 5x cmc, the numbers of micelles are increased. It caused the micelle to repel force among the negative charge of SDS that tends not to interact with the surface of the sand. If the surfactant is added and exceeds the CMC, the micelles number will continue to grow but their size will remain almost constant (Mulligan, C. and Suiling W., 2004). SDS tend to directly flow out without interacting with the surface of the sand which then produces a channeling effect (Haryanto, B., et al, 2014). According Ramamhurti (2013), when the SDS concentration passes CMC increases in metal ion released, are not significant.

An increase in the concentration of SDS, a strong repulsion occurs between the surface of the sand and surfactant molecules for group/aggregate negative head of surfactant SDS. Above experimental results show that the removal efficiency is unstable against SDS concentration. This is due to the channeling effect on the flow of washing solution, leads to a lower contact area between the washing solution and the surface of the sand. As a result, the group micelles can only interact with ion Cd (II) and generate small removal percentage of washing (Haryanto, B, et al, 2014).

3.2. Conclusions

The adsorption capacities of the sand were affected by variation of initial concentration, speed rotation and size of Sand. Increasing the concentration will increase the adsorption capacity. The larger sand surface area increases the ability to adsorb the metal ions. Increasing the rotation speed will increase the adsorption capacity but also will desorb the metal interaction on surface if the speed is too high. The adsorption capacity increases by increasing contact time until reached the optimum adsorption or achieves equilibrium. The kinetic

model tends to occur the chemical sorption and internal diffusion on inter particle area. The flushing with batch approach has limitation to remove the metal ion. Flushing without foam also tends to create channeling effect.

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5. References

1. Anhua Long a,b, Hui Zhang a,†, Yang Lei a “Surfactant Flushing Remediation of Toluene Contaminated soil: Optimization with Response Surface Methodology and Surfactant Recovery by Selective Oxidation with Sulfate Radicals” Separation and Purification Technology 118 (2013) 612–619.
2. Amruthur Ramamurthy and Hesham Schalchian. 2013. “Surfactant Assisted Removal Of Cu(II), Cd(II) And Pb(II) From Contaminated Soils”. Environment Protection Engineering. Vol. 39 2013. No. 3.
3. Arshadi, M., Amiri, M.J. and Mousavi, Sajjad. (2014). Kinetic, equilibrium and thermodynamic investigations of Ni(II), Cd(II), Cu(II) and Co(II) adsorption on barley straw ash. Water Resources and Industry. 6, 1-17.
4. Barros, M.A.S.D., Zola, A.S., Arroyo, P.A., Aguiar, E.F.Sousa., dan Tavares, C.R.G. Binary Ion Exchange of Metal Ions in Y and X Zeolites. Vol. 20 no.4. Departamento De Engenharia Química, Universidade Estadual De Maringá. Brazil. 2003
5. Catherine Mulligan and Suiling wang 2004 an evaluation of surfactant foam technology in remediation of contaminated soil , Department of Building, Civil and Environmental Engineering, Concordia University, Canada. vol 57 1079-1089
6. Chen, Suhong., Yue, Qinyan., Gao, Baoyu., Li, Qian and Xu, Xing. (2011). Removal of Cr(VI) using modified corn stalks. Journal Chemical Engineering. 168, 909-917.
7. Da Mota, De Oliveira, Izabel., De Castro, Adilson, Jose., De Goes Casqueira, Rui., De Oliveira Junior and Gomes, Angelo. (2014). Study of electroflotation method for threatment of wastewater. Journal of Materials Research and Technologi. 4 (2), 109-113.
8. Drastinawati, dan Zultiniar. Pengaruh Kecepatan Pengadukan dan Temperatur Terhadap Konstanta Kecepatan Adsorpsi Cu²⁺ dengan Arang Aktif Cangkang Kelapa Sawit Sisa Pembuatan Asap Cair. Jurnal Teknobiologi, Vol. 4, No. 1, Hal : 47-53. Jurusan Teknik Kimia, Universitas Riau. Pekanbaru. 2013.
9. Duruibe, J. O.I, dkk., 2007. “Heavy metal pollution and human biotoxic effects”. International Journal of Physical Sciences Vol. 2. 2007 (112-118).
10. Gusain, Deepak., Srivastava, Varsha., Sharma, Yogesh Chandra., “Kinetic and Thermodynamic Studies on The Removal of Cu(II) Ions from Aqueous Solutions by Adsorption on Modified Sand”. Journal of Industrial and Engineering Chemistry. 2013.vol. 20. (841-847)
11. Han, Young-Soo., Demond, Avery H., Gallegos, Tanya J., Hayes, Kim F., “Dependence of Particle Concentration Effect on Ph and Redox for Arsenic Removal by Fes-Coated Sand Under Anoxic Conditions”. Chemosphere. 2014. Vol. 134 (499-503)
12. Haryanto, Bode., and Chien-Hsiang Chang, “Foam-Enhanced Removal of Adsorbed Metal Ions from Packed Sands with Biosurfactant Solution Flushing”, Journal of The Taiwan Institute Of Chemical Engineers (2014a). Vol. 45 (2170-2175)
13. Haryanto, Bode., Jo-Shu Chang and Chien-Hsiang Chang, “Application of Biosurfactant Surfactin on Coper Ion Removal from Sand Surfaces with Continuous Flushing Technique”, Carl Hanser Publisher, Munich (2014b) 1-5.
14. Liuchun, Zheng., Dang, Zhi., Yi, Xiaoyun and Hui, Zhang. (2010). Equilibrium and kinetic studies of adsorption of Cd (II) from aqueous solution using modified corn stalk. Journal of Hazardous Materials. 176 (650-656).
15. Liu, Wen., Wang, Ting., Borthwick, Alistair G.L., Wang, Yanqi., Yin, Xiaochen., Li, Xuezhao and Ni, Jinren. (2013). Adsorption of Pb²⁺, Cd²⁺, Cu²⁺ and Cr²⁺ onto titanate nanotubes: Competition and effect of inorganic ions. Journal Science of The Total Environment. 456, 171-180.
16. Liu, Haibin., Wang, Cuiping., Liu, Jingting., Wang, Baolin and Sun, Hongwen. (2013). Competitive adsorption of Cd(II), Zn(II), and Ni(II) from their binari and ternary acidic systems using tourmaline. Journal of Environmental Management. 128, 727-734.
17. Raikwar, Mukesh K., Kumar, Puneet., Singh, Manoj., Singh, Anand. Toxic Effect of Heavy Metal in Livestock Health. Veterinary World. 2008. Vol. 1 (28-30)
18. Shi, Shan., Gondal., Mohammed A., Shen, Kai. Batch and column adsorption of dye contaminants using a low-cost sand adsorbent. College of Materials Science and Technology, Nanjing University of Aeronautics and Astronautics. China. 2014. Vol. 41 (6999-7013)
19. Sardar, Kamran., Ali, Shafaqat., Hameed, Samra., Afzal, Sana., Fatima, Samar., Shakoore, Muhammad Bilal., Bharwana, Saima Aslam., Tauqeer, Hafiz Muhammad., “Heavy Metals Contamination and what are the Impacts on Living Organisms”. Greener Journal of

- Environmental Management and Public Safety. Vol.2, No.4, Hal.172-179, 2013.
20. Thambavani, D. Sarala., Kavitha, B. Removal of Chromium (VI) Ions by Adsorption Using Riverbed Sand from Tamilnadu- A Kinetic Study. International Journal of Research. 2014. Vol. 1 Issue 4 (513-625)
21. Qinghai, Hu., Xiao, Zhanjin., Xiong, Xinmei., Zhou, Gongming., Guan, Xiaohong. (2014). Predicting heavy metals adsorption edges and adsorption isotherms on MnO₂. Journal Openvironmental Sciences. JES, 27, 207-216
22. Vafakhah, S., Bahrololoom, M.E., Bazarganlari, and R., Saeedikhani. (2014). Removal of copper ions from electroplating effluent solutions with native corn cob and corn stalk and chemically modified corn stalk. Journal of Environment Chemical Engineering. 2, 356-361.
23. Widihati, I. A. Gede. Adsorpsi Anion Cr (VI) Oleh Batu Pasir Teraktivasi Asam Dan Tersalut Fe₂O₃. Jurnal Kimia Vol. 2, No. 1, Hal. 25-30. Jurusan Kimia Fmipa Universitas Udayana, Bukit Jimbaran. Bali. 2008.
24. Xuhui Mao et al.,. Use of Surfactants for the Remediation of Contaminated soils.” Journal of Hazardous Materials (2014). School of Resource and Environmental Science, Wuhan University, Wuhan 430072, China. Vol 285 (419-435).

C 008

Piping System Upgrading At Waste Water Treatment System Of Steel Plant Based on Asme B31.3

Iman Satria¹, Rizky Arman², Yovial³

^{1,2,3}Department of Mechanical Engineering, Industrial Technology Faculty, Bung Hatta University
19 Gajahmada Street, Olo Nanggalo, Padang 25143 Telp. (0751) 7054257, Fax. 7051341
*extro_iman@yahoo.com, rizky.arm@gmail.com, jmahyoedin@yahoo.com

Abstract A steel plant requires upgrading the piping installation at the waste water treatment systems. Waste water pretreatment system use piping systems and basically an industrial want that the production process goes running with a good system and in accordance with the planned standards. In this research, stress analysis carried out by manual calculations and using CAESAR II software. The pressure in the pipe or piping system generated as a result of loads such as, sustained loads and loads due to expansion. From the simulation can be seen that the safe limit pipe materials used in piping systems wastewater treatment of steel plant to the stress resulting 31.2 MPa and the allowable stress 266.5 MPa. Theoretical calculations and by simulation software obtained error on Bending Stress (S_b) at 2.02%, and Displacement stress (S_E) at 2.02%. By providing variations input temperature of pressure 89.6 kPa, temperatures are not allowed greater than 246 °C, and at temperature 46 °C pressure variations are not permitted huge pressure of 15089.6 kPa past the allowable stress that the pipe will be through fatigue failure (exhaustion).

Keywords: piping; CAESAR II; Bending Stress; Displacement stress; Node; Stress.

1. Introduction

A steel industry requires upgrading the piping installation at the wastewater pretreatment systems. Pretreatment system is necessary to reduce the content of dissolved metals from wastewater before discharge to the environment. Due to wastewater discharged from the steel plant contain substances that may be harmful to human health and pollute the environment.

Wastewater pretreatment system use piping systems and basically an industrial want that the production process goes running with a good system and in accordance with the planned standards, in other words an industry want a process that occurs must be effective and efficient.

To design piping system properly, the engineer must understand the system behavior due to load and regulations (standard code of design) to adjust the design of piping systems. This piping system behavior is described by physical parameters, such as displacement, velocity, stress, force, moment and the other magnitude. Engineering work to obtain the behavior of piping system is known as piping stress analysis or formerly called flexibility analysis.

The design of the piping system is a major part of the design and engineering fluid flow. Stress analysis is an important component of the piping design through parameters such as pipe safety, components safety and deflection.

The use of CAESAR II by comparing the values of manual calculations, that the results of the software is identical to the manual calculation. In some case deviate from the expected value of the software. However, the disorder was only 3.6%. In an industry regulation, omission of 10% allowed.

Therefore, it can be concluded that the software gives the expected results and error-free.

In this study discusses the calculation of stress analysis piping system which refers to code or international standards are ASME B31.3 Process Piping. In this study conducted a case study with the help of CAESAR II ver.8.00 software and do the calculations manually.

2. Material and Method

Material

Pipe is a medium where the fluid flow from one place to another. In the piping system are some of the terms of the piping system such as piping and pipeline. Piping is a pipe system on a plant as a facility for delivering fluid (liquid or gas) between one component to another to get through certain processes. This piping will not be out of the area of a plant. While the pipeline is a pipe system to deliver fluid from one plant to another plant that normally pass through some areas.

Techniques to design the piping system are based on stiff piping system and flexible piping system. A flexible system is easier and can be done manually design calculations (simple calculation method) using the principle of increasingly flexible structure then the lower stress will happen. The flexibility of piping system can be made in several ways, such as by adding expansion loop that gives freedom of movement to the pipe. This method is only economical for pipes lower in price, due to the addition of the loop means that the addition of the pipe material and especially the elbow that price is relatively expensive.

Flexible piping systems do not need the support too much and usually kind of the support is simple and inexpensive. If the pipe material used is expensive and does not have enough space to create a loop, then the stiffness approach be an alternative.

a. Pipe Stress Theory

• Longitudinal Stress

Longitudinal stress is stress which direction parallel to the pipe axis or stress in the direction of the length of pipe. Longitudinal stress due to external loads such as dead weight, pressure and thermal expansion (displacement).

$$S_L = \frac{P \cdot d_i}{4t}$$

Where:

- P = Pipe pressure (Kg/mm²)
- A_i = Pipe cross-sectional area (mm²)
- A_m = Average cross-section area of piping (mm²)
- S_L = Longitudinal stress due to axial force (KPa)

• Tangential Stress (Hoop Stress)

This stress due to the fluid that is in piping, this fluid will put pressure to the direction of the length of the pipe and the pipe surface in all directions.

$$S_H = \frac{P \cdot d_i}{2t}$$

Where:

S_H = Tangential stress (Hoop stress)

b. Construction Materials

Most failures occurred in the piping system connecting pipe, flange, valves, fittings, etc. Therefore, it is important to choose the connection piping and materials that suit the environment expected. The choice of material is a material suitable properties optimization process itself and considerations including the cost and availability

Selection of pipe material chosen with the following considerations:

- Is it allowed or not by code or standard.
- Is the fluid chemical elements according to the pipe material will be used.
- Is the pressure and temperature values meet a variety of environmental conditions such as external corrosion.
- Is it compatible with environmental conditions such as external corrosion.

c. Coating on Piping System

Coating on piping system is an effective means to protect the metal pipe and defend it from internal and external corrosion. The coating on piping

systems are used where corrosive fluid. Pressure and temperature need metal strength on the pipe. Therefore, the determination of the maximum pressure is based on the same procedures and requirements as the pipe wall.

d. Piping System Design

Isometric drawings recommended as an initial test of the flow rate disorders and to assist in pipe stress analysis where necessary the pipe support details. Pipe support can be designed with components such as determining the load, the type of support, direction and degree of restraint.

❖ Pipe Size Design

Fluid flow design determines the minimum pipe diameter required to efficiently transfer fluid. Pressure design determines the minimum pipe wall thickness needed to overcome internal and external pressures are expected.

In designing the piping system must notice the pressure drop due to losses due to: major losses and minor losses, where major losses due to surface roughness of pipe while the minor losses caused by additional components, like flange, valves, nozzles, etc. The losses equation written below:

$$h_L = h_{L \text{ Major losses}} + h_{L \text{ Minor losses}}$$

$$h_L = \left[\frac{fL}{D_i} + K \right] \frac{V^2}{2g}$$

Where:

- h_L = Losses flow (m)
- g = Gravitational acceleration, 9.81 (m/s²)
- V = Fluid flow velocity (m/s)
- f = Friction factor
- L = Pipe length (m)
- K = Losses coefficient for pipe components

Required wall thickness of straight pipe, pipe code has set the wall thickness of the pipes allowed the so-called minimum wall thickness (t_m) that includes the ability to force material. The wall thickness can be calculated with the following equation:

$$t_m = t + c, \quad t = \frac{PD_o}{2(SE + P Y)}$$

Where:

- t_m = Minimum wall thickness (mm)
- t = wall thickness design against pressure (mm)
- P = Internal pressure (kPa)
- D_o = Pipe outside diameter (mm)
- S = Maximum allowable stress, refer to Table A-1 ASME, Psi (Kpa)
- E = Efficiency welding factor, refer to Table A-1B ASME B31.3

Y = Coefficient of the material properties and design temperature, refer to Table 304.1.1 t < Do/6 ASME B31.3 and t >Do/6 (ASME B31.3 2008)

$$Y = \frac{Di+2c}{D_o+Di+2c}$$

c = Additional wall thickness due to corrosion or erosion (mm)

e. Pipe Stress Analysis

❖ Stress Due to Sustained Load

Sustained load is a primary stress that causes a fatal failure. The sum of all longitudinal stress (S_L) due to pressure, weight and other sustain load should not exceed S_H .

If S_H is greater than the S_L , the restrictions are used (ASME B31.3, 2008) are:

$$S_L = \frac{F}{A} + \frac{\sqrt{(i_i M_i)^2 + (i_o M_o)^2}}{z} + \frac{P d_o}{4t} \leq S_h$$

Where:

F = Axial force due to sustained load (lb)

M_i = In-plane bending moment due to sustained load (in-lb)

M_o = Out-plane bending moment due to sustained load (in-lb)

i_i = In-plane stress intensification factor (SIF)

i_o = Out-plane stress intensification factor (SIF)

S_h = Base stress that allowed by the material according to ASME/ANSI B31.3

❖ Stress Due to Expansion Load

Expansion load is the stress that occurs due to changes in temperature, if the temperature rise will lead to expansion while if the temperature decreases there will be shrinkage. In the expansion load, is longitudinal stress due to the bending moment and shear stresses due to torsional moments, from maximum shear stress equation can be obtained equation:

$$S_E = \frac{\sqrt{(i_i M_i)^2 + (i_o M_o)^2 + 4(M_T)^2}}{z} \leq S_A = f(1,25 S_c + 1,25 S_h - S_i)$$

Where:

S_E = Displacement stress range, MPa (psi)

S_A = Allowable displacement stress range, MPa (psi)

M_T = Difference torsional moment due to expansion load (in-lb)

S_c = Base stress that allowed by the material according to ASME/ANSI B31.3 Code at low temperature

f = reduction factor by considering material fatigue

❖ Stress Due to Occasional Load

Stress due to occasional load on the pipe caused by the displacement load at the support, anchor, such as earthquakes and so on, which can be formulated as follows:

$$S_L + S_{occ} \leq 1,33 S_h,$$

Where:

S_{occ} = Stress due to occasional load

f. Flexibility Analysis

Flexibility analysis performed on piping system to study the behavior when the environmental temperature changes to its operating temperature, so that the layout of piping system that sought the most economical and safe.

• Characteristics of Flexibility

Characteristics of flexibility based on geometric which the nominal wall thickness and the radius of the pipe. In the case of pipe bends that distinguish the straight pipe is the modulus of elasticity due to differences in cross-sectional area shown in Figure 1 so that the flexibility factor as follows:

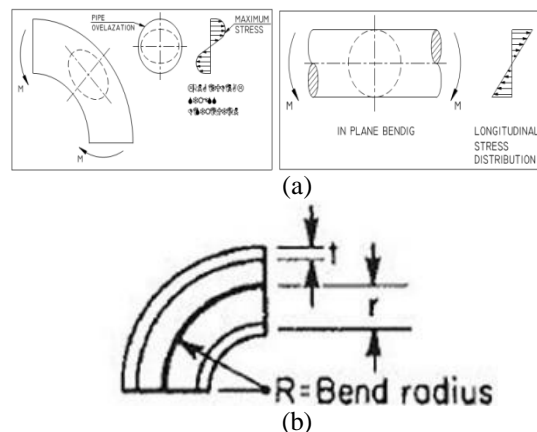


Fig. 1 (a) Differences in stress distribution
(b) Dimensions of the elbow

Thus, in the case of the elbow:

$$h = \frac{t R}{r^2}$$

• Stress Intensification Factor (SIF)

Stress intensification factor (SIF) is defined as the ratio of the maximum stress intensity calculated using the formula of regular mechanical. It is used as a safety factor to account for the effect of localized pressure due to repetitive load on the pipe.

$$\begin{aligned} \text{in-plane, } i_i &= \frac{0,9}{h^{2/3}} \\ \text{Out-plane, } i_o &= \frac{0,75}{h^{2/3}} \end{aligned}$$

g. Pipe Support Spacing (Pipe Span)

Pipe support spacing is a function of the size of the pipe, the conducting fluid by piping systems, fluid temperature and the temperature of the surrounding area. Typically, the allowable deflection was 2.5 mm (0.1 in), as long as the maximum pipe stress is limited to 10.3 MPa (1500 psi) or allowable stress design. A method for calculating the distance of the support is as follows:

$$l = n \left(m \Delta \frac{25}{W} \right)^{1/2}$$

Where:

- L = Pipe span/Pipe support spacing, m (ft)
- N = Unit conversion factor, 10⁻³ m/mm (1 ft/12 in)
- W = The total weight of pipe (N/m)
- M = Beam coefficient
- Δ = Beam coefficient = 5/48 for one support
- W = W_p + W_L
= W_p + $\frac{\pi}{4} \cdot Di \cdot \rho$

Where:

- W_p = Pipe weight provided by the manufacturer (N/m)
- W_L = Weight of the fluid in the pipe (N/m)

h. Expansion Thermal

Excessive stress due to the thermal load on the fluid contained by piping systems, allowable stress is reduced due to the high fluid temperature, and occurrence of bending moments that caused length of pipe increase.

$$\Delta = \alpha L_0 (\Delta T)$$

Where:

- Δ = Pipe expansion thermal, mm (in)
- α = Coefficient expansion thermal, 1.11 x 10⁻⁵ mm/mm°C
- L₀ = Pipe length, mm (in)
- ΔT = Temperature difference

i. Force and Moment on Support

When a pipe loaded with a force or moment, internal stress occurs on the trunk. Generally, there was a normal stress and shear stress. To determine the magnitude of the resultant on a support, we can use the equations of equilibrium.

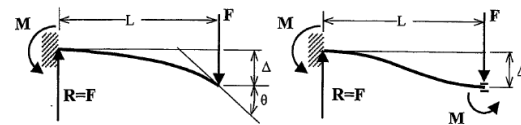


Fig. 2 Regular Cantilever Beam and Guide Cantilever Beam

$$\Delta = \frac{FL^3}{12EI}, F = \frac{12EI}{L^3} \Delta, M = \frac{FL}{2} = \frac{6EI}{L^2} \Delta$$

Methodology

a. Modeling Process of Piping System

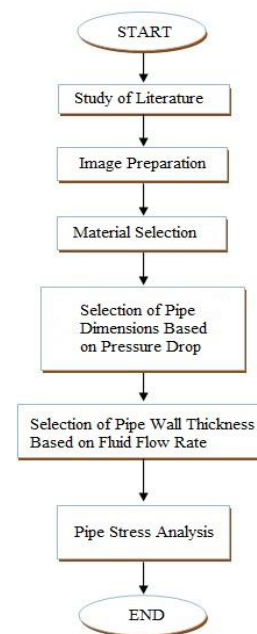


Fig. 3 Flowchart of piping system

Explanations which type of fluid that will be passed pipes contain: Aluminum, Bronze, Copper, Carbon steel and Stainless Steel. In overcoming these contents are corrosive coating is done by using PVDF (Poly Vinylidene Fluoride) and used as the outer wall (ASTM A 106 grade (class) A carbon steel.

Table-1 Pipe Specification

No	Pipe Specification	
1	Pipe length A-J	11,11 m
2	Pipe length C-J	10,81 m
3	Pipe material	ASTM A 106 Grade A

Table-2 Fluid Flow Specification

No	Fluid Specification	
1	Fluid type	Waste water
2	Maximum fluid temperature	46 °C
3	Minimum fluid temperature	16 °C
4	Normal fluid temperature	23,9 °C
5	Massa Jenis Fluida	0,00099 kg/cm ³
6	Correction factor	1,0005916
7	Fluid flow rate (Q)	5,36 x 10 ⁻³ m/s

Pipes used of manual calculations are pipes of 80 mm and 40, while the pressure drop in the piping system of 89.6 kPa. Pressure design is equal to the total pump head is equal to 89.6 kPa, where the pressure conditions when the outside of the pipe. Material corrosion allowed 2mm. According to the calculations in accordance with a code and standard pipe sizes 80 with a wall thickness is 5 mm and 40 with a wall thickness is 5 mm.

b. Determine Weight of The Pipe and Stress Analysis

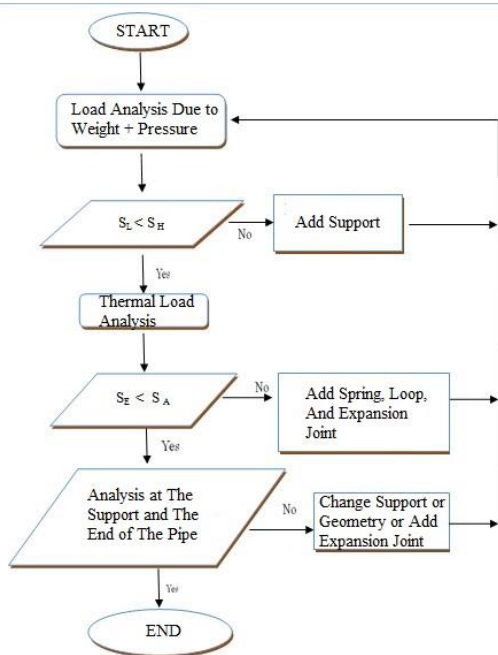


Fig. 4 Flowchart of determine the weight of the pipe

Based on the information described previously results of calculations per pipe segments tabulated

Table-3 The results of theoretical calculations

Segment	M _i (N.m)	S _b (MPa)	M _t (N.m)	S _t (MPa)	S _E (MPa)
B-E	40,07	1,48	0	0	1,48
E-H	706,69	0,13	42	2,89	5,78
H-I	42	15,61	0	0	15,61
I-J	818,76	30,43	74,27	1,38	30,55

c. Simulation Analysis CAESAR II

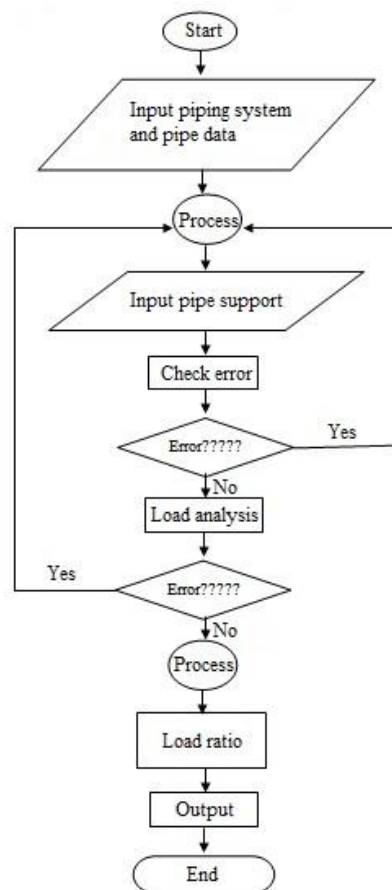


Fig. 5 Flowchart of CAESAR II simulation

Modelling of simulation on CAESAR II in figure 8 Where caesar II pipe modeling based on node



Fig. 6 Modelling shown from the results of data input in CAESAR II

Step on programming CAESAR II is the issuing calculation result, the results of the calculations are

Table-4 Check proses in CAESAR II

No	Load Case	Stress Category	Output
1	W+P1	SUS	Disp/Force/Stress
2	W+T1+P1	OPE	Disp/Force/Stress
3	L3 = L2-L1	EXP	Disp/Force/Stress

3. Analysis Report

Results of calculations CAESAR II are shown in the table, that were the values of the stress or any other value obtained from analysis. Discussion on stress analysis at 46 °C temperature and pressure conditions at 86.9 kPa.

Some loads that occurs in the simulation CAESAR II as follows

a. Expansion Load

The simulation results on CAESAR II seen that the highest result at the node 210 with results in accordance with code requirements where

$$S_E < S_A$$

$$31.2 \text{ MPa} < 270.1 \text{ MPa}$$

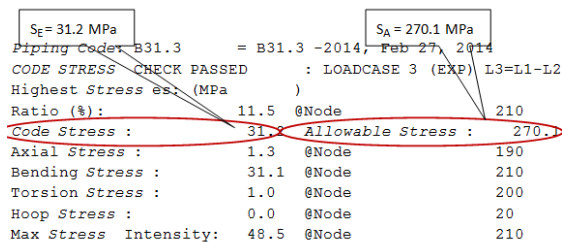


Fig. 7 Expansion load stress simulation on CAESAR II

b. Sustained Load

The results of the simulation CAESAR II seen the highest result at node 320 and in accordance with the requirements of the code which

$$S_E < S_A$$

$$31.2 \text{ MPa} < 270.1 \text{ MPa}$$

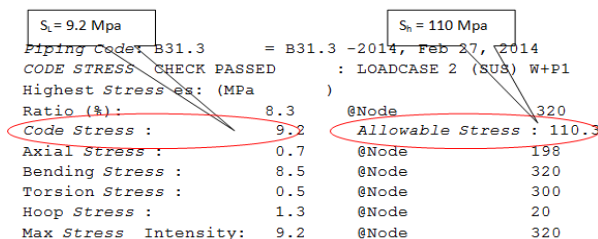


Fig. 8 Sustained load stress simulation on CAESAR II

Validation of Theoretical Calculations with The Calculations On The CAESAR II

• Stress Intensification Factor (SIF)

Calculation results of node SIF as follows:

Table-4 Calculation of the characteristics of flexibility, Stress intensification factor (SIF)

Node	R (mm)	r (mm)	T (mm)	h	Teoritis		CAESAR	
					SIF(In-plane)	SIF(Out-plane)	SIF(In-plane)	SIF(Out-plane)
50	80	40	5	0,25	2.272	1,893	2.272	1,893
120	80	40	5	0,25	2.272	1,893	2.272	1,893
190	80	40	5	0,25	2.272	1,893	2.272	1,893
200	80	40	5	0,25	2.272	1,893	2.272	1,893

• Stress On Expansion Load Conditions

The results of static analysis maximum stress that occurs when 46°C the operating temperature and pressure of 89.6 kPa that occurs on nodes 210 (expansion stress $S_E = 31.2 \text{ MPa}$, $S_A = 270.1 \text{ MPa}$) according to ASME B31.3:

Table-5 The error percentage between the theoretical with CAESAR II

Segment	Teoritis		CAESAR II		Galat (%)	
	Sb (MPa)	S _E (MPa)	Sb (MPa)	S _E (MPa)	Sb	S _E
B-E (Node 48)	1,48	1,48	1,34	1,48	9,4	0
E-H (Node 190)	22,1	22,3	21,54	22,82	2,5	2,27
H-I (Node 198)	15,61	15,61	14,69	15,97	5,8	2,25
I-J (Node 210)	30,43	30,55	31,06	31,18	2,02	2,02

Load Analysis On the Pipe

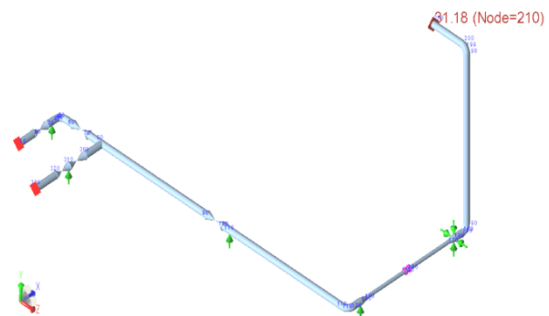


Fig. 9 Expansion load simulation result on CAESAR II

From Figure 9 shows that at temperature of 46 °C with a pressure of 89.6 kPa. Pipes at node 210 experienced a bending stress and code stress where the value of bending stress 31.06 MPa and 31.18 MPa code stress.



Fig. 10 Sustained load simulation result on CAESAR II

Shown in figure 13 that at temperatures of 46 °C with a pressure of 89.6 kPa. Pipes at node 320 on CAESAR II suffered bending stress of 8.53 MPa and stress code 9.19 MPa. Therefore, we need to be considered on a node pipe 320 caused the highest stress due to the sustained load, etc. This is due to the node 320 there is a valve.

Some of the data in stress conditions that occurs inversely with temperature, if the stress that occur in normal operation and maximum conditions is done by varying one variable ie, pressure and temperature:

- a. Chart between sustained load and expansion load in which the temperature varies and the pressure remains with the operating pressure 89.6 kPa

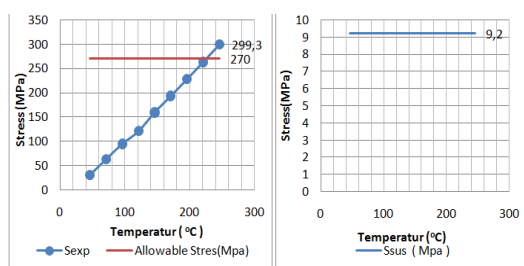


Fig. 11 Temperature-Stress at various temperature and operating pressure 89.6 kPa

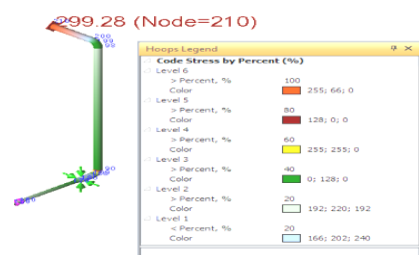


Fig. 12 Expansion load simulation result on CAESAR II at temperature 246 °C

Seen in the picture 11 and 12 that by varying the temperature, and pressure constant, the highest value that passes allowable stress at temperatures of 246°C at node 210, then to the operating at a temperature of 246°C is not allowed because it would be damage to the pipe or the pipe will hit the tank.

- b. The chart among sustained load and expansion load which varies of the pressure and temperature constant with the operating temperature 46°C.

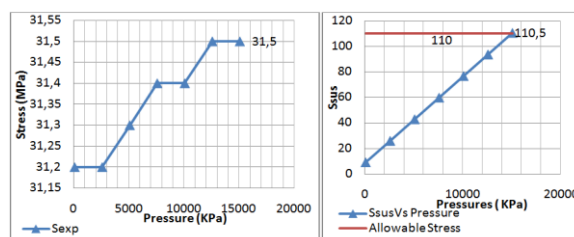


Fig. 13 Temperature- Expansion stress at various pressure and operating temperature 46°C

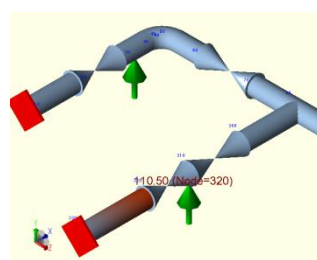


Fig. 14 Caesar II simulation results on sustained load

From Figure 14 shows that the piping system by varying the pressure and temperature constant for expansion load did not meet significant stress while on a sustained load at node 320 passes the allowed stress where the value of 110.50 MPa. It is evident that sustained load due to the weight valve close to node 320, there is a swing check valve. Where the load on the support at node 320 passes the allowed stress.

4. Conclusions

1. The location of the the maximum stress that occur along the pipe with the following details:
 - a. *Bending Stress* (S_b): 31.1 Mpa, at Node 210
 - b. *Displacement Stress* (S_E): 31.2 Mpa, at Node 210
 - c. *Longitudinal stress* (S_L): 9.1 Mpa, at Node 320
2. From the simulation can be seen that the safe limit the pipe materials used in piping systems wastewater treatment at steel plant to the stress that arises of 31.2 MPa with a limit of allowable stress: 270.1 MPa.
3. From the results of theoretical calculations and by simulation software error obtained on Bending Stress (S_b) at 2:02%, and Displacement

stress (SE) at 2:02% which occurs in the node 210.

4. The level of accuracy when using the CAESAR II software is very high seen from the results of calculations performed by CAESAR II software by the percentage ratio of pipe stress that occurs between the theoretical results with the results using CAESAR II software 11.5%.
5. To design the piping system operating temperature and pressure should not exceed 246°C (15089.6 kPa) caused by passing allowable stress so the pipe will suffer fatigue failure.

5. Reference

1. Bisht, Shweta and Farheen Jahan. *An Overview on Pipe Design using caesar III*. International Journal on Emerging Technologies 5(2): 114-118. 2014.
2. J. P. *Development of calculation methodologies for the design of piping systems*. (2005).
3. M. B. *Optimitation of piping layout with respect to pressure and temperature using caesar-II*. (2013).
4. Miranda, J. I., & I. a. *Piping Design the fundamentals*. (2011).
5. Munson. Bruce R. *Mekanika Fluida Edisi keempat Jilid 2*. Jakarta. 2003.
6. Peng, Ling-Chuan, dan Tsen Long Peng. *Pipe Stress Engineering*. USA: ASME Press. 2009.
7. Popov, Prof Egor dan Zainul Astamar. *Mekanikal Kekuatan Material*. edisi kedua terbitan Erlangga. 1989.
8. Shetty, s. k., & raghunandanak. *Vibration analysys of a piping system attached with pumps and subjected to resonance*. *certified journal*. (2014).
9. The American Society of Mechanical Engineering. *ASME B31.3 Process Piping*. New York: ASME Press. 2010.
10. US Army Corps of Engineers. *Liquid Process Piping*. Engineer manual. 1999.
11. Sivanagaraju, a. k., & D. m. (2015). *Stress Analysis of Process Pipe Line Systems (ASME B31.3) In A Plant Using Caesar*.
12. Yamit, Z, *Manajemen Produksi dan Operasi*, Edisi Kedua, Yogyakarta: Ekonisia. 2003.

D 001

Influence of the Weighing Bar Size and Dispersion Liquids on Settling Particle Size Distribution Measurements of Wheat Flour by using the Buoyancy Weighing-Bar Method

Rondang Tambun*, Riando O Sihombing, Agosto Simanjuntak, Farida Hanum

Department of Chemical Engineering, University of Sumatera Utara, Jl. Almamater Kampus USU Medan 20155, Indonesia

*Corresponding author : rondang@usu.ac.id

Abstract The Buoyancy Weighing-Bar Method is a new simple and cost-effective method to determine the particle size distribution. The principal of this method that the density change in a suspension due to particle migration is measured by weighing buoyancy against a weighing-bar hung in the suspension, and the particle size distribution is calculated using the length of the bar and the time-course change in the mass of the bar. This apparatus consists of an analytical balance with a hook for underfloor weighing, and a weighing-bar, which is used to detect the density change in suspension. We have reported that the buoyancy weighing-bar method can measure particle size distributions of the settling particles and floating particles. In this study, we experimentally investigate the influences of diameter of weighing bar and liquids on settling particle size distribution measurements of wheat flour by using the Buoyancy Weighing-Bar Method. The diameters of weighing bar in this experiment are 8 mm, 10 mm, 15 mm and 20 mm, while the graduated cylinder (diameter : 65 mm) is used as vessel. The dispersion liquids used are kerosene, ethanol, methanol and water. The results obtained show that the variations of the size diameters of weighing bar (10 mm, 15 mm and 20 mm) give the similar results on determination the particle size distribution of wheat flour by using kerosene, ethanol and methanol as dispersion liquids, and the results obtained are comparable to those measured by settling balance.

Keywords: Buoyancy; wheat flour; particle size distribution; weighing-bar.

1. Introduction

Various approaches have been used to measure particle size distribution (PSD) such as Andreasen pipette method (Society of Eng. Jpn, 1988), sedimentation balance method (Fukui et al., 2000), centrifugal sedimentation method (Arakawa et al., 1984), etc. Besides, PSD can be analyzed using a different principle through microscopy (Kuriyama, et al., 2000), laser diffraction/scattering method (Minoshima, et al., 2005), and Coulter counter method (Ohira, et al., 2004).

We have reported the influence of ethanol and methanol concentration as liquids to measure PSD of wheat flour by using Buoyancy Weighing-Bar Method (BWM) (Tambun et al., 2015). Now, we experimentally investigate the influence of the weighing bar size and dispersion liquids on settling PSD measurements of wheat flour by using the BWM. We have reported that the BWM can measure particle size distributions of the settling particles. In this method, density change in a suspension due to particle migration is measured by weighing buoyancy against the weighing-bar hung in a suspension.

Then the particle size distribution is calculated using the length of the weighing-bar and the time-course change in the apparent mass of the weighing-bar (Motoi et al., 2010, Obata et al., 2009,

Ohira et al., 2010, Tambun et al., 2011, Tambun et al., 2012a, 2012b, Tambun et al., 2016).

In this experiment, the initial buoyant mass of the weighing-bar W_0 depends on the particles between the top and bottom of the weighing-bar in a suspension. The initial density of suspension ρ_{S0} , initial buoyant mass of the weighing-bar W_0 , and initial apparent mass of the weighing-bar G_0 in a suspension at $t = 0$ are given by the following equations.

$$\rho_{S0} = \rho_L + \frac{C_0}{\rho_P} (\rho_P - \rho_L), \quad (1)$$

$$W_0 = V_B \rho_{S0}, \quad (2)$$

$$G_0 = V_B \rho_B - W_0 = V_B (\rho_B - \rho_{S0}) \quad (3)$$

where ρ_L and ρ_P are the liquid density and the particle density, respectively. C_0 is the initial solid mass concentration of suspension, ρ_B is the density of the weighing-bar in suspension, and V_B is the volume of the weighing-bar.

The solid mass concentration of suspension $C(t)$ decreases with time because large particles settle. The density of suspension ρ_S , buoyant mass of the weighing-bar W , and apparent mass of the weighing-bar G in a suspension at time t are expressed as

$$\rho_S(t) = \rho_L + \frac{C(t)}{\rho_P}(\rho_P - \rho_L), \quad (4)$$

$$W(t) = V_B \rho_S(t), \quad (5)$$

$$G(t) = V_B \rho_B - W(t) = V_B(\rho_B - \rho_S(t)) \quad (6)$$

The solid mass concentration of suspension $C(t)$ becomes zero once all the small particles also settle. The final density of suspension $\rho_{S\infty}$, final buoyant mass of the weighing-bar W_∞ , and final apparent mass of the weighing-bar G_∞ in a suspension at $t = \infty$ are given by the following equations.

$$\rho_{S\infty} = \rho_L \quad (7)$$

$$W_\infty = V_B \rho_L, \quad (8)$$

$$G_\infty = V_B \rho_B - W_\infty = V_B(\rho_B - \rho_L) \quad (9)$$

Equation (10) shows the mass balance of settling particles in a suspension (Allen., 1990).

$$C_0 - C(t) = C_0 \int_{x_i}^{x_{\max}} f(x) dx + C_0 \int_{x_{\min}}^{x_i} \frac{v(x)t}{h} f(x) dx \quad (10)$$

The left side in Eq. (10) is the quantity of particles that move onto the bottom side of the weighing-bar. The first term on the right side represents the mass of particles larger than particle size x_i among the particles that move, while the second term on the right side is the mass of particles smaller than particle size x_i among the particles that move. From Eqs. (2), (5), (8), and (10),

$$W_0 - W(t) = (W_0 - W_\infty) \int_{x_i}^{x_{\max}} f(x) dx + (W_0 - W_\infty) \int_{x_{\min}}^{x_i} \frac{v(x)t}{h} f(x) dx \quad (11)$$

where $v(x)$ is the settling velocity of the particle and $f(x)$ is the mass frequency of the particle size x .

Differentiating Eq. (11) with respect to the time t gives

$$-\frac{dW}{dt} = (W_0 - W_\infty) \int_{x_{\min}}^{x_i} \frac{v(x)}{h} f(x) dx \quad (12)$$

From Eqs. (11) and (12),

$$W = W_R + \left(\frac{dW}{dt} \right) t, \quad (13)$$

The apparent mass of the weighing-bar, which is given by Eq. (6), gradually increases from G_0 to G_∞ . The volume and density of the weighing-bar are constant values. Differentiating Eq. (6) with respect to time t gives

$$\frac{dG}{dt} = -\frac{dW}{dt}, \quad (14)$$

Therefore, according to Eqs. (6), (13), and (14),

$$G = V_B \rho_B - W_R + \left(\frac{dG}{dt} \right) t = G_R + \left(\frac{dG}{dt} \right) t \quad (15)$$

where $G_R = V_B \rho_B - W_R$. The value of G_R is calculated from the tangent line based on Eq. (15). The cumulative mass oversize is

$$R = 100 \int_x^{x_{\max}} f(x) dx = \frac{G_0 - G_R}{G_0 - G_\infty} \times 100 \quad (16)$$

$$= 100 - D,$$

where D is the cumulative mass undersize.

Particle size x is given by Stokes formula

$$x = \sqrt{\frac{18\mu_L v(x)}{g(\rho_L - \rho_P)}}, \quad (17)$$

The settling velocity of the particles $v(x)$ is calculated using Eq. (18)

$$v(x) = \frac{h}{t}, \quad (18)$$

where h is the length of the weighing-bar and t is the time lapse.

From Eqs. (17) and (18), time t is an inverse function of particle size x . The particle size distribution of the suspended particles is calculated using the particle size at each time and then plotting the corresponding cumulative mass undersize D .

2. Material and Methods

Figure 1 schematically illustrates this experiment. The weighing-tools was weighing-bar (diameter: 8-20 mm, length: 210.0 mm, submerged length: 200.0 mm) which was composed of aluminum (density: 2700 kg/m³). The particle suspension was placed in a 1000 ml measuring glass cylinder (diameter: 65.0 mm). The analytical balance (minimum readout mass 0.1 mg) had a below-balance-weighing hook for hanging measurement.

The sample material was wheat flour (density: 1250 kg/m³). Kerosene, ethanol (p.a), methanol (p.a) and water were used as a dispersion liquid. The suspensions had a solid concentration of 10 kg/m³ (ca. 1 wt.%) (Ohira et al., 2010). To prepare a suspension, a 1000 ml liquid and the particles to be tested were mixed in a glass cylinder. Using a hanging wire, which did not extend due to

the weight of the weighing-bar, the weighing-bar was hung from the analytical balance. The room temperature was approximately 298 K. After thoroughly stirring the suspension using an agitator, the weighing-bar was set with the balance. The measuring data, which consist of time t and the corresponding mass of the bar G_B , were recorded. The measuring time was two hours and the data were collected every 60-second intervals. After the measurement, the particle size distribution was calculated based on the aforementioned theory. As comparison method, the particle size distributions were also measured by using the settling balance method.

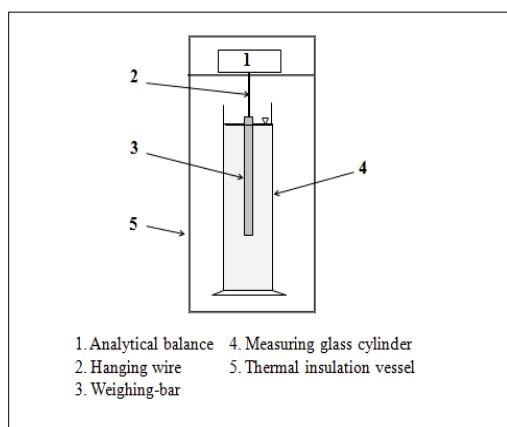


Figure 1 Schematic diagram of the experimental apparatus

3. Results and Conclusions

Figure 2 shows the change with time in the apparent mass of weighing-bar G_B when wheat flour was used. The figure 2 was the representation of the experiments using several diameters of weighing-bar size (8-20 cm) and variation of dispersion liquids (kerosene, ethanol, methanol, water). The liquid used in this figure 2 was kerosene and diameter of weighing-bar was 15 cm. The figure shows that the apparent mass of the weighing-bar increased until all the wheat flour particles settled below the lower end of the weighing-bar, and then the apparent mass of the weighing-bar became constant. The change in the apparent mass was due to the change in the buoyant mass against the weighing-bar as well as particle settling.

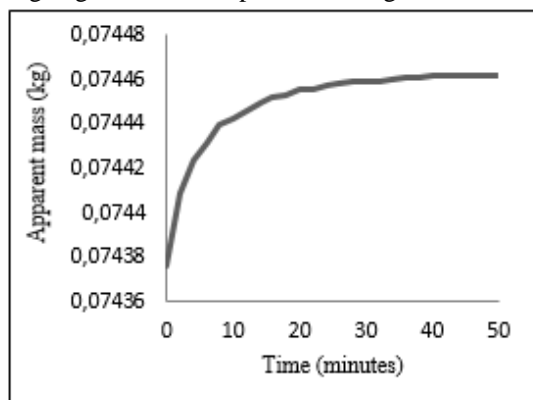


Figure 2 Apparent mass of the weighing-bar as a function of time using kerosene

Figure 3 shows the particle size distributions determination of wheat flour by BWM using ethanol and methanol, kerosene and water. In this experiment, the rod diameter used was 10 mm and the samples were sieved by using sieve tray 140 mesh. The results show that the ethanol gave the closer result to that measured by settling balance than methanol and kerosene. Water is not suitable as dispersion liquid to measure the PSD of wheat flour by using BWM. Hence, the ethanol is more suitable as liquid in determination of wheat flour's PSD by using BWM.

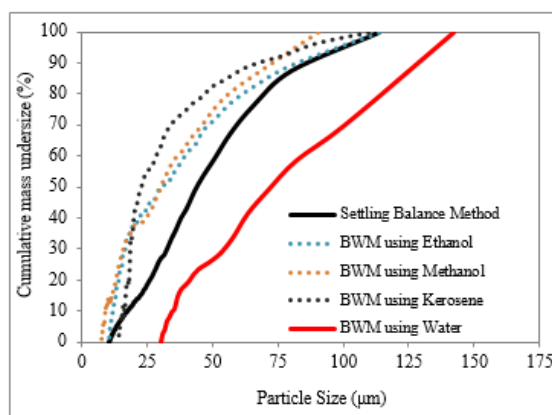


Figure 3 Particle size distributions measurement of wheat flour using ethanol, methanol, kerosene and water

Figure 4 shows the influence of the weighing bar size on settling particle size distribution measurements of wheat flour by using BWM. In this experiment, the liquid used was ethanol and the samples were sieved by using sieve tray 70 mesh. The results show that the PSD measured using the rod diameter 10 mm, 15 mm and 20 mm were similar to that measured PSD by using settling balance method. Hence, the rod diameter 8 mm is not suitable to determine wheat flour's PSD by using BWM in ethanol.

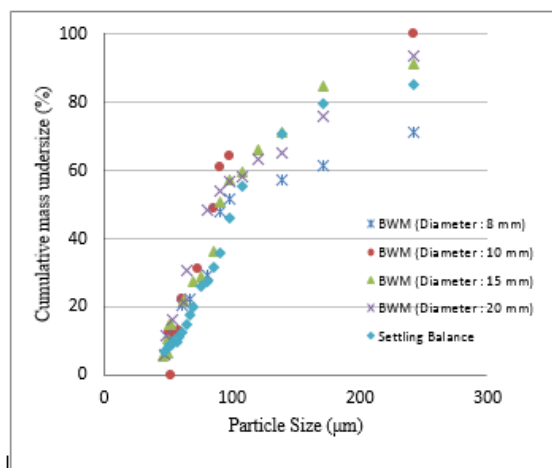


Figure 4 Influence of the weighing bar size using ethanol on settling PSD measurements of wheat flour

4. Conclusions

The study investigates the influence of the weighing bar size and dispersion liquids on settling PSD measurements of wheat flour by using the BWM. The results led to the following conclusions:

1. The PSD of wheat flour could be measured by BWM using ethanol, methanol and kerosene as liquid, and the PSD obtained were comparable to those measured by settling balance.
2. Water is not suitable as dispersion liquid to measure the PSD of wheat flour by using BWM.
3. The PSD of wheat flour in ethanol by using BWM with the rod diameter 10 mm, 15 mm and 20 mm gave the similar results to that measured PSD by using settling balance method.

5. Acknowledgement

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6. References

1. Allen, T (1990), Particle Size Measurement, Fourth edition, Chapman and Hall, London, pp. 345–355.
2. Arakawa, M., Shimomura, G., Imamura, A., Yazawa, N., Yokoyama, T., Kaya, N (1984), A New Apparatus for Measuring Particle Size Distribution based on Centrifugal Sedimentation. *Journal of The Society of Materials Science of Japan*, 33, 1141–1145.
3. Fukui, K., Yoshida, H., Shiba, M., Tokunaga, Y (2000). Investigation about Data Reduction and Sedimentation Distance of Sedimentation Balance Method. *Journal of Chemical Engineering of Japan*, 33, 393–399.
4. Kuriyama, M., Tokanai, H., Harada, E (2000), Maximum Stable Drop Size of Pseudoplastic Dispersed-Phase in Agitation Dispersion. *Kagaku Kogaku Ronbunshu*, 26, 745–748.
5. Minoshima, M., Matsushima, K., Shinohara, K (2005), Experimental Study on Size Distribution of Granules Prepared by Spray Drying: The Case of a Dispersed Slurry Containing Binder. *Kagaku Kogaku Ronbunshu*, 31, 102–107.
6. Motoi, T., Ohira, Y., Obata, E (2010), Measurement of the Floating Particle Size Distribution by Buoyancy Weighing-Bar Method. *Powder Technology*, 201, 283–288.
7. Obata, E., Ohira, Y., Ohta, M (2009), New Measurement of Particle Size Distribution by Buoyancy Weighing-Bar Method. *Powder Technology*, 196, 163–168.
8. Ohira, Y., Furukawa, K., Tambun, R., Shimadzu, M., Obata, E (2010), Buoyancy Weighing-Bar

Method: A Particle Size Distribution Measurement using New Settling Method. *Journal of the Sedimentological Society of Japan*, 69, 17-26.

9. Ohira, Y., Takahashi, H., Takahashi, M., Ando, K (2004), Wall Heat Transfer in a Double-Tube Coal-Slurry Bubble Column. *Kagaku Kogaku Ronbunshu*, 30, 360–367.
10. Society of Chemical Engineering of Japan (1988), *Chemical Engineering Handbook*, 5th edition, Maruzen, Tokyo, Japan, pp. 224–231.
11. Tambun, R., Furukawa, K., Hirayama, M., Shimadzu, M., Yamanaka, S., And Ohira, Y (2016), Measurement and estimation of the particle size distribution by the buoyancy weighing-bar method and the rosin-rammler equation. *Journal of Chemical Engineering of Japan*, Vol. 49 (2), 229-233
12. Tambun, R., Motoi, T., Shimadzu, M., Ohira, Y., Obata, E (2011), Size Distribution Measurement of Floating Particles in the Allen Region by a Buoyancy Weighing-Bar Method. *Advanced Powder Technology*, 22, 548–552.
13. Tambun, R., Nakano, K., Shimadzu, M., Ohira, Y., Obata, E (2012), Sizes Influences of Weighing Bar and Vessel in the Buoyancy Weighing-Bar Method on Floating Particle Size Distribution Measurements. *Advanced Powder Technology*, 23, 855-860.
14. Tambun, R., Pratama, N., Ely, Hanum, F (2015), Penentuan Distribusi Ukuran Partikel Tepung Terigu dengan Menggunakan Metode Pengapungan Batang (Buoyancy Weighing-Bar Method), *Jurnal Teknik Kimia USU*, Vol. 4 (1), 30-35.
15. Tambun, R., Shimadzu, M., Ohira, Y., Obata, E (2012), Definition of the New Mean Particle Size based on the Settling Velocity in Liquid. *Journal of Chemical Engineering of Japan*, Vol. 45 (4), 279-284.

E 002

Design of E-Recruitment in Lancang Kuning University

NurlianaNasution, S.T, M.Kom[#],Mhd. AriefHasan,M.Kom^{*}

[#]Informatic Engineering, University Of LancangKuning, Rumbai,Pekanbaru, 28265,Indonesia
E-mail:nurliana_2006@yahoo.co.id

^{*}Informatic Engineering, University Of LancangKuning, Rumbai,Pekanbaru, 28265,Indonesia
*m.arif@unilak.ac.id

Abstract One of the most important activities in a company or organization is a matter of human resources. The process of recruitment is a strategic step to identify the right candidates. The same thing also expressed by a researcher that the process of recruitment of new employees took part in taking the organization's policy. LancangKuning University is one of the educational institutions that make the process of recruitment and faculty independently or not to use the outsourcing company's services. LancangKuning University use the services of advertising in print media such as newspapers so that the process is quite long and not infrequently the administrative staff are faced with circumstances that the number of vacancies are limited but get a potential employees and lecturer candidate who are interested and meet the administrative requirements volume tripled. The next problem is the acceptance of the application file that still use manual methods which cause major problems in the storage of files. LancangKuning University do not have good database management in the process of recruitment of employees and lecturers so the overlap in data management happen. So we need some applications that can answer all the problem started on the process of submission of application, the election positioning, scheduling tests, the announcement of the interview, and selection results. As for the problems faced by LancangKuning University Admission especially in the division are: The amount of costs to be incurred by the company each time they hire employees and lecturers, The backlog of applicants so that the data get the filing cabinet cupboard full, theres no good mechanism in the recruitment process of employee and lecturers. The method used by the writer is descriptive and comparative research methods. As for the systems approach is to use object-oriented approach and developing a system using a prototype model paradigm. System approach in use is the Object Oriented approach that uses AOO (Object Oriented Analysis) and DOO are in visualized with UML and among them are as follows: Use Case Diagram,Sequence Diagram, ClassDiagram, CollaborationDiagram, Component Diagram dan Deployment Diagram.

Keywords : Recruitment; Lecturer Based Web; e-Recruitment; UML; Waterfall.

1. Introduction

One of the most important activities in a company or organization is a matter of human resources. Because, the main focus of human resource management is to contribute to the success or failure of a company. Human resources management itself not only organize employees in the company, but starting from the selection of a prospective employee, an employee performance appraisal, selection and placement of employees as well as filling managerial positions correspond to the fit and proper.

The process of recruitment is a strategic step to identify the right candidates. The same thing also expressed by a researcher that the process of recruitment of new employees took part in taking the organization's policy. The main purpose of the recruitment process is to get the right people in the right placement anyway so in accordance with the conditions and needs of the organization or company (Suhendra, 2006). A good company will always look for individuals who have a good work ethic. Thus, when it was owned by a company or organization that he would be able to survive in the competitive full competition and rapid change.

LancangKuning University is one of the educational institutions that make the process of

recruitment and faculty independently or not to use the outsourcing company's services. In the process of recruitment and lecturers, usually LancangKuning University use the services of advertising in print media such as newspapers so that the process is quite long and not infrequently the administrative staff are faced with circumstances that the number of vacancies are limited but get a potential employees and lecturer candidate who are interested and meet the administrative requirements volume tripled. Such conditions, if not addressed properly can be a potential source of problems for the company in the future, both internally and externally. In turn, if the process of recruitment and lecturers are not positioned correctly, then potential employees and lecturers received did not meet the criteria to be expected, and would be a burden in the future on an ongoing basis.

The next problem is the acceptance of the application file nowadays that still use manual methods which cause major problems in the storage of files. In recruitment and lecturer at the University of LancangKuning is usually fixed schedule for each. So that each call applicants often imperfect because there are some files that have been entered previously notbarranged and stored properly.

2. Material and Method

2.1 Research methodology

The research methodology are steps and procedures that will be performed in the collection of data or information in order to solve the problems and test the research hypothesis.

The method used in conducting research is the basis for the drafting of the study and the elaboration of the scientific method in general.

2.1.1 Research Design

The method used by the writer is descriptive and comparative research methods. Descriptive research is the study of phenomena or population obtained by the researchers of the subject in the form of individual, organizational, industry or any other perspective. Descriptive study was conducted to answer the question of: what, who, when, where, and how that relates to the characteristics of the population or the phenomenon. Research is also done using the comparative method by comparing the existing theories with practices encountered and draw conclusions.

To facilitate the conduct of research related easier to the problem studied, the authors conducted a case study approach. By using this approach, the data collected can be adjusted to the actual situation and compared with theories that support. Thus, it can provide a fairly clear picture and can draw conclusions from the object under study.

2.1.2 Types and methods of data collection

Types and data collection methods used by the author to obtain data as study materials in the writing of research with the aim of making a planning application E-Recruitment in LancangKuning University. In this case the author uses the method of data collection in the form of primary data sources (observation, interview and observation systems) and secondary data sources (documentation).

2.2 Method and System Development Approach

In the construction of an application some approach and the development of systems that will determine the completion of the software engineering process is needed, as for the systems approach is to use object-oriented approach and developing a system using a prototype model paradigm.

2.2.1 System Approach Method

System approach in use is the approach with Object Oriented using AOO (Analysis Object Oriented) and DOO that visualized with UML and among them are as follows: Use Case Diagram, Sequence Diagram, Class Diagram, Collaboration

Diagram, Component Diagram and deployment Diagram.

2.2.2 System Development Method

System development method in this research are developed using a prototype approach. Prototyping is one software development methods that widely used. Prototype built to define the requirements.

Prototyping is one software development methods are widely used. With prototyping methods, developers and customers can interact with each other during the manufacturing process of the system.

It often happens a customer only defines in general what he wanted without mention in detail the output of what is needed, data processing and what is needed. On the contrary side of the developer less attention to the efficiency of the algorithm, the ability of the operating system and interfaces that connect people and computers.

To overcome the incompatibility between customers and developers, it takes a good cooperation between the two so that developers will know exactly what customers want without ignoring the technical aspects and the customer will know the processes in the system solve desired. Thus generating system in accordance with the schedule completion time has been determined.

The key to this prototype model works well is to define a set of rules at the beginning, the customer and the developer must agree that the prototype was built to define the requirements. Prototype will be eliminated in part or in full and actual real-time software is engineered with the quality and the implementation of which has been determined.

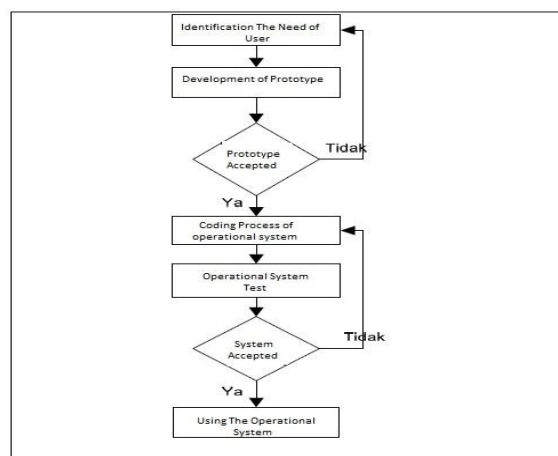


Figure 1 : Prototype

Here are the steps in designing a system that I use in the prototype system development mechanism, such steps are:

1. Identifying the needs of users

- Analysis of the system affects to the user to get an idea of what is users desired and want from the system.
2. Building the prototype
Analysis systems may work together with other information specialists, using one or more hardware prototype to develop a prototype. Build prototyping to create the design while focusing on presenting the customer (eg by making the input and output format)
 3. Evaluation Prototyping
This evaluation is done by the user, the prototype that has been built is compared with the wishes of the customer. If it is appropriate then step 4 will be taken. If not, prototyping revised by repeating steps 1, 2, and 3.
 4. Encoding
In this stage, prototyping agreed translated into appropriate programming language.
 5. Testing the system
Once the system has become a ready-made software, should be tested before use. The test is performed by Black Box
 6. Evaluation System
Customers evaluate whether the system is already so it was as expected. If yes, step 7 is done; if not, repeat steps 4 and 5
 7. Using the system
The software has been tested and accepted the customer is ready to use.

2.3 Analysis and Design Tools

In the analysis and design the authors describe about the characteristics of the system by using a model called Unified Modelling Language (UML).

Unified Modeling Language (UML) is a graphical modeling language to specify, visualize, construct, and document the entire design of the software system. The use of this model aims to identify the parts that are included in the scope of the system are discussed and how the relationship between subsystems and systems with other systems on the outside.

Besides UML is a modeling language that uses the concept of object orientation. UML made by Grady Booch, James Rumbaugh, and Ivar Jacobson under the banner of Rational Software Corp. UML provides a notation notasi- help model the system from a variety of perspectives. UML is not only used in the modeling software, but almost in all fields that require modeling.

3. Results and Conclusions

3.1 System Configuration

In creating a program for writing the report, the authors use a computer with the following specifications:

1. Hardware Spesification
 - a. Processor: Pentium Dual Core 2.8 GHZ
 - b. Monitor: Sync Master E1920, 16 "
 - c. RAM: 2048 MB
 - d. Hard disk: 250 GB
 - e. Mouse: Optic
 - f. Keyboard: classic
 - g. Printer: Laserjet, Deskjet
2. Software Spesification
 - a. Linux
 - b. Open Office.org Writer
 - c. Open Office.org Calc

3.2 Access Right

To operate and manage these systems can only be done by the department of HR Training & Personnel, as the department hiring process.

3.3 Proposed Procedures Systematics

- A. applicant
 1. Applicants registering
 2. Applicants login system
 3. View the main page
 4. Applicants saw job vacancies available
 5. Applicants choose jobs available
 6. Applicants complete the job application requirements
 7. Applicants seeing information from companies
- B. Admin
 1. Admin login system
 2. The system displays the menu admin
 3. Admin perform data checking applicants
 4. Admin dopersetujan if the requirements of a complete job application
 5. Admin providing information to applicants next stage
- C. Leader
 1. Leaders login system
 2. The system displays the menu leader
 3. Chairman checking requirements and test applicants
 4. Leaders see graph interest of applicants to available employment
 5. Leaders see the personal data of applicants

3.4 Procedures for Proposed System

To analyze the proposed system, this study used Software Visual Paradigm for UML 6.4 Enterprise Edition to describe the Use Case Diagram, Activity Diagram, Sequence Diagram and Class Diagram.

3.4.1 Proposed Draft System in Use Case Diagram Applicants

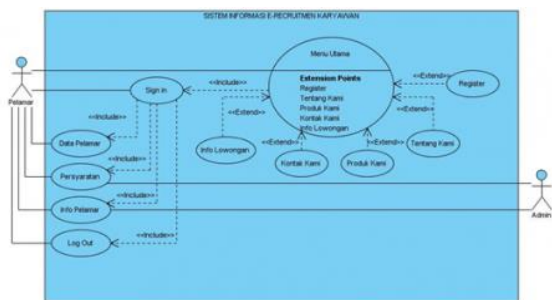


Figure 2: Use Case Diagram For Applicant
Based on Figure 2 above, the design Use Case Diagram for applicants:

1. A system that design from the proposed process on a system of applicants
2. Two actors, namely the applicant and admin
3. There are eleven use case that can be done, which display the main menu, registers, about us, our products, contact us, vacancy, sign in, applicant data, requirements, applicants information, and log out.

3.4.2 Proposed Draft System in Use Case Diagram Admin and Leaders

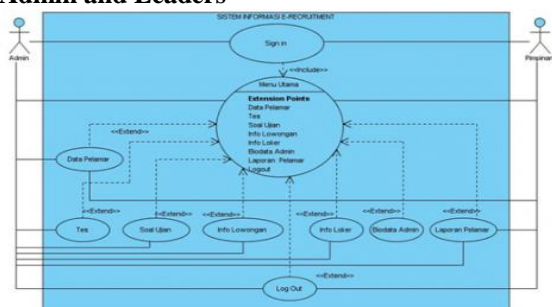


Figure 3. Use case diagram for Admin/ Leader

Based on Figure 3 above, the design Use Case Diagram in the Admin / Head there:

1. A system is the design of the proposed process on the system Admin / Leader.
2. Two actors, namely the admin and leadership. admin can input the exam, applicants view the report in the form of the selection process of applicants, selecting applicants, and view the data of applicants. While the leadership, only able to see the test results, and view the data of applicants.
3. There are ten use case, which display the sign in, the main menu, applicant data, test, exam, applicants report, information lockers, vacancy, bio admin, and log out.

3.4.2 Proposed draft system in Sequence Diagram Applicants

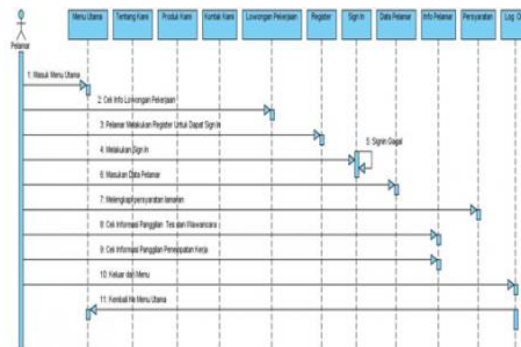


Figure 4. Applicant Sequence Diagram

Based on Figure 4 above, the draft Sequence Diagram on applicants are:

1. There is one actor that applicants
2. There are eleven life line, the main menu, about us, our products, contact us, jobs, register, sign in, applicant data, information of applicants, requirements, log out.
3. There are eleven message, which enter the main menu, check the job vacancy, applicants to register to be able to sign in, sign in, sign failed to return to sign in, enter applicant data, complete the application requirements, call information check tests and interviews , check employment call information, exit from the menu, and return to the main menu.

3.4.3 Proposed draft system in Sequence Diagram Admin

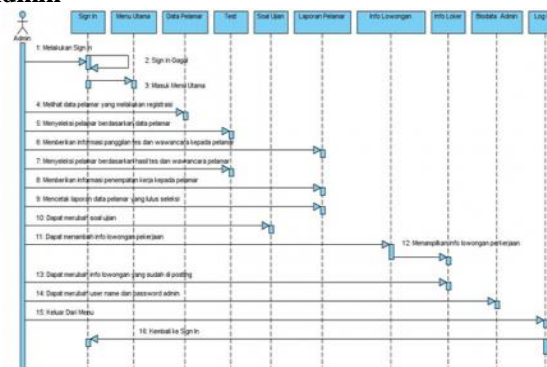


Figure 5. Admin Sequence Diagram

Based on Figure 5 above, the draft Sequence Diagram in admin are:

1. There is one actor that is admin
2. There are ten life line, a sign in, the main menu, applicant data, test, exam, applicants report, vacancy info lockers, bio admin, and log out.
3. There are sixteen message, which do admin sign in, sign failed to return to sign in, enter the main menu, see the data of applicants who register, selects applicants based on data of applicants, provide call information to the applicant tests and interviews,

selecting applicants based on the results of the test and interview applicants, provide information of employment to applicants, print data reports applicants who pass the selection, can alter the exam, can add to the info job listings, show info about jobs, it can change the vacancy that has been posted, it can change the username and admin password, exit a menu, go back to the sign in the display.

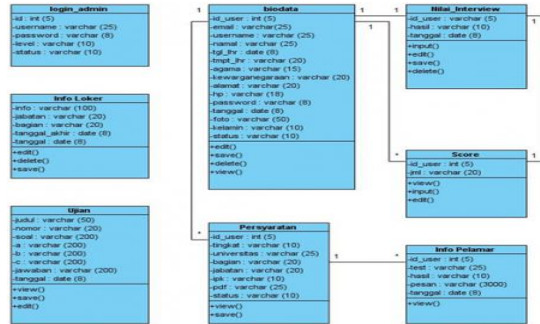


Figure 8. Class Diagram

3.4.4 System Proposed Draft on State Machine Diagrams Applicants

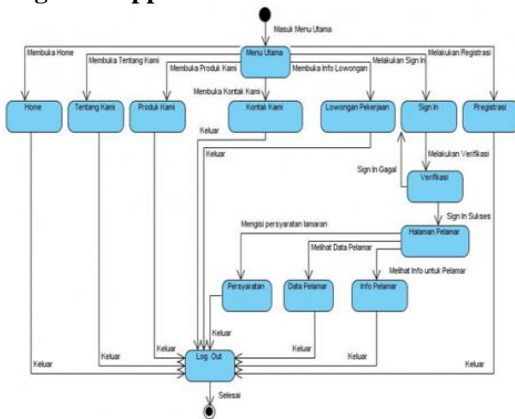


Figure 6. Applicant State Machine Diagram

3.4.9 Program Implementation

Making the application coding is an advanced stage after the creation of the design. With the making of the program it will behold the final outcome of the application program. Here is the main page of the application.

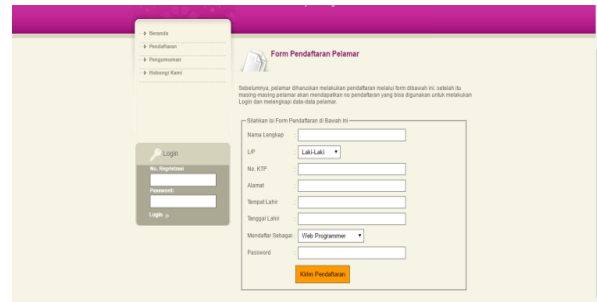


Figure 8.Implementation

3.4.5 System Proposed Draft on State Machine Diagrams Admin

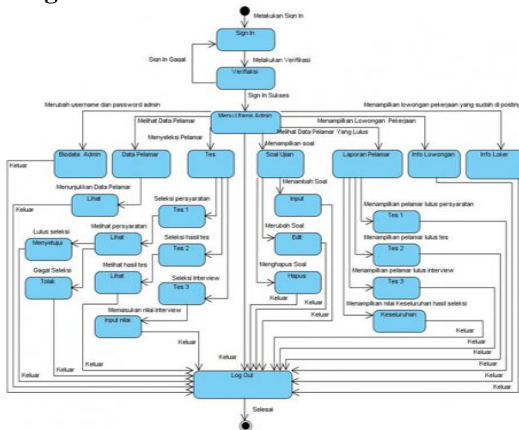


Figure 7. Admin State Machine Diagram

3.5 Testing Systems

Testing the system uses black-box method, namely by providing a number of enter into the application to determine the output produced, whether it is in accordance with the function of the application. Application testing procedure are shown in Table 5.9.

Case Number	Description	Testing Procedure	Expected Output	Result
UJ- 01	Running the application and Login to the system	Input the username dan password on login form	Appears Successful login form and show a page menu	As expected

UJ- 02	See List of the Jobs	Clicking h / tap the icon list of vacancies Entering form Bios	A list of jobs appear and the input file	As expected
UJ- 05	Viewing Files Registration	see Applicants incoming list And approval to the next process	The data appear to enter a file And can be determined participants can qualify for the next stage	As expected
UJ- 06	Print the Registrant Recap	Prints anyone whose entering file	Muncultampilancet akberkas yang memasukkanberkas	As expected

Based on the results of testing the system, output and scheduling applications that are designed has compliance with the expected, so it can be concluded that the design of this course scheduling applications successfully.

3.6 Conclution and Recommencation

3.6.1 Conclution

1. Lecturer Recruitment and Information Systems Web-based at the University of LancangKuning can process applicant data in a database so that the data of applicants has been completed with the required Party LancangKuning University
2. The application has undergone a blackbox testing method that summed up all features of the application runs well

3.6.2 Recommendation

1. The need for field testing to measure the efficiency and efficiency that occur after or before using the system.
2. The weakness that occurs when the testing would be a correction of researchers for the development of future applications.

4. Acknowledgement

The research was done through research funding Budget Cost Research Faculty of Computer Science University of LancangKuning in 2012

5. References

- Abdullah, Kadir. *Pengertian Jaringan Computer*. Andi Offset. Yogyakarta, 2003.
- Adi, Nugroho. *Konsep Pengembangan Sistem Basis Data*, Cetakan pertama. Bandung: Informatika, 2004.

Al Bahra Bin Ladjamudin. *Analisis dan Desain Sistem Informasi*. Graha Ilmu. Yogyakarta, 2005.

Anatan, Lina dan Lena Ellitan. *Manajemen Sumber Daya Manusia Dalam Bisnis Modern*. Bandung: Penerbit Alfabeta, 2007.

Bunafit Nugroho. *Aplikasi Pemrograman Web Dinamis dengan PHP dan My SQL*, Yogyakarta: Gava Media, 2009.

David Yoon Kin Tong. *E-recruitment service providers review International and Malaysia*, 2004.
<http://www.emeraldinsight.com/0142-5455.htm>.

Handoko, T. Hani, *Manajemen Edisi Kedua*, BPFE: Yogyakarta, 2003

Hasibuan, A. Zainal. *Metodologi Penelitian Pada Bidang Ilmu Komputer Dan Teknologi Informasi*. Depok: Universitas Indonesia, 2007.

Jogiyanto. *Analisis dan Desain Sistem Informasi*. Yogyakarta: Penerbit Andi, 2005.

Madcoms. *Seri Panduan Lengkap Macromedia Dreamweaver 8*. Yogyakarta: Penerbit Andi, 2007.

Manullang, M. *Dasar-Dasar Manajemen*. Yogyakarta: Gajah Mada University Press. Mankunegara, 2006

- Mankunegara, Prabu A. *Manajemen Sumber Daya Manusia Perusahaan*. Bandung: PT. Remaja Rosda Karya.2009
- Mondy, R. Wayne. *Manajemen Sumber Daya Manusia*.Jakarta: Penerbit Erlangga,2008.
- Munawar.*Pemodelan Visual dengan UML*. Yogyakarta:Graha Ilmu,2005.
- Prabu A. *Manajemen Sumber Daya Manusia Perusahaan*. Bandung: PT. Remaja Rosda Karya. 2004
- Pressman, RogerS. *Rekayasa Perangkat Lunak: pendekatan praktis (Buku1)Edisi2*. Terjemahan: LNH arnaningrum. Yogyakarta:Andi,2002.
- Pustaka 2011.Sidik, Betha. *MySQL untuk Pengguna,Administrator dan Pengembangan Aplikasi Web*. Bandung: Informatika,2005.
- Raymon McLeod, Jr.,George P.Schell.*Sistem Informasi Manajemen*. Edisi10th.Alihbahasa Jakarta:Salemba Empat,2008.
- Rivai,Veithzal.*Manajemen Sumber Daya Manusia untuk Perusahaan dari Teorike Praktik*, Jakarta :PT. Raja Grafindo Persada,2005.
- Rizky,Soetam.*Konsep Dasar Rekayasa Perangkat Lunak*.Jakarta:Prestasi
- Situmorang, Syafrizal Helmi, dkk. 2010. *Analisis Data untuk Riset Manajemen dan Bisnis*. Medan: USU press.
- Sukarno,Mohamad.*Membangun website dinamis interaktif dengan PHP-My SQL*.Eskamediapress,2006.

E 003

Enhancing the Capability of SME through CIMOSA Framework

Yudha Prasetyawan, Achmad Zulfikar, Rahma Nurul A'lima, Youvita Nainggolan

Industrial Engineering Department, Institut Teknologi Sepuluh Nopember
Surabaya, East Java, Indonesia
yudhaprase@ie.its.ac.id

Abstract A Small to Medium Enterprise (SME) were known as the strongest economical participation of local community. However, the prominent weaknesses of business development are the awareness of creating business values and runs the values within production activities. Computer Integrated Manufacturing Open System Architecture (CIMOSA) offer an integrative business framework for the strategic, operational and support function that can be both applied in manufacturing and service. This research deploy the framework of CIMOSA into detail product and service development activities in order to have maturity system of procedures, apparatus and performance measurement. Through the observation of three different SME Cluster in East Java Province – Indonesia, it can be inferred that different characteristic of SME Cluster need a particular approach of business value stepping stones. A complete strategy of has been described to achieve a certain level of business maturity grade. With the unfailing implementation in the further 10 years, approximately 77% of the observed SME will have the capability growth.

Keywords: small to medium enterprise, CIMOSA, maturity system, maturity grade.

1. Introduction

Small to Medium Enterprises (SMEs) were known as the strongest economical participation of local community in Indonesia. SMEs are able to survive in national economic crisis. SMEs also has importance role in unemployment reduction and GDP growth. In the last five years, the contribution of SMEs in GDP is increasing from 57.84% to 60.34%, and its contribution in unemployment reduction also increasing from 96.99% to 97.22%.

However, the capability and performance of SMEs in Indonesia are still considered weak. The contribution of SMEs in export is 15.8%, relatively lower compared to other countries in Southeast Asia. SMEs capabilities and performance can be optimized by doing internal and external factor evaluation and strategy formulation.

There are many different SME clusters that have different criteria. Hence, conducting evaluation needs standard criteria and score to generate instrument that can be generally used in every business performers, especially SMEs. The prominent weaknesses of general business development are the awareness of creating business values and run the values within production activities. Computer Integrated Manufacturing Open System Architecture (CIMOSA) offer an integrative business framework for the strategic, operational and support function that can be both applied in manufacturing and service. This research deploys the framework of CIMOSA into detail criteria and standard of business activities in order to have maturity system of procedures, apparatus and performance measurement.

In this reseach, the observed SMEs are Sentra Industri Logam in Ngingas Sidoarjo, SMEs in Surabaya, and agricultural commodities processing SMEs in Ngancar Kediri.

2. Material and Methods

This section will be presented the methodology of formulating strategies to increase SMEs competencies. This formulation contains 6 steps. Considerations used in this formulation are internal-external factors affecting both directly indirectly and interconnection between strategies. The interconnections between strategies are important to accomplish integration goal.

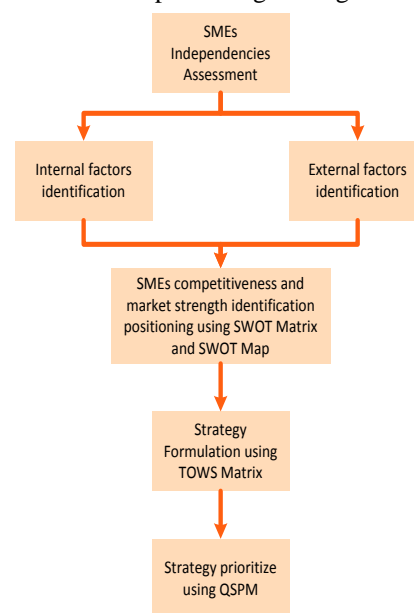


Figure 1
Steps

of Strategy Formulation Based on CIMOSA Framework

2.1 SMEs Independencies Assessment

Before going further on formulating strategies, first, an assessment is needed to get to know the current condition of SME. An instrument was designed based on CIMOSA's frame work to assess the SME independencies and maturity. This instrument assesses scores of each CIMOSA's elements and the integration between elements. CIMOSA itself is a business model that integrate interrelationship between divisions to reach the business goals. CIMOSA contains 3 elements and 11 sub elements. Likert scale is being used in this instrument. Each criterion have its own weight but it can be changed depend on the characteristic of the SMEs.

Independent SME can by defined as the capability of balancing all the CIMOSA's criteria, needing no fostering from government, and competing in free market. The criteria of independent SME will be shown by its global and each criterion score. The independent is a SME that could pass 62.5% of global score and no criterion with score under 2. This instrument is an Self-Assessment Questionnaire (SAQ) so the scoring process is held directly by the owner.

2.2 Internal – External Factors Identification

In this step, internal and external factors of SMEs will be identified. Internal factors could be obtained from the assessment below meanwhile external factor could be obtained by interviewing the SME's owner or those who had particular intention of the SMEs. External factors could be also obtained by observation (secondary data). All the numerical data should be figured by Likert scale.

The internal factors are categorized in 3 elements, i.e.: manage process, core process, and support process. Its weights are obtained using AHP method by interviewing experts. After that, each criterion will be grouped as strengths and weaknesses.

David (2005) mentioned that external factors are divided to 5 major categories, i.e.: (1) economic power; (2) social, cultural, and demographical power; (3) political, governmental, and laws factor; (4) technological power; and (5) competitive power. After identifying, each factor should be weighted based on its importance level and scored based on how the real implementation.

2.3 Competitiveness and Market Positioning by SWOT Matrix and SWOT Map

The goal is to know the competitiveness (strong –weak) and market position (opportunistic – threatening) of each SME. From the internal and external factors below, an Internal Factor Evaluation

(EFE) and External Factor Evaluation (EFE) Matrix could be constructed.

In EFE matrix, each weighted opportunity and threat gotten from interview will be multiplied with its score. Then, each multiplied score is summed to get the total balanced score. After that, EFE score will be gotten by lessen the opportunities score with threats score. Positive result indicates that the market growth is in good condition, but if the result is negative indices that the market growth is in bad condition.

Table 1 Weakness score conversion standard

Achieved Score	New Weaknesses Score	
	Likert Scale for Criterion	
	1-4	0-4
0	-	4
1	4	3
2	3	2

The same goes for internal factor. But the differences laid in how to group criterion as strength and weakness. If the criterion score is below 2, it's grouped as weakness and converted into a new score. Table 1 will show the conversion standard for weakness score. For the strengths score, there is no conversion needed. After total balanced scores for strengths and weaknesses are obtained, IFE score will be gotten by lessen the strengths score with weaknesses score. Positive result indicates that the competitiveness of SME is in good condition, but if the result is negative indices that the competitiveness is in bad condition

The next step, the EFE and IFE score of each SME will be plotted in SWOT Map. SWOT Map is divided into 4 quadrants. Each quadrant represent different market growth condition and competitiveness of SMEs observed. By plotting it into SWOT Map, the suitable strategies will be obtained.

2.4 Strategy Formulation Using TOWS Matrix

The strategy formulation in this research is the same as the common method. All the internal and external factors will be paired to get the matched strategies.

2.5 Strategy Prioritize Using QSPM

This step has the same step as the common method. All the strategies will be grouped and be evaluated by its attractiveness score on each criterion and factor.

3. Results and Conclusions

This research was conducted on three different SME Cluster in East Java. Table 2 shows list of the observed SMEs.

Table 2 List of Observed SMEs

1	UD Jayatama Teknik	9	UD Lancar Jaya	17	Kasiyati
2	UD APB Mandiri	10	UD NH	18	Zahrotul Ummah
3	UD Trilaksana Mandiri	11	Murni Mandiri	19	Pawon Kue
4	UD Rukun Makmur	12	Sari Alam	20	LILIX
5	UD KSPRO	13	Lagita	21	Kerupuk Ikan
6	UD Karya Jaya	14	Ibu Eni	22	Penjahitan
7	UD Borneo Putra	15	Dieva Cake	23	Sepatu
8	UD Elang Jagad	16	Puspa Guna		

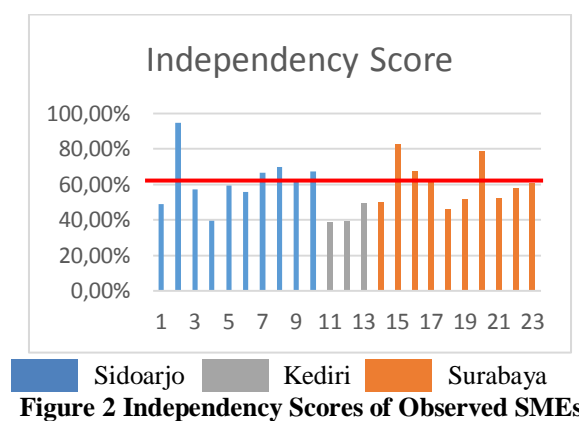


Figure 2 Independency Scores of Observed SMEs

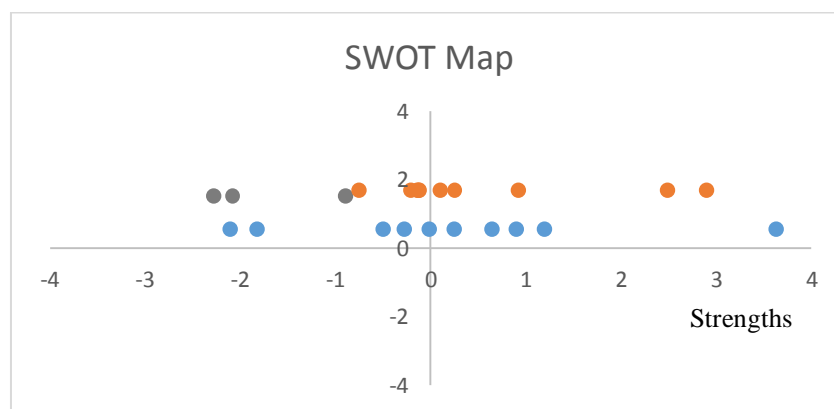


Figure 3 SWOT Map of Observed SMEs

From the observation, it can be obtained the independencies score of all observed SMEs. Figure 2 shows independency score of SMEs in Sidoarjo, Kediri, and Surabaya. The result score indicates SMEs capability of running business. 50% of SMEs in Sidoarjo and Surabaya classified as independent SME due to its capability of running business based on CIMOSA. Meanwhile, all of SMEs that being object in Kediri classified as non-independent SME. From the calculation and data processing made, the prominent weakness of SMEs in Kediri is due lack of

skill, knowledge, and awareness to optimize capability.

Figure 3 shows the position of SMEs in SWOT Map. The vertical axis value shows external factor evaluation result while the horizontal axis value shows internal factor evaluation. Figure 3 indicates running business of consumer goods in Surabaya and Kediri have better opportunity than metal industries in Sidoarjo. The outcome is due to business scale and criteria. Metal industries have more significant international relationship while

consumer goods have more local supplier and customer.

From the figure 3 above, it can be generally concluded that Indonesia, especially East Java has a potential market that brings a lot of opportunities for business growth. From the competitiveness aspect, may exploit the existing opportunities to develop their business (SO – Strategies). Table 3 will show the example of SO- strategies that obtained from TOWS Matrix for SMEs in Sentra Industri Logam Ngingas, Sidoarjo. Table 4 to 6 below will show strategies that obtained from SWOT Method with considering CIMOSA framework for each SME Cluster.

some of SMEs couldn't compete greatly. This condition brings to strategies that support SMEs to strengthen their competitiveness to obtain the benefit from the existing opportunities (WO – Strategies). In the other hand, SMEs that had a great competitiveness

may exploit the existing opportunities to develop their business (SO – Strategies). Table 3 will show the example of SO- strategies that obtained from TOWS Matrix for SMEs in Sentra Industri Logam Ngingas, Sidoarjo. Table 4 to 6 below will show strategies that obtained from SWOT Method with considering CIMOSA framework for each SME Cluster.

Table 3 TOWS Matrix of SO Strategies for SME in Sidoarjo

I E	Streghths		Notasi
	Opportunities	DB 4.1	
DB 4.1		Collaborating with medium and large manufacturer	SO - Manage 2
DB 1.3			
FO 3.1		Market expansion by buying new machine of adding the number of machine	SO - Core 1
FO 4.1			
GO 1.1			
GO 3.1			
FO 8.1		Utilizing government export assistance for the distribution of products abroad	SO - Core 2
GO 6.1			
GO 7.1			
FP		Analyzing and projecting the budget requirements for the company's long-term credit requirements planning (preparing investment)	SO - Support 1
HR 1.1		Gather fresh ideas from workers, held recreational activities, and always motivate workers	SO - Support 2
HR 3.1			
HR 4.1			
HR 5.1			

Table 4 Strategies for SMEs in Sentra Industri Logam Ngingas, Sidoarjo

	Streghths	Weakness
Opportunities	Market expansion into national and international scoop	Training and coaching from government
	Investation on machine or other production support	Strengten the business assosiation
	Develop new product	New/current product development
	Utilizing information technology for marketing and managing production process	Utilizing information technology for marketing and managing production process
	Manage business permit	Collaborating with medium and large manufacturer
	Strenghtens HR by regular motivation and bonuses	Manage business permit
	Collaborating with medium and large manufacturer	Strenghtens HR by regular motivation and bonuses
Threats	Develop new product/services	Likuidation
	Strengthen the business relation between suppliers	Exit strategy
		Develop new product/services

Table 5 Strategies for SMEs in Surabaya

	Strenghts	Weakness
Opportunities	Market expansion into national and international scoop	Training and coaching from government
	Investation on machine or other production support	Utilized government funding
	Develop new product	New/current product development
	Developing ecommerce	Developing ecommerce
	Manage business permit	Market expansion into national scoop
	Strenghtens HR by regular motivation and bonuses	Manage business permit Strenghtens HR by regular motivation and bonuses
Threats	Develop new product	Liquidation
	Strengthen the business relation between suppliers	Exit strategy
		Develop new product

Table 6 Strategies for SMEs in Surabaya

	Strenghts	Weakness
Opportunities	Experiential Marketing (product testing) for visitor and consultant	Utilize training from government for learning and training
	Utilize over-supply of commodities for diversification (develop new product)	Utilized government funding
	Investation on machine or other production support	Partnership among SMEs to for bargaining power and personal branding (horizontal integration)
	Market expansion through online marketing and java souvenir center	
	Manage business permit	Propose appropriate training according to key weakness
	Strenghtens HR by regular motivation and bonuses	Product development by benchmarking
	Market penetration through online marketing	Liquidation
Threats	Strengthen the business relation between suppliers	Exit strategy
	Product and service evaluation by benchmarking	Develop new product
	Develop new product	Product and service evaluation by benchmarking

4. Conclusions

From this research, we can conclude that:

1. The strategies between SME Cluster was different based on its characteristics. It is affected by the business type, the government program, business culture, and the existance of coaching and funding institution. The more complex the business process, the more complex the formulated strategy.
2. Using CIMOSA framework, the chosen strategies will integrate all the elements of business. This framework will show in what aspect should be strengthen and in what aspect should be utilized. CIMOSA framework also providing a assessment standard to obtain internal factor score for SMEs.
3. With the unfailing implementation in the further 10 years, approximately 77% of the observed SME will have the capability growth.

5. Acknowledgement(s)

We would like to give gratitude and appreciation to the Government of Kediri, Sidoarjo,

and Surabaya – East Java, and also local SME from the related area.

6. References

- [1] David, F. R. (2005). “Strategic Management”.
- [2] New Jersey: Salemba Empat.
Kementerian Perindustrian, "Kementerian
- [3] Perindustrian," Republik Indonesia, 28 Januari 2015. [Online]. Available: <http://www.kemenperin.go.id/artikel/14200/Kontribusi-UMKM-Naik>. [Accessed 5 Agustus 2016].
Jumayla, S. (2014).”Perancangan Instrumen Penilaian Tingkat Kemandirian UKM Tenant di Pusat Inkubator ITS. Surabaya”: Institut Teknologi Sepuluh Nopember.

E 006

Application of Analytical Hierarchy Process in Determining for Material Handling Systems to Increase Performance Product Layout

Dessi Mufti^{1*}, Moses L Singgih², Nurhadi Siswanto³

¹ Industrial Engineering Department, Universitas Bung Hatta, Padang, West Sumatera, Indonesia

^{2,3} Industrial Engineering Department, Institut Teknologi Sepuluh Nopember, Surabaya, East Java, Indonesia

* dessimufti@bunghatta.ac.id

Abstract One way to improve the efficiency of a factory and reduce production costs is by doing process improvement in each department. This factory that production piston expects the flow of material and material handling system has not been optimized, so it is necessary to improvement system. In this research transporter are the ways that operators in the handling of material handling in factory manufactur (production piston) that using a product layout with a U- line flow. Choosing of the material handling system model is done between the existing conditions, the scenario I is transporter priority resource that has a Work In Process (WIP) / machining time and scenario II is transporter highest priority to WIP / machining time highs and the shortest distance. Performance is used in production volume, WIP, resource and cycle time. Choosing based on the business plan by way of consensus in the engineering department of the factory. Weight and choose using Analytical Hierarchy Process (AHP) and processing with Expert Choice. The selected alternative is the scenario I with a weight of 46.2% and a performance that has the greatest weight is the cycle time of 44.8%. It shows the company set the task priority transporter on the resource that has the highest work in process. It is hoped in this way will reduce bottlenecks and facilitate the production system so as to reduce cycle time.

Keywords: Product layout; performance; cycle time; analytical hierarchy process.

1. Introduction

This research focuses on the study of “piston” fabrication works production line in a particular company in Indonesia. this factory using product layout with U line and S line flow material. Plant layout design has become a fundamental basis of today’s industrial plant which can influence/parts of work efficiency (Vaidya,R.D, 2013). An efficient layout may also contribute to the reduction in the production cycles, work in progress, idle times, number of bottlenecks or material handling times and to the increase in the production output, with obvious implication on productivity (Vaidya, R.D, 2013).

According to Abhinav, Shukia (2013), rearranging layout decreased distance and time consumption in flow material and accidents, resulting in an increase in productivity. The efficiency of production depends on how well the various machines, services production facilities and employee’s amenities are located in a plant (Godi, Vivekanand S, 2014). A good layout is one which allows material flow rapidly and directly for processing. this reduces transport handling and other costs per unit, space requirement are minimized and idle machine and idle man time reduces (Patil, Subodh B, 2015). The human resources, efficient materials use, and visual control be improved in any given facility. working condition of employees should be analyzed (Vaidya, R.D, 2013).

A good placement of facilities contributes to the overall efficiency of operation and can reduce until 50% the total operating expenses (Tompkins et

al, 1996). As applied to material handling system, the effectiveness of a material handling system describes to what extend the system performs the required handling tasks, whereas efficiency describe how economically (in terms of resource utilization) these tasks are performed. Thus, it is possible for an effective system to be in efficient, it is also possible for an efficient system to be ineffective (Beamon, B.M, 1998). According to Drira, Amine (2007) differents facility layout from products variety and volume consist of fixed position layout, cellular layout, process layout and product layout. Here, one is concerned with finding the best arrangement of material handling system in product layout with U-line and S-line. The analytic hierarchy process (AHP) deveoped by Saaty, (1980) is one of the common methods used for qualitative data, which easily be converted to ranked information or pairwise comparison data. Felice, Fabio (2015) in his research said AHP can be used as a decision-making tool when it comes to making strategic decision, e.g selecting a supplier with which to establish a long term relationship or from which to procure critical material for the company.

This company estimate that flow material and material handling system has not been optimized.. Especially purposed in this research is determine of flow material in machining process and material handling systems that exactly and adjust with the business plan of the company, so work in process (WIP) and cycle time can be decreased and output of product, utility of resources can be increased. The

selection is doing consensus with the engineering department as decision makers on the performance evaluation of the material flow. Data processing is performed by analytic hierarchy process and software expert choice.

The piston's process production consist of melting-casting-sprue cutting-machining-visual inspection-warehouse. In this research focused at machining process.

Data Engineering and operator of machining:
Allocation of operator U line of 4 people / shift job descriptions as follows:

2. Material and Methods

Table 2.1 The Sequence of Tasks and Activities Cycle U-Line Operator

Operator	Urutan Pengerjaan Tugas	Siklus Tugas
1.	Batch – Guide Bore Roughing (GBR) – Center Boss Casting (CBC) – Stamping (STP) – Visual	
2.	Rough Turning (RT)– Out Diameter Finish (ODF)	
3.	Guide Bore Finished (BGF)– Pin Hole Roughing (PHR) – Pin Hole Finished (PHF)	
4.	Semi Finish Out Diameter (SFOD) – Ring Groove Finish (RGF) – Drill Oil Hole (DOH)	

The allocation operator S line of 3 people / shift job descriptions as follows:

Table 2.2 Sequence of Tasks and Activities Cycle S Line Operator

Operator	Urutan Pengerjaan Tugas	Siklus Tugas
1.	Guide Bore Roughing (GBR) – Rough Turning (RT) - Guide Bore Finished (GBF)– Semi Finish Out Diameter (SFOD)	
2.	Drill Oil Hole (DOH)– Pin Hole Roughing (PHR) – Ring Groove Finish (RGF) – Pin Hole Finished (PHF)	
3.	Burnish Machine (BM) - Out Diameter Finish (ODF) - Center Boss Casting (CBC) – Grafir (GFR)	

Performance of Existing Conditions

Table 2.3 Flow Material Performance of Existing Conditions

Performance	U line	S line	Performance	U line	S line
Utility (%)			Utility (%)		
GBR	40.70	25.47	PHF	75.58	45.41
RT	66.86	53.61	ODF	65.50	36.32
GBF	58.14	47.30	SBC	29.07	21..79
SOD	78.49	40.03	BM	-	50.85
DOH	69.77	49.10	STP	29.07	-
RPH	72.67	56.30	GFR	-	14.53
RGF	58.14	54.49	Work in Process	593 unit(2.03%)	511 unit(2.8%)
			Output	116 batch	71.8 batch

Selection of material flow only from the output is not appropriate because material handling system U line and S line is different. The right way is the condition of material handling systems for the S line equated with U line especially for the arrival material at the first machine, the following results:

Table 2.4 Differences System Material Handling U Line and S Line

Existing Condition	U Line	S Line	Action
Arrival	High	Kecil	Arrival S aquated with U
Operator work cycle	Based on the distance of the nearest	Based on the distance of the nearest and sequence of process	-
Distance between work station	1-2 meter	4-5 meter	The distance between the station changed on 1 meter
Batch	No batch	Batch	S Line without batch by using shuter
Operator	4 people	3 people	-
Machine (unit)	11	12	-

Table 2.5 Results of the Performance Calculation U Line and S Line After Likened

Performance	U existing	S1 Arrival time same with U line	S2 No batch , the distance between work station shorten	The Best
Output	116	112	114	U
Utilitas	60-70%	60% - 80%	60% -80%	S2
WIP	2.03%	3.4%	2.4%	U
Cycletime	134	134	134	U

Based on 4 (four) performance used , U line has the best performance, so that the chosen one is U line. Work in process can still be decreased by setting task priority (handling to material handling system) to be carried out by the operator/transporter. In this

research proposed two scenarios ie WIP highest precedence operator/transporter (scenario I) and based on the shortest distance (scenario II) with the following results :

Table 2.6 Comparison of the Performance of the Existing Condition, Scenario I and Scenario II

Performance	U line	Scenario I	Scenario II	Performance	U line	Scenario I	Scenario II
Output	28188 unit (116 batch)	28480 unit (117 batch)	28577 unit (117 batch)	Utility (%)			
WIP	2.03%	1.8%	2.09%	DOH	69.77	76.51	76.90
Cycle time	134.09	133.32	134.04	RPH	72.67	79.90	80.11
Utility (%)				RGF	58.14	64.74	65.07
GBR	40.70	47.23	47.47	PHF	75.58	82.39	82.81
RT	66.86	73.80	74.18	ODF	65.50	69.15	69.50
GBF	58.14	73.80	74.18	SBC	29.07	35.31	35.49
SOD	78.49	85.34	85.78	STP	29.07	35.31	35.49

Design or material flow scenarios proposed to be evaluated by comparing with existing conditions. Evaluation is done by applying the method of Analytical Hierarchy Process. At this stage of the selection on the existing conditions and proposals that are based on the business plan of the company.

Rate pairwise comparisons obtained from questionnaires filled out by the engineering department as decision makers on the performance evaluation of the material flow. Data processing is performed by software expert choice and obtained the results as in the Figure 2.1:

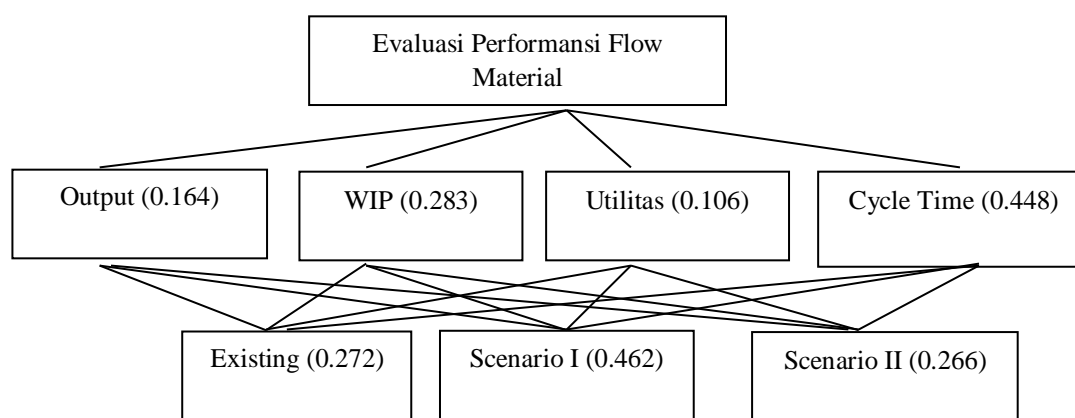


Figure 2.1. The Structure of the Hierarchy and Weighting Material Flow Performance

3. Results and Conclusions

The selected scenario is to use the first scenario with the highest weights of the other two conditions, is 0.462 (46.2%), and the best performance is performance that has value Cycle Time is 0.448 (44.8%).

From this research can conclude the company should be choose the first scenario that is by setting the priorities for operator (transporter) tasks on the resources that have the highest work in process. Work in process occurs on a resource that has a high processing time, is expected to prioritize the work on a resource that has a high process (WIP have high) will reduce bottlenecks and facilitate the production system that will reduce cycle time.

4. References

1. Abhinav, Shukla, Vimal jyoti, Chaturvedi Vedansh. (2013), International Journal of Scientific Research and Reviews (IJSRR), ISSN;2279-0543, Vol. 2 (1), pp. 141-147.
2. Amine Drira, Henri Pierreval, Sonia Hajri-Gabouj. (2007), Facility layout Problems; A Survey. Annual Reviews in Control 31, pp.255-267.
3. Beamon, B.M. (1998), Int. J. Prod.Pres, Vol. 36. No. 2, pp. 377-393
4. De Felice, Fabio., Mostafa H. Deldoost., Mohsen Faizollahi and Antonella Petrillo. (2015), International Journal of Engineering Business Management, 7:17|doi:10.5772/61702.
5. Gogi, Vivekanand., Rohith D.,Shashi Kiran K., Suhail M Shaikh. (2014), International Journal of Innovative research in Science, Engineering an Technology, ISSN:2319-8753, Vol.3 (4), pp.11203-11209.
6. Patil, Subodh B., S.S. Kuber. (2014), International Journal of Research in Engineering and Technology, eISSN:2319-1163, pISSN:2321-7308, Vol. 3 (4), pp. 770-775.

7. Saaty TL. (1980), The analytic hierarchy process, New York, Mc Graw-Hill.
8. Tompkins, J.A., White, J.A., Bozer, Y.A., Frazelle, E.H., Tanchoco, J.M., & Trevino, J. (1996), Facilities Planning, Neo York, Wiley.
9. Vaidya, R.D, P.N. Shende, N.A.Ansari and S.M Sorte. (2013), International Journal of Engineering and Advanced Technology (IJEAT)-ISSN: 2249 – 8958, Vol. 2, February 2013, pp 500-504.
10. Vaidya, R.D. (2013), The International Journal of Business & Management, ISSN 2321-8916, Vol. 1 (2), pp.1-9

E 008

Bleaching Process Improvement Using Evolutionary Operation Method

Yesmizarti Muchtiar¹ , Lestari Setiawati², Rusi Oktavia³.

^{1,2} Industrial Engineering Bung Hatta University

³ Alumni Industrial Engineering Bung Hatta University

*yesmizartimuchtiar@bunghatta.ac.id

Abstract In bleaching process have three factors that are influencing the process are time discoloration, deferent dose discoloration material from oil mass and temperature of discoloration process. The aim of the research is to preparing bleaching process bases on factors that influence process, then PTPO quality has produce will increase. EVOP (Evolutionary Operation) method is one of on line process methods that definite operate condition will more optimum. EVOP method give information about how that product prepare the it quality. After preparing uses EVOP method got temperature factor that is not influence process, discoloration material dose turned out and temperature of discoloration process increasing from first condition to percentage of color intimating increase to 29,8% and amount water decrease to 29,2%. This result makes operate condition in bleaching process to be better than before.

Keywords: EVOP; optimum; better.

1. Introduction

The process to change CPO (Crude Palm Oil) into PTPO (Pre-Treatment Palm Oil) is conducted through bleaching process. The outcome of this process will affect the quality significantly. It can be seen from red color and water content. The less red color and water content, the higher the quality of palm oil.

Nowadays, ongoing operational condition always changes due to variation of material used, uncomfortable environment, etc. Even though a process operates continuously in certain condition, the process tends to shift from its optimum condition.

There are several experimental design methods that can be used to control product quality, such as factorial experiment, factorial design 2k, Taguchi, EVOP (Evolutionary Operation). Almost all experimental designs need big changes in process variable to determine the effect, and need individual with certain capability to execute it, such as employee from engineering department and trained technician. But EVOP method only change process variable a little bit, so product quality is not sacrificed and the design can be executed by factory employees although they have not been trained specifically in statistics. In bleaching process that produce PTPO, EVOP method is used to find factor level that affect the process and the effect toward response variable. From this, we can get optimum process condition.

2. Material and Methods

Steps in EVOP method as follows :

1. Determine quality characteristics (response variable), that is color and water content of PTPO

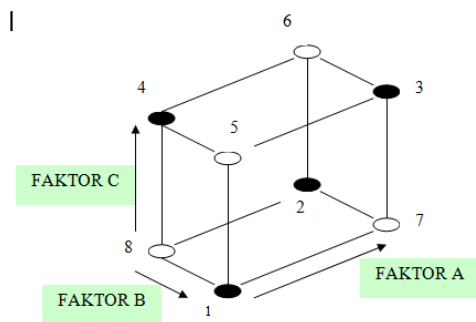
2. Identify factors that affect performance of product quality (free variable) in bleaching process.
3. Operational condition in current bleaching process in the company (initial condition).
4. Determine standard range (level) in bleaching process.
5. Determine appropriate EVOP design.
6. Determine number of cycles needed.
7. Change operational condition that suitable to target specification.

3. Results and Conclusions

Table 3.1 Factor that affect and value level bleaching process

No.	Factor	Level	
		Low (α)	High (β)
1	Bleaching time (minute)	40	50
2	Dosage of bleaching material (%)	1.0	2.0
3	Temperature of bleaching process ($^{\circ}C$)	100	110

Determination of EVOP design that suitable with the data, consist of three factors and two levels that can be seen below:



Picture 3.1 EVOP design for three factor (Sitompul,2003)

Explanation :

- Factor A : bleaching time
- Factor b : dosage of bleaching material
- Factor C : temperature of bleaching process
- Point 1,2,3,...8 : changing condition, that is to change operational condition in several direction but under tolerance level allowed by the company.

Points 0 and O is used as reference condition, that is operational condition run by the company. From these ten operational conditions, we take sample from each of them. These ten condition sets is called cycles. To design three factors of EVOP, these ten conditions is divided into two blocks, Block I and Block II. Block I consists of condition 0, 1, 2, 3, 4, while Block II consists of condition O, 5, 6, 7, 8. For this research, we do 4 cycles.

PTPO color absorption

Based on data for color absorption percentage conducted by the company nowadays, and the changes applied, specification limit that must be obeyed to run EVOP is taken from Table 3.2.

Table 3.2 PTPO color absorption

Condition	Reference Condition (%)	Condition change (%)
1	52	35
2	44	23
3	50	58.5
4	48	47
5	40	61
6	46	45
7	52	34.5
8	44	24.5

Respond to PTPO water content.

Maximum PTPO water content allowed by ministry of commerce and conducted by the company is 2%. Based on data of water content percentage obtained, and changes conducted, specification limit that must be obeyed to run EVOP is taken from Table 3.3.

Table 3.3 PTPO water content

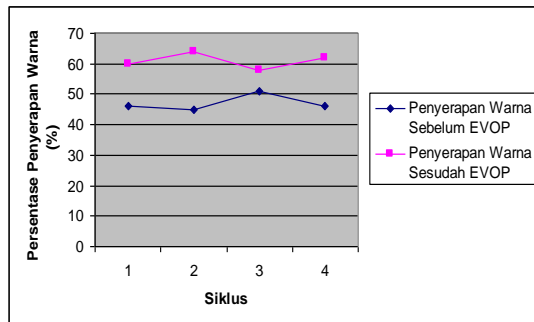
Condition	Reference condition (%)	Condition change (%)
1	1.12	1.383
2	0.95	1.635
3	1.01	0.818
4	1.25	1.093
5	1.05	0.77
6	1.18	1.148
7	0.99	1.365
8	1.15	1.608

All responds obtained from experiment using EVOP method are still below control limit specified by the company, so it doesn't harm PTPO quality, and can be re-used for the next process into *Refined Bleache Deodorized palm Oil (RBDPO)*. The result of EVOP stage at information board shows that operational condition under EVOP Method is better, with response variable result as follows ; percentage of oil color absorption increase, and wáter content decrease. It means, palm oil quality will be better than current condition run by the company (Table 3.4)

Table 3.4 Comparison between EVOP result and current condition

Bleaching process		Reference condition	Condition after implementing EVOP	Suggestion for improvement
Design of combination factor	Time	45 minutes	Not significant	No suggestion
	BE dosage	1,5%	1%	Use lower dosage
	Temperature	105 ⁰ C	110 ⁰ C	Increase temperature
Output (respon variable)	Color	47%	61%	Better
	Water content	1,087%	0,77%	Better

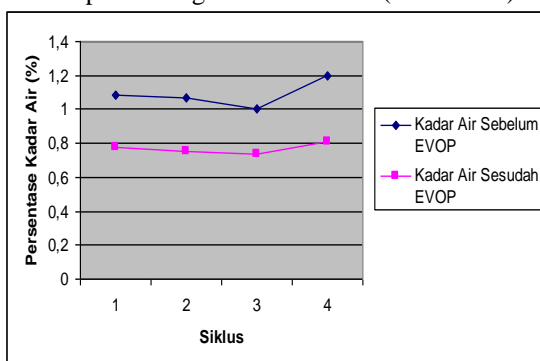
- There is increasing absorption percentage on PTPO red color from current reference condition applied by the company from average 47% into 61%, or 29.8% improvement by implementing EVOP method.



Picture 3.2 Comparison PTPO color absorption before and after EVOP

Picture 3.2 shows that we have better respond after implementing EVOP. Percentage of PTPO color absorption is increasing, compare to respond we get from reference operational condition. It means that current operational condition is not optimum yet.

- There is decreasing PTPO water content from current reference condition, that is from 1,087% to 0,77%, or 29,2% decrease by implementing EVOP method. (Picture 3.3)



Picture 3.3 Comparison PTPO water content before and after EVOP

It also means that operational condition we get after implementing EVOP method is better than current operational condition run by the company

5. References

1. Bestterfield, Dale H, 1995, *Quality Control*, Prentice Hall International, New Jersey
2. Evans, R, James, 2001, *The Management And Control Of Quality*, 5e, United States Of America
3. Luftig Jeffrey T & Victoria S. Jordan, 1997, *Design Of Experiment In Quality Engineering*, Mc. Grow Hill
4. Sitompul, Imelda, 2003, *Penerapan Metode EVOP (Evolutionary Operation) untuk Pencapaian Kondisi Operasi yang lebih Optimum di PT. Coca-cola Medan*, Universitas Sumatera Utara, medan

F 001

Evaluation of Learning Ability Practice Course At Craft Arts 1 Education Studies Program dressmaking State University of Medan

Netty Juliana

Department of Family Welfare Education Faculty of Engineering University of Medan
*nettyjuliana@ymail.com

Abstract The approach used in this study is a quantitative research. This study aims to reveal how the evaluation of practice learning ability in the subject of craftsmanship 1 education courses dressmaking State University of Medan. Analysis of the data showed that the evaluation of the ability of practical learning crafts 1 expected in the labor market based on the ability be organized high category (86%), Effective Communication high category (86%), mastery and enthusiasm Class high category (89%), Positive Attitude Students high category (86%), administration of exams and Rated Justly high category (87%), Dexterity Teaching categorized as moderate (75%), confidence in the students of high category (90%), creativity in learning high category (91%), motivation student high category (91%), and the Student Learning Outcomes Good high category (85%).

Keywords: Evaluation; Ability; Student.

1. Introduction

Learning is something that intentionally or unintentionally gained from the experience for all behavior change towards the better. Or a process of learning from life experiences that apply to self-improvement. Learning does not only apply dibangku school, but outside of the school environment, pembelajaranpun apply in any case so as to form patterns of thinking and attitudes to be better than ever. Based on Law No.20 of 2003 on National Education System Article 1 paragraph 20 states Learning is a process of interaction between educators and learners with learning resources in a learning environment.

Learning is an activity undertaken in integrating the sequence of events starting from organizing the lecture material, students, equipment, materials, and time spent in the learning process. So that teaching and learning activities carried out by students and lecturers can be run in accordance with a systematic and optimal. And targets achieved in the mastery of science can be mastered by students to produce a value of learning outcomes that are theoretical or practical.

Practical learning the teaching and learning activities in the classroom, especially in the media laboratory space with good ingredients that electronic media, visual media, print media, audio media, or media projections silent. Learning practices commonly use tools and equipment in the form of a simple (manual) shaped machines and equipment. Thus, in practice learning are expected to mastercontrol of media and equipment that have been determined at each learning materials with the goal of students have special skills in the field that they do during the lectures.

In practice learning often use the method of demonstration and experimentation. Both of these

methods are often used in the practice of alternating or complementary. Experiment is a method that is usually used in science lessons. In the experiment, hypothesis testing is done through an investigation to find specific science concepts and principles. Experiments were carried out involving thinking, technical skills, scientific skills, and skills to 'manipulate'. In practice learning Kriya art using practical methods of creating art products textile craft archipelago. In practice learning craftsmanship always departs from the concept of Indonesian culture, process, until the creation of wall hangings prodak artistic.

To analyze the practice learning crafts courses dressmaking Medan State University referred to the literature that the researchers developed a research instrument to measure students' skills namely 1) Organizing, 2) Communication, 3) Mastery & Enthusiasm Class, 4) Positive Attitude, 5) Provision Trials and Value Fair, 6) Dexterity Teaching, 7) The confidence of students, 8) creativity, 9) Motivation of students, and 10) Student Learning Outcomes.

2. Studies Theory

The term "craftsmanship" is derived from the Sanskrit "craft" which means "work". Of the basic words are then developed into a word that is diverse, ranging from the work, craft and work. In a special sense kriya is doing something to produce an object or objects. However, along with all its development work as well as the results of a wide range of manufacturing techniques which then produce a piece of art that has a specific function is also called the "art of Kriya". (Timbul Haryono, 2002).

Craft art is one part of the instructional practices that perform simple demonstrations, because the use of equipment and supplies from

nature. So that the kriya prodak creation processed by human hand skills to require quite limited and prodak actions is limited. Practical learning crafts including category type design surface. Design is defined as the surface of a decorative design on the surface of plain fabric. Which in turn have aesthetic value (beauty) in prodak craft. Examples produced by a surface design, among others; batik, jumputan rainbow, hand painting, screen printing, embroidery, embroidery, and sequins (mute / beads).

In the course craft art practice is focused on the creation of works of art that is traditional and departs from; 1) the concept of culture in North Sumatra Batak tribe, 2) material selection of materials Payet-sequins and beads, 3) sketch, 4) collage, and 5) prodak craft-making process in the form of wall hangings. Prodak on the creation of craft art should be based on the principles of art and art elements. So prodak prodak craft art in the form of textile craft is generated has a value and a good function. The principles applied to prodak art wall decoration consists of; 1) balance (balance); 2) the principle of unity (unity); 3) the principle of rhythm; 4) the center of attention (center of interest); 5) the principle of proportion or ratio; and 6) alignment. While the elements of art consists of; points, lines, shapes, and colors. Rate on learning subjects craft art on students of fashion Medan State University in 2014, using the ratings of ten indicators, namely: 1) Organizing, 2) Effective Communication, 3) Mastery & Enthusiasm Class, 4) Positive Attitude Students, 5) Giving Fair Trials and Values, 6) Dexterity Teaching, 7) self-esteem in students, 8) creativity in learning, 9) Motivation of students, and 10) Student learning Outcomes Good.

3. Research Methods

This research uses descriptive quantitative approach to analyze how the ability to undertake the development of practical learning, particularly in the manufacture of wall hangings prodak subjects 1 Student Art craft dressmaking courses at Unimed in the academic year 2014-2015.

Population and sample are students of Department of dressmaking Unimed academic year 2014-2015 amounted to 120 people, with the consideration that the students studied are students who attend lectures crafts 1.

Based on purposive sampling techniques and techniques of sampling Slovin it is known that the number is 30 people. To collect research data conducted by using a questionnaire instrument (questionnaire). Questionnaire was conceived and developed in accordance with the indicator variable capabilities required 10 working market, then the indicator is based on the study of the theory suggested by experts that later developed into the

questions. By using a Likert Scale modified in accordance with the measurement indicators with a positive attitude measurement scale up negative.

Data analysis was performed using percentage and categorization by the formula:

$$\frac{\text{Total acquisition score}}{\text{The highest total score ideal}} \times 100 \%$$

$$\frac{\text{Acquisition Total Score}}{\text{The highest answer} \times \text{number of respondents} \times \text{Number of question}} \times 100 \%$$

The results of the analysis based on the above formula and then do the categorization of the results based on the scale of the achievement level Responen. Sudjana (1996) according to the following table 1:

Table 1: Scale

Percentage of Achievement	Criteria
90 – 100 %	Very high
80 – 89 %	High
65 – 79 %	Moderate
55– 64 %	Low
0 – 54 %	Very low

4. Results and Discussion

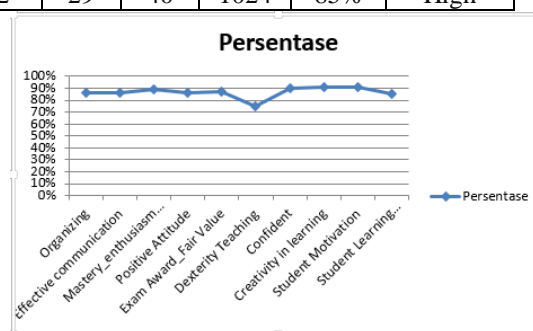
The results of the study are described based on the average (mean), the mean (median), the lowest value (minimum), the highest value (maximum), the total score (sum), the percentage of respondents attainment levels and categories. Here are the results of data analysis evaluation Student Learning Practices in Education craftsmanshi dressmaking Medan State University in 2014. Table 2 above shows the results of evaluation of learning crafts 1 on majors.

No	Learning Evaluation Results	Mean	Mdi	Mode	Min	Max	Sum	%	Category
1	Organizing	34,23	34,00	32	29	40	1027	86%	High
2	Effective communication	43,13	43,00	40	37	50	1294	86%	High
3	Mastery and enthusiasm Class	13,37	14,00	12	12	15	401	89%	High
4	Positive Attitude Students	21,50	21,00	20	18	25	645	86%	High
5	Exam Award and Fair Value	17,33	17	16	15	20	520	87%	High
6	Dexterity Teaching	30,13	30	28	21	40	904	75%	moderate
7	Confident	22,50	22	22	20	25	675	90%	High
8	Creativity in learning	18,13	18	18	16	20	544	91%	High
9	student Motivation	13,70	14	14	12	15	411	91%	High
10	Student Learning Outcomes	34,13	33	32	29	40	1024	85%	High

Table 2 : Results of Data Analysis

Fashion education in the category of organizing lectures with a high percentage of 86%. The results of effective communication in practice learning in the category of high craftsmanship with a percentage of 86%. Results mastery and enthusiasm towards learning lectures in the category of high craftsmanship with the presentation of 89%. The results of the evaluation of the students a positive attitude towards learning the practice of craft art including high category with a presentation of 86%. Evaluation of the test results and a fair value at study entry crafts category is high with 87% presentation. The evaluation results of flexibility in teaching the craft art 1 medium category with a percentage of 75%. The results of the confidence of students during practice learning craftsmanship is very high entry category with the presentation of 90%. The creativity of the students in learning the practice of kriya including very high category with a percentage of 91%. Evaluation of student motivation for learning the practice of craft art including very high category with a percentage of 91%. And evaluation of learning outcomes of students in 2014-2015 at study entry craft art high category with a percentage of 85%.

Analysis of the data presented, more clearly stated the results of research in the form of the following histogram:



Based on the data analysis described in the table data and image histogram above explains that the practice of learning evaluation craftsmanship 1 has several indicators, namely; 1) organization, 2) effective communication, 3) Mastery & Enthusiasm Class, 4) Positive Attitude Students, 5) Provision of Examination and Value Fair, 6) Dexterity Teaching, 7) Self-esteem in students, 8) Creativity in learning, 9) Motivation of students, and 10) The results of student learning. The results of the evaluation of the data above shows that students are able to process concepts with creative and create a new field of art craft prodak needed today's society. hangings, 2) tablecloths, 3) glove canceled seats, 4) curtains, 5) cup decorative lights, and 6) pajanggan ornate parlor.

The new Prodak craft art created by students of fashion education in 2014-2015 Unimed departing from North Sumatra culture consisting of five Batak. Then the results of culture of North Sumatra developed on household linen, namely; 1) craft art wallhangings, 2) tablecloths, 3) glove canceled seats, 4) curtains, 5) cup decorative lights, and 6) pajanggan ornate parlor.

An indicator of the positive attitude of students, self-confidence in students, giving exams and fair value, and indicators of student learning

results in the category of good and satisfactory. So that all the indicators above demonstrate the preparation of students on employment prepared and mature as optimal as possible as a candidate kriyawan or craft designer. With hope after completing his studies at the College, students are ready to enter the world of work and students are ready to create new jobs in the corporate world at the craft of household linen in accordance with fashion trends and needs of today's society.

5. References

- 1) Netty, Juliana, 2015, Journal of Community Service, Publisher UNIMED.
- 2) Netty, Juliana 2014, Journal Arts, Publisher FBS UNIMED.
- 3) Soekanto, Soerjono, 1982, An Introduction to Sociology, Jakarta, CV.Rajawali.
- 4) Sumardjo, Jakob, 2000, Philosophy of Art, Bandung, Printing ITB.
- 5) Sumardjo, Jakob 2006, Aesthetics paradox, Bandung, Sunan Ambu Press.
- 6) Suyanto, 2013, Being a Professional Teacher Qualifications and Strategy Improving Teacher Quality in the Era of Global, Jakarta, publisher.
- 7) Widagdo, 2001, Design and Culture, Bandung, Ministry of Education.

F 002

Analysis of the Effectiveness of Microsoft Office Certification by Using Mamdani Fuzzy Inference System (FIS) Method

Karmila Suryani, Khairudin

Computer Education, Math Education, Bung Hatta University
Padang, West Sumatera, Indonesia
*karmilasuryani.ptik@gmail.com

Abstract In this article, it will be analyzed to what extent is the effectiveness of International Standard Microsoft Office Training 2010 in preparing the students to face Industrial world, and the analysis on the administering and study process of the Training. The research method being used is Quantitative Descriptive Method based on variable of questionnaires and result of competency test of each trainee. Application of Mamdani Fuzzy Inference System (FIS) method is necessary in order to determine the extent of effectiveness of Microsoft Office 2010 Training Program held in cooperation with Trust Microsoft Partner. By applying fuzzification, implication function, composition of rules and defuzzification processes, it can be found the level of effectiveness of the program for each student taking part in the Microsoft training. The inputs for fuzzification process are the grades in Word, Excel and Power Point obtained by the trainees in the competency test. Implication function being used is min implication. Composition of rules is obtained by examining the sample data of 20 students. Finally, the defuzzification phase is obtained from the grade given by Microsoft and the output of the level of effectiveness as seen in the questionnaire filled in by the trainees.

Keywords: Microsoft Competency Test of Microsoft; Mamdani FIS Method; Level of Effectiveness.

1. Introduction

Development of Information and Communication Technology (ICT) has affected almost all aspects of human life in such a way that it prompts the emergence of a new era, namely the information era; an extension of the previous industrial era. Munir (2014, 1) stated that the society in the information era is keen on knowledge assets than capital assets. This signifies that all components in the society, particularly teachers must also prepare themselves to enrich their knowledge assets by mastering the Information and Communication Technology, particularly with regard to the creation of collaborative learning model and multimedia. In addition, UNESCO has declared that the 21st century is the century of long life education which means that mastering the Information and Communication Technology by all components in the society will become a standard procedure in learning process, not only in a classroom but also anywhere, at anytime and for whatever learning activities. Furthermore, Saripudin (2015, 1) stated that the 21st century's learning paradigm has been shifted in such a manner that the role of the teacher from previously "Teacher-as-Director" in the industrialization era has now shifted into "Teacher-as-Facilitator, Guide, and Consultant" in this information era. Such condition is reasonable because learning resources and learning materials can now be obtained from many sources, not from one source only.

Furthermore, the Director General of Higher Learning in its policy has stipulated that all universities must be able to prepare the graduates

who are ready to compete in a competitive job market due to a significant gap between demand and offer in job opportunities. The universities must also make the quality of human resources of their graduates compatible with the needs of the real world. Mastery of computer skills is one of the components of ICT that shows the quality of ready-for-use human resources. In order to prepare a skilled manpower in computer operation (Microsoft Excel, Power Point and Word), the Department of PTIK of Bung Hatta University has engaged in a partnership with Microsoft Partner for training its students in computer operation based on Microsoft curriculum applicable internationally.

As a candidate of computer teacher, PTIK graduates must master basic computer skills. This is necessary because there are indications that computer ability of teachers at primary and secondary school grades are still very much low, many of them have not yet mastered computer applications properly. These indications are found based on the results of observations and community service programs performed by PTIK team in several schools in the city of Padang. Most of the teachers do not know how to operate computer applications effectively and efficiently. They use Microsoft applications only for processing word and data at the very simple level, not for information processing and visualization of data for education and learning purposes. In addition, the alumni of PTIK who have found a job or who involved in non-teaching professions also reported that they found themselves having lack of computer skills in information and data processing as required

in their work place. That's why PTIK decided to organize the Microsoft Certification Training which until now has already completed five batches. However, the effectiveness of the training carried out so far has not been studied scientifically. It is in this paper, the researchers will analyze and describe the effectiveness of Microsoft 2010 Training to the students and graduates of PTIK Department in facing the world of work. The research will also give information in more detail about the picture of the extent to which the effectiveness of programs that have been designed by Microsoft to support job readiness and to support learning process.

According to Alliger and Janak (1989) there are four aspects for measuring the effectiveness of training, namely: Reaction, Learning Process, Behavioral Changes and Outcomes. Reaction is a measure of the effectiveness of the training in view of the response of the participants, especially the immediate reaction. Learning Process is a measure of the effectiveness of the training in view of the extent of knowledge that can be absorbed by the trainee in the training. Outcomes is the measure of effectiveness of the training in view of the achievement of the goals of the organization after the training, such as an increase in performance productivity, employee turnover, quality of work, time efficiency, and decrease of inefficiency. According to Haywood (1992) there are eight variables that may influence the effectiveness of a training, namely: (1) organizational support for a change, (2) commitment and strong belief in education, training and development of individuals, (3) training and development which should be related to the strategy and purposes of the business, (4) formulation and implementation of business strategies, (5) trainees who not only receive knowledge and abilities but also can demonstrate competence, including to find out the needs of customers, (6) setting the objectives and expected results of the training, (7) determining the specifications in training, and (8) thorough evaluation of the effectiveness of the training and commitment of the trainees during the training process.

Indicators of each variable of the effectiveness of training in this research shall be as follows:

- a. Accuracy of Training Method, which shall be measured by the indicators of suitability of the method with the background of participants, suitability of the method with the career level of participants and the suitability of the method with training facilities.
- b. Quality of Training Content, which shall be measured by the indicators of sufficiency of the material being presented, suitability of the material with the needs of participants, material which is a new information or new

skill for the participants, and regularity in the arrangement of the material.

- c. Qualification of the Trainers, which shall be measured by the indicators of the trainer's experience, and capability of the trainer to transfer the material and knowledge.

This paper shall discuss the effectiveness of Microsoft Certification Training using Mamdani FIS Method. There is no previous research regarding effectiveness of a training using Mamdani FIS method before. Some of the researches using Mamdani FIS only discussed about performance assessment, among others: Triayudi and Nazori (2012) which discussed about Assessment of Teachers Performance using Mamdani FIS, Muthohar and Rahayu (2016) which discussed about Assessment of Nurse Services using Mamdani FIS, Sumiati and Nuryadin (2013) which discussed about Assessment of Lecturer's Performance with Fuzzy Database of Mamdani Model. Suryani and Khairudin (2015) also conducted a research for evaluating the performance of teachers by using Mamdani FIS. Nowadays, Fuzzy Logic is widely applied for research in various disciplines, particularly when the research uses indefinite measurements by using questionnaire of Likert scale. It is with Fuzzy logic that such kind of research is more appropriate. The level of effectiveness being analyzed by using fuzzy logic in this paper is taken from the results of Microsoft test and questionnaire given to participants. The variable of input is the score of training test and the variable of output is the score of training questionnaires. Furthermore, the data is processed using fuzzy logic by firstly applying the rules against the process of input and output.

2. Material and Methods

The method used in this research is that of descriptive analysis against primary data being obtained through Microsoft Certification scores and questionnaire score resulting from the test given to participants who took part in Microsoft Certification Training. Questionnaire of effectiveness was designed using indicators of effectiveness as, according to the opinion of the experts, divided into three major sections, namely preparation, training materials and implementation of the training in accordance with the expected goals. Instruments of the questionnaires have been validated and computed for their reliability, with valid results and sufficient reliability values. In this study, the population of study is all of the 100 participants attending Microsoft Certification Training, and the sample was taken at random for 20 participants in accordance with the requirements. Because the input scores are obtained from results of test on the subjects such as Excel, Word and Power Point, and the output scores are obtained from the scores of questionnaires of the participants, it is necessary to use Universal Set

(Universe of Discourse) based on the range of scores as provided for in table 1.

Table 1: The Universal Set for Microsoft Training Effectiveness

Function	Variable	Universal Set
Input	Microsoft mark (x_1)	[0,100]
	Preparation score (x_2)	[0,12]
	Material score (x_3)	[0,36]
	Performance score (x_4)	[0,20]
Output	Decision	[0-68]

There are four stages for obtaining the output using Mamdani FIS method, namely:

a. Fuzzification

Because the grade of effectiveness is determined through questionnaire score after the training, the sets of input and output are fixed by table 2.

Table 2: The sets of input output fuzzy for the effectiveness of training

Function	Variable	Fuzzy Sets	Domain
Input	Microsoft mark (x_1)	Not Good (NG)	$0 \leq x < 80$
		Good (G)	$50 \leq x \leq 100$
	Preparation score (x_2)	Not Good (NG)	$0 \leq x < 9$
		Good (G)	$3 \leq x \leq 12$
	Material score (x_3)	Not Good (NG)	$0 \leq x < 27$
		Good (G)	$9 \leq x \leq 36$
	Performance score (x_4)	Not Good (NG)	$0 \leq x < 15$
		Good (G)	$5 \leq x \leq 20$
Output	Decision (z)	Not Effective (NE)	$0 \leq x < 51$
		Effective (E)	$34 \leq x \leq 68$

This research assumes that if the test score is getting higher, the effectiveness score shall be better. Therefore, it can be said that the membership function for effectiveness of the training applies linear membership function. This is in accordance with the triangular shape of Mamdani FIS method. Membership function for each variable shall be as follows:

1) Variable x_1

$$\mu_{TB}(x_1) = \begin{cases} 1 & ;0 \leq x_1 < 50 \\ \frac{(80-x)}{(80-50)} & ;50 \leq x < 80 \\ 0 & ;80 \leq x \leq 100 \end{cases} \quad (1)$$

$$\mu_B(x_1) = \begin{cases} 0 & ;0 \leq x_1 < 50 \\ \frac{(x-50)}{(80-50)} & ;50 \leq x < 80 \\ 1 & ;80 \leq x \leq 100 \end{cases} \quad (2)$$

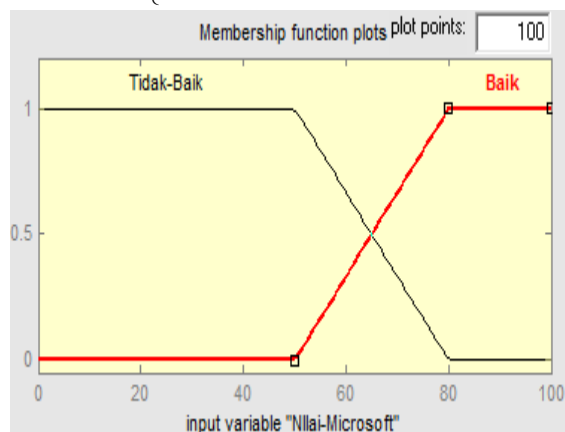


Figure 1 (Membership Function for Variable x_1)

2) Variable x_2

$$\mu_{TB}(x_2) = \begin{cases} 1 & ;0 \leq x < 3 \\ \frac{(9-x)}{(9-3)} & ;3 \leq x < 9 \\ 0 & ;9 \leq x \leq 12 \end{cases} \quad (3)$$

$$\mu_B(x_2) = \begin{cases} 0 & ;0 \leq x < 3 \\ \frac{(x-3)}{(9-3)} & ;3 \leq x < 9 \\ 1 & ;9 \leq x \leq 12 \end{cases} \quad (4)$$

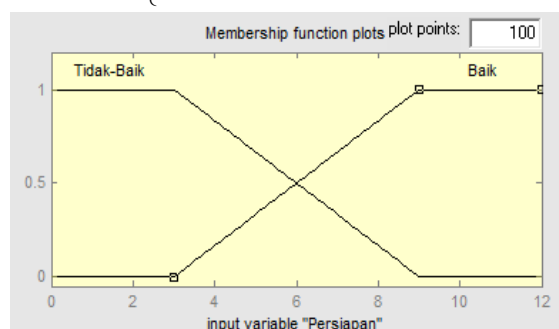


Figure 2: Membership Function for Variable x_2

3) Variable x_3

$$\mu_{TB}(x_3) = \begin{cases} 1 & ;0 \leq x < 9 \\ \frac{(27-x)}{(27-9)} & ;9 \leq x < 27 \\ 0 & ;27 \leq x \leq 36 \end{cases} \quad (5)$$

$$\mu_B(x_3) = \begin{cases} 0 & ;0 \leq x < 9 \\ \frac{(x-9)}{(27-9)} & ;9 \leq x < 27 \\ 1 & ;27 \leq x \leq 36 \end{cases} \quad (6)$$

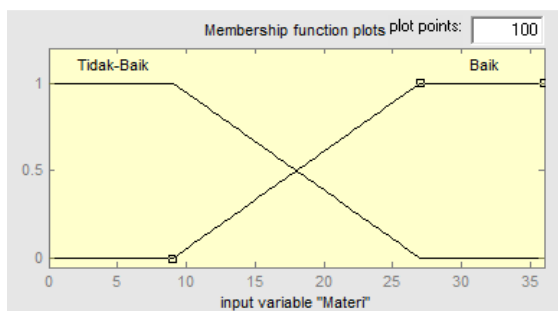


Figure 3: Membership Function for Variable x_3

4) Variable x_4

$$\mu_{TB}(x_4) = \begin{cases} 1 & ;0 \leq x < 5 \\ \frac{(15-x)}{(15-5)} & ;5 \leq x < 15 \\ 0 & ;15 \leq x \leq 20 \end{cases} \quad (7)$$

$$\mu_B(x_4) = \begin{cases} 0 & ;0 \leq x < 5 \\ \frac{(x-5)}{(15-5)} & ;5 \leq x < 15 \\ 1 & ;15 \leq x \leq 20 \end{cases} \quad (8)$$

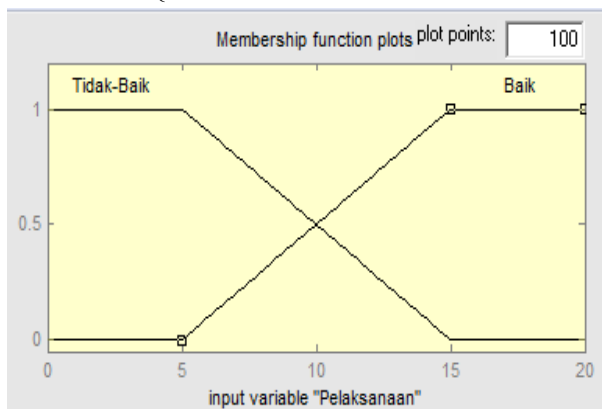


Figure 4: Membership Function for Variable x_4

And the membership function for output (z) shall be as follows:

$$\mu_{TE}(z) = \begin{cases} 1 & ;0 \leq z < 34 \\ \frac{(51-z)}{(51-34)} & ;34 \leq z < 51 \\ 0 & ;51 \leq z \leq 68 \end{cases} \quad (9)$$

$$\mu_E(z) = \begin{cases} 0 & ;0 \leq z < 34 \\ \frac{(z-34)}{(51-35)} & ;34 \leq z < 51 \\ 1 & ;51 \leq z \leq 68 \end{cases} \quad (10)$$

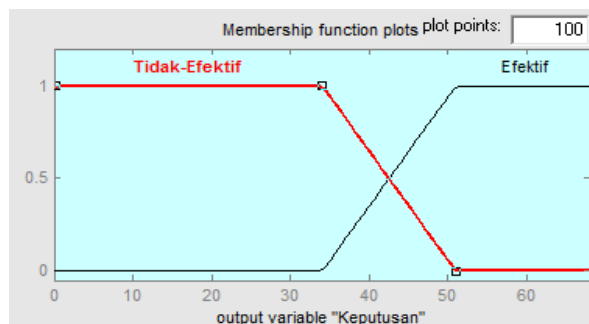


Figure 5: Membership Function for Variable z

b. Formation of *fuzzy (rules)* reasoning basis

Moreover, the *Fuzzy* rule is thereafter defined, in which such *Fuzzy* rule comprises a qualitative statement formed by statement IF THEN. The *Rule* is arranged on the basis of the facts obtained from the Microsoft training in which the input variable for preparation do not so much affect the effectiveness of the training. There are 10 rules being formed in accordance with the data obtained as follows:

- [R1] IF x_1 is TB and x_2 is TB and x_3 is TB and x_4 is TB THEN z is TE
- [R2] IF x_1 is TB and x_2 is TB and x_3 is B and x_4 is B THEN z is E
- [R3] IF x_1 is TB and x_2 is TB and x_3 is B and x_4 is TB THEN z is TE
- [R4] IF x_1 is TB and x_2 is B and x_3 is TB and x_4 is B THEN z is E
- [R5] IF x_1 is TB and x_2 is B and x_3 is B and x_4 is B THEN z is E
- [R6] IF x_1 is B and x_2 is TB and x_3 is TB and x_4 is TB THEN z is TE
- [R7] IF x_1 is B and x_2 is TB and x_3 is B and x_4 is B THEN z is E
- [R8] IF x_1 is B and x_2 is TB and x_3 is B and x_4 is TB THEN z is E
- [R9] IF x_1 is B and x_2 is TB and x_3 is TB and x_4 is TB THEN z is E
- [R10] IF x_1 is B and x_2 is B and x_3 is B and x_4 is B THEN z is E

The *Rules* which have been obtained are thereafter applied to Matlab application program as in figure 6.

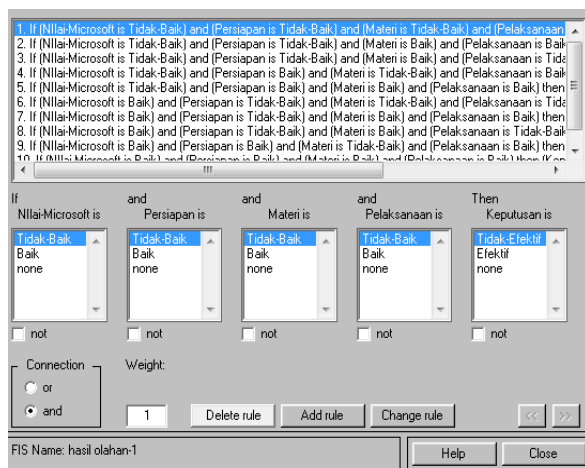


Figure 6: Formation of Rules

c. Application of implication function using MIN and composition among the rules using MAX function.

Because of using Mamdani method, the implication function uses minimum method. The implication function (α) expresses one degree of membership, namely the minimum value from the four inputs based on the rule previously formed.

$$\begin{aligned} \alpha 1 &= \mu_{TB_X1}[x] \wedge \mu_{TB_X2}[x] \wedge \mu_{TB_X3}[x] \\ &\wedge \mu_{TB_X4}[x] \\ &= \min(\mu_{TB_X1}[x]; \mu_{TB_X2}[x]; \\ &\mu_{TB_X3}[x]; \mu_{TB_X4}[x]) \\ \alpha 4 &= \mu_{TB_X1}[x] \wedge \mu_{TB_X2}[x] \wedge \mu_{TB_X3}[x] \\ &\wedge \mu_{TB_X4}[x] \\ &= \min(\mu_{TB_X1}[x]; \mu_{TB_X2}[x]; \\ &\mu_{TB_X3}[x]; \mu_{TB_X4}[x]) \end{aligned}$$

d. Defuzzification using centroid method

The method being used in defuzzification process in this research is centroid method wherein the output value thereof is obtained by taking the central point in fuzzy area. By using Matlab program the result is shown in figure 7 below:

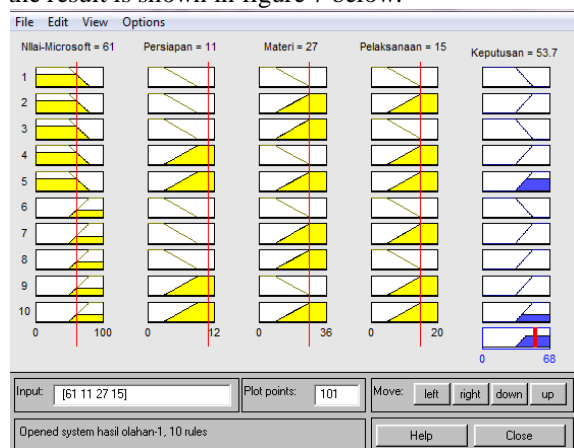


Figure 7: Defuzzification process

3. Results and Conclusions

Based on the stages of process in Fuzzy Inference System (FIS) Mamdani, a simulation is then conducted to the data with the results as shown in the following table 3.

Table 3. Data Of Training

No Resp	X1	X2	X3	X4	Z
1	62	10	30	16	53,6
2	72,67	9	28	16	54,2
3	62	11	34	20	53,6
4	60,33	12	31	18	53,8
5	85,33	9	31	18	55
6	71,67	8	31	19	54,1
7	46,33	8	26	15	54,4
8	69,67	12	32	18	53,8
9	60,33	12	29	20	52,8
10	74	10	29	17	54,3
11	58	12	33	20	54,1
12	70	11	30	16	53,8
13	70,67	9	29	16	53,4
14	67	8	32	13	44
15	78,33	12	32	18	54,7
16	61,33	11	27	15	53,7
17	36,67	11	29	15	55
18	71	10	29	14	53,9
19	61,33	11	31	18	53,7
20	41	11	30	20	55

Table 3 above shows that the result of calculation using Mamdani FIS almost close to the actual Z value. Therefore, if the result is seen from the point of view of effectiveness value, then it can be concluded that the Microsoft Office 2010 training can be categorized as a success and “effective”. Example:

a. Determine the degree of Membership

Var (x_1):

Var (x_2):

$$\mu_{TB}(62) = \frac{(80 - 61)}{80 - 50} = 0,6$$

$$\mu_B(10) = 1$$

$$\mu_B(62) = \frac{(62 - 52)}{80 - 50} = 0,4$$

Var (x_3):

Var (x_4):

$$\mu_B(30) = 1$$

$$\mu_B(16) = 1$$

b. Determine α predikat from Implications Function

$$\alpha_1 = \mu_{TB}(x_1) \wedge \mu_B(x_2) \wedge \mu_B(x_3) \wedge \mu_B(x_3) \wedge \mu_B(x_4)$$

$$= \min(0,6;1;1;1) = 0,6$$

$$\alpha_2 = \mu_B(x_1) \wedge \mu_B(x_2) \wedge \mu_B(x_3) \wedge \mu_B(x_3) \wedge \mu_B(x_4)$$

$$= \min(0,4;1;1;1) = 0,4$$

c. The Rule Inference

Conclude between the rule use maximum method, such as fig 8

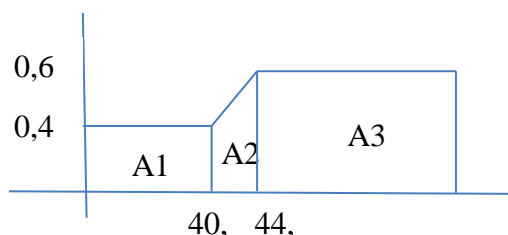


Figure 8: Maximum Method for Concluded between The Rule

$$\mu_E(Z) = \frac{(z-34)}{51-34}$$

$$0,4 = \frac{z-34}{17}$$

$$0,4 \times 17 = z - 34$$

$$z = 40,8$$

$$\mu_E(Z) = \frac{(z-34)}{51-34}$$

$$0,6 = \frac{z-34}{17}$$

$$0,6 \times 17 = z - 34$$

$$z = 44,2$$

So Membership function for the composition ie;

$$\mu(z) = \begin{cases} 0,4 & ; z \leq 40,8 \\ \frac{(z-34)}{(51-35)} & ; 40,8 \leq z < 44,2 \\ 0,6 & ; z \geq 44,2 \end{cases}$$

d. Centroid methods for Defuzzyfication, such as;

$$M_1 = \int_0^{40,8} \mu(z)z \, dz = \int_0^{40,8} 0,4z \, dz = \left[0,2z^2 \right]_0^{40,8} = 332,928$$

$$M_2 = \int_{40,8}^{44,2} \mu(z)z \, dz = \int_{40,8}^{44,2} \frac{(z-34)}{17}z \, dz = \left[\frac{z^3}{51} - z^2 \right]_{40,8}^{44,2} = 72,443$$

$$M_3 = \int_{44,2}^{68} \mu(z)z \, dz = \int_{44,2}^{68} 0,6z \, dz = \left[0,3z^2 \right]_{44,2}^{68} = 801,108$$

$$A_1 = 40,8 * 0,4 = 16,32$$

$$A_2 = (0,4 + 0,6) * \left(\frac{44,2 - 40,8}{2} \right) = 1,7$$

$$A_3 = (68 - 44,2) * 0,6 = 14,28$$

Then the centroid is obtained;

$$z = \frac{332,928 + 72,443 + 801,108}{16,32 + 1,7 + 14,28} = 54$$

Based on the centroid, it can be concluded that for the case student 1 is nobtained a score 54. This mean that Microsoft is very effective training for students. The results of this research indicate that the level of training effectiveness can be measured by using FIS Mamdani.

4. References

1. Munir, 2014, *ICT Competency Framework for Teachers*, Alfa Beta, Bandung
2. Saripudin, 2015, *Advancement of Teaching Model in 21st Century By Using Web 2.0 Technology*, Teknodik: Journal Vol 19 Nomor 1, pp:1-11
3. Alliger, Goerge M., dan Janak, Elizabeth A, 1989, "Kirkpatrick's Levels of Training Criteria : Thirty Years Later", *Personnel Psychology*.
4. Haywood, K. Michael, 1992, "Effective Training : Toward a Strategic Approach", *The Cornell H.R.A. Quarterly*, December
5. Triayudi,A. And Nazori AZ., (2012), *Analysis of Teacher Performance Assessment System Using Mamdani Fuzzy Inference System: A Case Study in Technical Executive Unit of the Education Services of Panengahan Sub-District of South Lampung*, *TICOM Journal*, Vol 1 No.1, pp:24-28
6. Muthohar,A., and Rahayu, Y., 2016, *Implementation of Fuzzy Mamdani Logic to Performance Assessment to Nurse Services*, *Journal of Applied Intelligent System*, Vol.1, No.1, pp.67-76
7. Sumiati and Nuryadin,S., 2013, *Supporting System for Making a Decision in Determining the Performance Assessment of Lecturers by using Fuzzy Method Database Mamdani Model*, *Electrans*, Vol.12, No. 2, pp. 161-170
8. Suryani, K., and Khairudin, 2015, *Evaluation to Performance of Teachers by Using Mamdani Fuzzy Inference System (FIS) Method*, *Proceeding SENATKOM –ISSN 2460-4690* hal 149-152

F 008

Posttest Evaluation on the Development Model of Blended Learning

#1 **Riswan**, #2 **Eril Syahmaidi**

#1 STMIK Nurdin Hamzah, Jambi, Indonesia

*ris_wone@yahoo.com

#2 Bung Hatta University, Padang, Indonesia

*erilsyahmaidi@gmail.com

Abstract This research is advanced than the initial research has been done on matakuliah project management information system (MPSI), and have been added to the seminar on the International Conference on Technical and Vocation Education and Training, High on a hill on the 16th-17th-October 2015, organized by the State University of Padang (UNP). And Jambi International Seminar on Education (Jise), organized by the State University of Jambi (Unja). The results of initial research showed, that the quality of the teaching model of face-to-face with MPSI was at categories fairly, so that needs to be developed a Blended Learning model that is merging model of face-to-face with models of e-learning, to improve the quality of teaching for the better. Do class experiments and Posttest grade controls as a continuation of the pretest conducted earlier, the results will be compared with posttest pretest to see signifikansi of model development is done.

Keywords: Model face-to-face; *E-Learning*; *Blended Learning*; *Pretest*; *Posttest*; MPSI.

1. Introduction

Development of blended learning lecture model courses toward project management information system (MPSI) is already entered on the posttest testing phase. Testing done to see the influence of the students' learning results against significant after being given the treatment. The results of the data processing posttest will be evaluated to find out the significance or whether the treatment has been given. The resulting data is processed so that it can give information about the condition of the students against the model of blended learning on lecture MPSI. The development of this model is indispensable to improve the quality of teaching in STMIK Nurdin Hamzah, where in early research, showed that the quality of teaching MPSI position categories suffice. [15]

Pretest evaluation against the object of research has been done on the control class and classroom experiments showed no difference who significant against second class. This indicates that both objects there is no more difference between the two significant. If there is it due to the treatment given to the object of research.

2. Research Methodology

Do need analysis form to question posttest in the form of multiple choice question to the class 60 and class control experiment to see how far the student understand the subjects MPSI after being given the treatment. Posttest results this will be analyzed using SPSS applications. Processed data becomes the source for analyzing the perception of students toward blended learning model. This model was developed with Borg and Gall

2.1. Model Perkuliahan Konvensional

Conventional meaning by Convention (Agreement) General (such as customary, habitual, customary), traditional. In relation to the improvement of the quality of education, quality improvement efforts of the conventional approach to education that is based by default on the paradigm of the input – process – output. In conjunction with the teaching and learning process, learning approach as already commonly used in the learning activities in the classroom are called conventional learning approach [2].

Conventional learning approach is an approach which is done by combining a variety of learning methods. In practice this method is centered on the teacher (teacher centered), teachers are more dominating in the learning activities. Method of learning is done in the form of methods lectures, granting and faqs. The conventional approach is the approach of learning a lot at the moment, schools are using the sequence activity awarding examples and descriptions of exercises [5]. This learning approach is thus closer to methods lectures. Lecturer becomes a deciding the course of the process of learning or a source of information. While passive students with listening to the lecture carefully and take note of things that are considered important.

Lecture method is a method of delivering learning materials with oral communication. This method is an economical and effective to convey information and understanding. However in the learning of students with this method tends to be passive, it puts the teacher as the final authority, setting the pace in classical determined by faculty, so that this method is less suitable for the formation of

the skills and attitudes of students [9].

Based on explanation above it can be concluded that the conventional learning approach in this research is the learning approach that combines methods lectures, q & a, and the granting of duty in the process of learning in the classroom. It has the characteristics of conventional approaches include:

a) Lecturer considers the ability of the students of the same, b) use the class as the only place to learn, c) teach more speaking engagements, d) Separation of subjects is apparent, e) Provide activities that do not vary, f) Communicating in one direction, g) The climate of learning emphasizes the achievement of the effect of interaksional based on the orientation of the Group, h) Teaching using only the books and the information only from the lecturer, i) Only assess the results of the study.

2.2. E-Learning Model

E-Learning is a word that is often used for all educational activities that use computer or internet media. There is a terminology that has a meaning similar to the e-learning, web based learning, online learning, computer-based learning/training, distance learning, computer-aide instruction. E-learning is basically has two types namely synchronous (same time) and asynchronous (not at the same time). And offers the advantage of side (1) cost, (2) Flexibility of time, (3). The flexibility of the site, (4) Flexibility of learning speed, (5). Standardization of teaching, (6) teaching Effectiveness, (7). Speed distribution (8). The availability of On-Demand, (9) administrative process automation. In addition there are benefits, there are certainly disadvantages including (1) culture, (2). Investment, (3). Technology, (4). Infrastructure, (5). Material [7]. E-learning also was defined as a form of information technologies applied in education in the form of a virtual school, or as an attempt to make a transformation of existing teaching and learning process in school into digital form the bridged by technology the internet [10]

To make perkuliah online by using the internet facilities, Allen & Seaman, 2010 in Crawley (2012:5-6) mentions that online lectures can shape was defined: A Fully online course, lessons with content ranging from 80-100% online with web-based terknologi support, no face-to-face lectures. A blended or hybrid course, lessons with content ranging from 30-80% of lectures online, using the web-based technology, and reduce the number of face-to-face meetings in the class. A web-enhanced course, technology based lesson content, ranging from 1 to 29% of face-to-face lectures [4].

Many design e-learning lessons are not right so that learners are tired and do not want to finish his studies, and most e-learning still shaped text books and a little animation. And there is also mention that not all learning can be done with e-learning (Web),

so this research produces new innovations in teaching that is mixing the web and face-to-face learning, known as blended learning [3]. Based on the foregoing also encourages researchers to develop a blended learning model of learning for MPSI lectures.

2.3. Blended Learning Model

Blended learning is an amalgamation of thought of learning experiences face-to-face and online. The basic principle is direct communication face-to-face and written communication online [8]. Other experts also mendefenisikan blended learning as follows:

- Integration of face-to-face and online learning to help improve learning experiences in classrooms and expand knowledge through the use of information and communication technology. Blended strategy improve student involvement in learning through online activities, and increase the effectiveness and efficiency of the lecture time.
- a learning that combines online and face-to-face. The proportion of content that is delivered online, typically using the online discussion, and some face-to-face meetings. "The Sloan Consortium blended program defines conducted between 30 per cent and 79 per cent of the content is delivered online, the rest of the learning content delivered by teachers/lecturers through face-to-face or other web-based methods of non, as textbooks.
- Combination of multiple approaches to learning. Blended learning can be achieved through the use of resources "blended", virtual and physical resources [13].

Another definition of blended learning in the journal portalgaruda.org is:

1. Thorne (2003), Blended learning is a combination of multimedia technology, CD ROM, video streaming, virtual classroom, voicemail, email and telephone conferencing, online text animation and video-streaming. All of this combined with traditional forms of training in the classroom. Blended learning into the most appropriate solution for learning in accordance not only with the needs of learning but also the styles of the learners.
2. Harding, Kaczynski and Wood (2005), Blended learning is an approach to learning that integrates the learning of traditional face-to-face and distance learning that uses online learning resources and a wide selection of communication that can be used by teachers and students of the implementation of this approach allows the use of online learning resources, mainly web-based, with face-to-face activities without leaving. With the implementation of blended learning, learning takes place more meaningful because of the

- diversity of the learning resource may be retrieved.
3. Wilson & Smilanich (2005) concluded that blended learning is the use of the most effective training solutions, applied in a coordinated manner to achieve the desired learning objectives.
 4. Macdonald (2008), the term blended learning is usually associated with incorporating online media on learning programs, while at the same time retaining contacts face-to-face and other traditional approaches to support students. The term is also used in asynchronous media such as email, forums, blogs or wikis coupled with technology, text or audio sinkronus [11]

From some of the defenisi blended learning and the etymology refers to a description of that process of learning with a blended learning not to instead of the traditional learning process but rather to improve the quality of the learning process by making use of a variety of approaches. Approach can benefit from a wide range of media and technology. In simple terms it can be said that blended learning is learning that combines face-to-face (conventionally, where learning between students and teachers interact directly at each other, each can exchange information on teaching materials), independent study (studied with a variety of modules which have been provided) as well as independent study online.

2.4. Test Definition

In the great dictionary of the language of Indonesia (KBBI) online test means the written exam, oral interview, or to find out the knowledge, ability, talent, and personality of a person [6]. As for the notion of tests according to some experts, is:

1. Thorne (2003), Blended learning is a combination of multimedia technology, CD ROM, video streaming, virtual classroom, voicemail, email and telephone conferencing, online text animation and video-streaming. All of this combined with traditional forms of training in the classroom. Blended learning into the most appropriate solution for learning in accordance not only with the needs of learning but also the styles of the learners.
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 5. According to Sudijono (2011:67), the test is a way (which may be used) or procedure (which need to be taken) in the framework of measurement and assessment in the field of education, which shaped the giving task or series of tasks both in the form of questions (which must be answered), or commands (to do) by teste, so (on the basis of data obtained from the measurement result). Initial tests (pretest) is a test that is executed before the materials given to students with the aim to find out the extent to which of the material or materials has taught lessons that will be mastered by students [12]

From some sense, it can be concluded that the test is a tool or procedure used to evaluate individual and group objective standards to observe one or more of the characteristics of a person that the results can be used as a basis in decision making.

3. Results and Discussion

3.1. Face-to-Face Lectures

The quality of learning face-to-face on MPSI learning has been done need analysis, by spreading the now instrument to students, grouped into the four dimensions of the dispersion in grating instrument (organizing strategy delivery strategy, learning, learning, learning management strategies, the evaluation study). Application research of refined from SPSS and analysis of fishbone diagram is done, it brings the description answers questions posed to 60 students such as table 1 below:

Table 1: Description of Respondents Answer
Deskripsi Jawaban Responden

Dimensi	N	Minimum	Maximum	Mean	Std. Deviation
Strategi Pengorganisasian Pembelajaran	54	22.00	50.00	38.8333	4.90956
Strategi Penyampaian Pembelajaran	54	27.00	90.00	39.9074	9.00999
Strategi Pengelolaan Pembelajaran	54	12.00	35.00	25.1852	4.92615
Evaluasi Pembelajaran	54	14.00	30.00	23.0926	3.95860

From the description of the count's answer to the actual mean from each lattice instrument (Azwar, 2003) with the results of calculations put the quality teaching lies in the requirement of sufficient.

3.2. Research Analysis

Data obtained from this new research on quantitative data obtained from the results after performing a posttest of two classes, namely class experimentation and grade control where each given treatment or equal treatment

3.2.1. Quantitatif Data Analysis

Based on the research results obtained from the posttest, the data obtained are calculated, analyzed to provide the basics in drawing conclusions from a hypothesis. Questions to be tested consists of 60 grains reserved for 30 students class experiments and 30 students of the class of the control. From the results of the experimental group posttest obtained the highest score and lowest score 52 25, mean, and median 42.63 43.00. Posttest score frequency distribution capability of understanding the material groups of experiments can be seen in table 2.

Table 2 Frekuensi Distribution Score Posttest Eksperimen Group

Interval	Frekuensi	Presentase Frekuensi	Frekuensi Kumulatif	Presentase
51-60	3	10	30	100
41-50	13	43,3	27	90,0
31-40	13	43,3	14	46,7
21-30	1	3,3	1	3,3
11-20	0	0	0	0
1-10	0	0	0	0
Total	30	100		

Based on the table above, if displayed in the form of histograms figure 1 are shaped as follows:

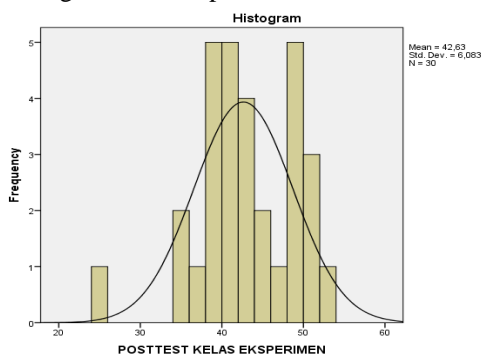


Fig 1. Frekuensi Distribution Score Posttest Eksperimen Group

From above, the histogram can be known to students who got the score 20-30 there, score 31-40 there were 8 people, the score 41-50 there were 17 people and score 50-60 there is 4 people.

For the control group gained frequency distribution in understanding materi as shown in table 3.

Table 3. Frequency Distribution Score Posttest Control Group

Interval	Frekuensi	Presentase Frekuensi	Frekuensi Kumulatif	Presentase
51-60	0	0	0	0
41-50	0	0	0	0
31-40	8	26,7	30	100
21-30	20	66,7	22	73,3
11-20	2	6,6	2	6,6
1-10	0	0	0	0
Total	30	100		

Based on the table above, if seen from the shape of the histogram figure 2 as follows.

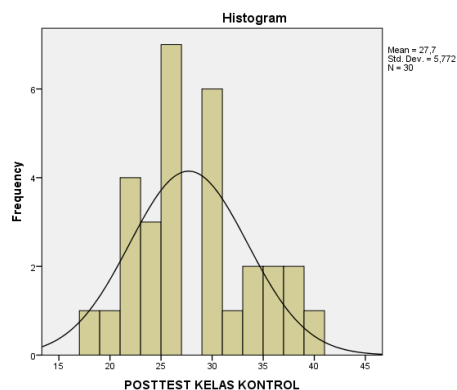


Fig 2. Frekuensi Distribution Score Posttest Control Group

From the above histogram can be known that getting the score 15-20 there are 2 persons, score 21-25 there were 7 people, the score 26-30 there were 13 people, score 31-35, there are three people, and a score of 36-40 there were 4 people, as well as the score 40-45 there was 1 person.

A comparison of the highest score, the lowest, the average rating for class experiments and classroom control, median, either at the time the pretest or posttest can be seen in table 4.

Table 4. Comparison of Pretest and Posttest Statistics Experiments and Group Control

Data	Skor Tertinggi	Skor Terendah	Mean	Median
Pretest KE	24	12	19,27	19,50
Posttest KE	52	25	43,00	43,00

Pretest KK	33	12	21,40	21,00
Posttest KK	40	18	27,70	26,00

Comparison of the data above, if displayed in the form of histograms figure 3 as follows:

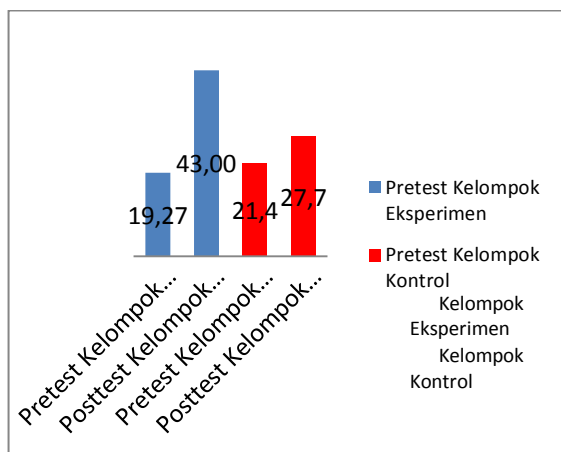


Fig 3. Comparison of Pretest and Posttest Statistics Experiments and Group Control

4. Conclusion

The implementation of matakuliah against MPSI posttest research phase is to get the information the extent of influence of a model that is designed against students in knowing and understanding these subjects, and the results of the evaluation of the posttest will be used as a reference for developing the model BL more optimal in order to improve the quality of teaching in the future.

5. References

[1] Arikunto, 2010. *Dasar-Dasar Evaluasi Pendidikan (Edisi Revisi)*. Jakarta: Bumi Aksara.
 [2] Basuki Wibowo dan Farida Mukti, 1992. *Media Pengajaran*. Jakarta, Depdikbud
 [3] Bersin, Josh. (2005). *The Four Strages of E-Learning. A Maturity Model For Online Corporate Training*.
 [4] Crawley, Anita. (2012). *Supporting Online Students, A Guide to Planing Implementing, and Evaluating Service*. USA: Jossey-Bass
 [5] Depdiknas, 2001. *Manajemen Peningkatan Mutu Pendidikan Berbasis Sekolah*. Jakarta, Depdikbud, Buku 1
 [6] Depdiknas, 2008. *KBBI Daring*. Download Februari 07, 2016, dari Pusat Bahasa Departemen Pendidikan Nasional:
 [7] Effendi dan Zhuang. 2005, *E-Learning, Konsep dan Aplikasi*. Yogyakarta: Andi
 [8] Garriso dan Vaughan, (2008). *Blended Learning in Higher Education, Framework, Principles, and*

Guidelines. San Francisco: Jossey-Bass
 [9] Hassibuan, JJ, dan Mudjiono. 2002. *Proses Belajar Mengajar*. Bandung, Remaja Rosdakarya
 [10] Purbo, Onno W. 2002. *Teknologi E-Learning Berbasis PHP dan MySQL*, Jakarta, PT. Gramedia
 [11] Prasetyo, Murdiono Purbo. 2008. *Perancangan dan Implementasi Conten Pembelajaran Online dengan Metode Blended Learning*?. <http://download.portalgaruda.org/article.php?article,22-2-2015>
 [12] Sudijono. 2011. *Pengantar Evaluasi Pendidikan*. Jakarta: PT RajaGrafindo Persada.
 [13] Watson, John. 2008. *Blended Learning The Convergence of online and Face-to-Face Education*, Nacol
 [14] Riswan, 2015. *Model Blended Learning On The Project Management Information System Course (MPSI) In Higher Education*, Bukittinggi, 2015, 3rd International Conference on Technical and Vocational Education and Training

G 001

Application of Taguchi Method L₉ for Tool Life and Surface Roughness in Turning of Inconel 718 under Dry Cutting

Gusri Akhyar Ibrahim¹, Arinal Hamni²

^{1,2}Mechanical Engineering Departement of Lampung University, Bandar Lampung Indonesia
gusri.akhyar@eng.unila.ac.id
*arinal.hamni@yahoo.com

Abstract Taguchi method offers a simple and systematic approach to optimize performance, quality and cost in manufacturing process. Taguchi optimization methodology with orthogonal array of L₉ was applied to optimize cutting parameters in turning of inconel 718 with PVD coated cemented carbide tools. The turning parameters evaluated were cutting speed of (50, 70 and 80) m/min, of (0.20, 0.25 and 0.30) mm/rev and depth of (0.30, 0.40, and 0.50) mm. The results show that the most significant factor which effects on the tool life was the cutting speed with the significant value of 0.019%. The depth of cut also gave significantly on the tool life of machining of inconel 718 in dry cutting condition. And other hand, the most significant factor which influences the surface roughness was the . The percentage of significant value of the was 0.032% or the gave contribution of 93.61%. The optimal machining condition for the tool life was at the lowest cutting parameters. Then the optimal condition for the surface roughness was at cutting speed of 70 m/min, of 0.20 mm/rev, and depth of cut of 0.40 mm.

Keywords: Taguchi Method; inconel 718; tool life; surface roughness; turning.

1. Introduction

The nickel-based super alloys are known as a difficult to cut material and heat-resistant alloys with high melting temperatures. The ability to retain high mechanical and chemical properties at elevated temperatures makes these super alloys an ideal material for use in land-based power generators and aerospace aero-engine components. About 50 wt% of all aero-engine alloys are nickel-based alloys (Ezugwu, 2003). However, nickel-based super alloys are also used for other applications such as marine equipment, nuclear reactors, petrochemical plants, food processing equipment, and pollution control apparatus. They are generally used in aggressive environments because of their ability to maintain high resistance to corrosion, mechanical and thermal fatigue, mechanical and thermal shock, creep and erosion at elevated temperatures. Inconel 718 super alloy is one of the nickel-based super alloys mostly used in manufacturing of aero-engine components of the hot section, shown as 35% of all productions (Loria, 1988). This alloy is often used in a solution-treated and aged condition. Several problems that exist after machining nickel-based super alloys are reported in the literature, including surface tearing, cavities, cracking, metallurgical transformation, plastic deformation, increased microhardness, increased surface roughness and the formation of tensile residual stresses (Arunachalam et al., 2004; Sharman et al., 2006; Dudzinski et al., 2004).

The quality of products can be improved by improving the quality of design and process in company-wide activities (those activities concerned with quality, include in quality of product planning,

product design and process design (Park, 1996; Ranjit, 2001). Robust design is an engineering methodology for obtaining product and process condition, which are minimally sensitive to the various causes of variation, and which produce high-quality products with low development and manufacturing costs (Park, 1996). Taguchi's parameter design is an important tool for robust design. It offers a simple and systematic approach to optimize design for performance, quality and cost. Signal to noise ratio and orthogonal array are two major tools used in robust design. Signal to noise ratio, which measures quality with emphasis on variation, and orthogonal arrays, accommodates many design factors simultaneously (Park, 1996; Phadke, 1998).

Taguchi method offers the quality of product measured by quality characteristics such as: nominal is the best, smaller is better and larger is better (Park, 1996; Ranjjit, 2001). Optimization using Taguchi method in orthogonal cutting using conceptual S/N ratio approach and Pareto ANOVA is suitable to analyze the metal cutting problem. Gusri et al. (2009) found that the conceptual S/N ratio and ANOVA approaches for data analysis draw similar conclusion in process turning use at high cutting speed of 95 m/min, low of 0.15 mm/min and low depth of cut of 0.1 mm. For tool life, the main factor gave the most contribution was cutting speed.

Yang and Tarng (1998) applied Taguchi method for optimizing the cutting parameters in turning operations. The Taguchi method proved to be a systematic and efficient methodology for the design optimization of the cutting parameters with far less

effect than would be required for most optimization techniques. They found that tool life and surface roughness can be improved significantly for turning operation. The improvement of tool life and surface roughness from the initial cutting parameters to the optimal cutting parameters is about 250%.

Application of Taguchi's method for parametric design was carried out to determine an ideal and desired force combination. Although small interactions exist between a horizontal and desired force, the experimental results showed that surface roughness decreases with a slower and larger grinding force, respectively (Liu and Andrian, 2005). Conceptual S/N ratio approach of Taguchi method provides a simple, systematic and efficient methodology for optimizing of process parameters and this approach can be adopted rather than using engineering judgment. Furthermore, the multiple performance characteristics such as tool life, cutting force, surface roughness and the over all productivity can be improved by useful tool of Taguchi method (Mohan et.al, 2005).

This paper describes the turning of inconel 718 with parameters of turning at three levels and three factors each. The main objective is to develop a study of Taguchi optimization method for high tool life and low surface roughness value in term of cutting parameters when turning of inconel 718 with PVD coated cemented carbide tools under dry cutting condition and high cutting speed.

2. Material and Method

The experiments were carried out with three factors at three levels each, as shown in Table 1. Three factors used in this experiment are cutting speed, feed rate and depth of cut. The fractional factorial design used was a standard L9 orthogonal array, which is calculated by using 3^{3-1} (level^(factor-1)) (Kalpakjian and Schmid, 2001). This orthogonal array was chosen due to its capability to reduce the number experiment without interaction. The machining trials were carried out by using the lathe machine (Colchester T4, with maximum spindle rotation of 6000 rpm) in dry condition. The cutting tools (inserts) used were Physycal Vapor Deposition (PVD) coated carbide tool with the coating layer of TiAlN. Chemical composition of substrate the cutting tool is 91.25% WC (wolfram carbide), 2.5% Ti/Ta/NbC (titanium/tantalum/niobium carbide) and 6% Co (cobalt).

The average flank wear land (VB) and maximum flank wear (Vb_{max}) were measured every one pass machining by using Mitutoyo Tool Maker Microscope with magnification up to 50x. The machining will be stopped when the VB reached 0.3 mm, whereas the surface roughness value of the machined surface was measured by using the surface roughness tester model Mpi Mahr Perthometer. The recordings of surface roughness were done every one pass machining and be done for three times.

Table 1. Factors and levels used in the experiment

Factors	Levels		
	0	1	2
A- Cutting speed (m/min)	60	70	80
B- (mm/rev)	0.20	0.25	0.30
C- Depth of cut (mm)	0.30	0.40	0.50

3. Result and Conclusions

Tool life

Table 2 shows the significant values and contribution of cutting parameters when turning Inconel 718 with PVD carbide tools in dry machining. The significant value of cutting speed (P) is 0.019 (lower than 0.05). It means that the cutting speed significantly influences on the tool life value (Park, 1996, Ranjit 2001). In addition to, the depth of cut and feed rate are insignificant factors on the tool life due to P values bigger than 0.05. The cutting speed has a contribution for the tool life of 45.47%, otherwise, for and cutting speed are 39.53% and 15.00%, respectively, as shown in Table 2. From this result, it can be concluded that the cutting speed is the most significant factor and give most contribution on the tool life. In line with the theory that the cutting speed is the main machining factor that generated temperature and high generated temperature contribute significantly on cutting tool failure (Trent, 2001). The higher cutting speed causes high temperature generated that influences on wear progression of tool (Gusri, et.al, 2011). He also reported cutting speed significantly influenced on flank wear of tool life when machining inconel 718 compared to the depth of cut and .

Meanwhile, the cutting speed and depth of cut were the most significant factor that affected the cutting force and the cutting force also gave a significant contribution on flank wear or tool life when cutting inconel 718 under dry condition. It can be seen clearly that the cutting speed is the most significant factor influences on the tool life at high cutting speed and dry machining. Some previous researchers also suggest similar results. They claimed that the tool life or flank wear well strongly depends on the cutting speed followed by the depth of cut and.

Table 2. Analysis variance of signal to noise ratio (ANOVA) for tool life

No	Variable Factors	DF	Sum of Square (S)	Variance (V)	F	Percent (P)	Contribution (%)
1	Cutting speed	2	26.7231	13.3360	51.60	0.019	45.47
2		2	8.8253	4.4126	17.03	0.220	15.00
5	Depth of cut	2	23.2434	11.6217	44.86	0.055	39.53
	Error	2	0.5181	0.2590			
Total		8	59.3188				100

Table 3 shows response values of signal to noise ratio for tool life at each factors and levels. The signal to noise ratio for tool life has characteristic larger is better. Response factor which has higher value contributes more on tool life. Factor A (cutting speed) gave a delta value bigger than others factor. The delta value of cutting speed of 4.12, it is better than others factors. So this factor considered as factor which influences significantly on the tool life. Factor C (depth of cut) is the second factor which has delta value of 3.81. Its value is lower than factor A and bigger than factor B. The effect of each factor on tool life can be seen on Figure 1.

Table 3. Response table for signal to noise ratios (larger is better)

Level	A	B	C
1	22.32	21.36	21.63
2	19.49	19.03	20.56
3	18.20	19.62	17.82
Delta	4.12	2.33	3.81
rank	1	3	2

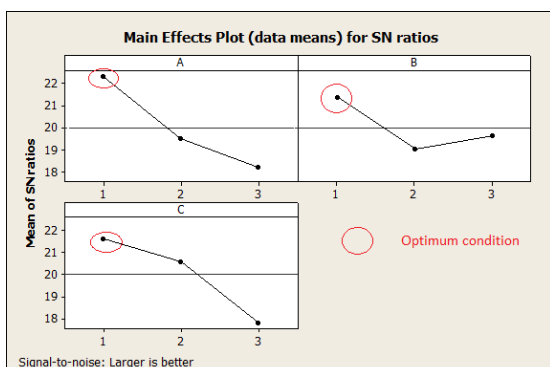


Figure 1. S/N response table for tool life

The optimum condition of turning process when machining inconel 718 for tool life can be shown in Table 3 and Figure 1. The maximum value of response at each factor indicates the optimum condition. It can be seen clearly that cutting speed at level 1 (60 m/min), feed rate at level 1 (0.20 mm/rev) and depth of cut at level 1 (0.3 mm) is the optimum condition. The lowest level of every factor produced the longest tool life. Theoretically, the low cutting speed selected while machining of super alloy materials resulted the low heat generated so that increasing in cutting time (Gusri, et.al, 2011). As found by Yazid et.al (2011) when cutting inconel 718 by lathe machine that the longest tool life achieved

when cutting at low cutting parameters in term of cutting speed, feed rate and depth of cut. Therefore, it can be recommended that to get long tool life can be selected low main cutting parameters.

Surface Roughness

As shown in Table 4 that the significant values of cutting parameters while machining of Inconel 718 with PVD coated carbide inserts in dry machining. The is the most significant factor which influences on surface roughness. The significant value on the is 0.032 (lower than 0.05). In addition to, the cutting speed and depth of cut are insignificant factors on the surface roughness due to P values bigger than 0.05. The contribution of is 93.61%. In contrast with others parameters, cutting speed and depth of cut are not very insignificant, in which, its contribution values are 0.49% and 2.80%, respectively. From this result, it can be concluded that the feed rate is the most significant factor and give most contribution on the surface roughness values.

Surface roughness values are indicator in machining process, by which a good quality is presented by low surface roughness. Table 4 shows that the is the most significant factor in controlling the material surface roughness values when machining inconel 718 alloy under dry cutting condition. Classically, The surface roughness values related to equation $h \approx f^2/8R$ or $h_{CLA} \approx f^2/18 (3R)^{1/2}$ [Bhattacharya 1991, Shaw 2005]. Where, h is the peak-to-valley height, h_{CLA} the centerline-average roughness, f the and R the nose radius of insert. The formula shows that surface roughness is primarily dependent on the and the geometry of nose radius. The higher feed rate causes high distance between peak to peak of machine (Gusri, et.al, 2010).

The previous researcher found that the surface roughness trends to become smoother when selected feed rate parameter at low level. This is probably due to short distance between peak to peak at texture of machine surface (Park, 1996). Whereas according to Bhattacharya (1994), decreases of the surface roughness values recorded were caused by using low feed rate. Gusri et al. (2009) found that Taguchi Method successfully applied in machining super alloys material as like titanium with orthogonal. By using orthogonal array L27 and four factors and three levels each, the was the most significant factor which influenced the surface roughness of new machined surface.

Table 4. Analysis variance of signal to noise ratio (ANOVA) for surface roughness

No	Variable Factors	DF	Sum of Square (S)	Variance (V)	F	Percent (P)	Contribution (%)
1	Cutting speed	2	0.2528	0.1264	0.16	0.864	0.49
2		2	48.5841	24.2920	30.15	0.032	93.61
5	Depth of cut	2	1.4505	0.7252	0.90	0.526	2.80
Error		2	1.6112	0.8056			3.10
Total		8	51.8985				100

The optimum condition while cutting inconel 718 for surface roughness can be shown in Table 5 and Figure 2. It can be seen clearly that cutting speed at level (70 m/min), feed rate at level 1 (0.20 mm/rev) and depth of cut at level 2 (0.4 mm) is the optimum condition. Even so, the feed rate demonstrates effect extremely on surface roughness as shown at Figure 2.

Table 5. Response table for signal to noise ratios (smaller is better)

Level	A	B	C
1	-8.013	-5.437	-8.138
2	-7.636	-7.161	-7.293
3	-7.954	-11.004	-8.171
Delta	0.377	5.567	0.88
Rank	3	1	2

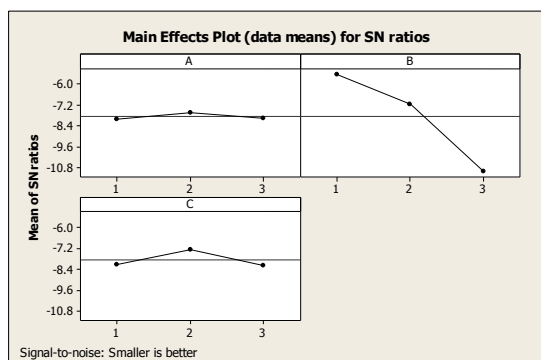


Figure 2. Response table surface roughness

Determination of the maximum tool life and surface roughness

Prediction of the optimum tool life performance using the cutting parameters at A1, B1 and C1.

Predicted S/N ratio (maximum) for tool life.

$$\begin{aligned}
 &= \eta + (\eta A1 - \eta) + (\eta B1 - \eta) + (\eta C1 - \eta) \\
 &= 20.23 + (22.32 - 20.23) + (21.36 - 20.23) \\
 &\quad + (21.63 - 20.23) \\
 &= 20.23 + 2.09 + 1.13 + 1.4 \\
 &= 24.85 \text{ dB.}
 \end{aligned}$$

With this prediction, one could conclude that the machine creates the best tool life with optimum condition for S/N ratio value is 24.85 dB.

With similar method prediction of the optimum surface roughness can be found using A1, B3 and C3:

Predicted mean (minimum roughness):

$$\begin{aligned}
 &= \eta + (\eta A2 - \eta) + (\eta B1 - \eta) + (\eta C2 - \eta) \\
 &= -7.98 + (-7.636 + 7.98) + (-5.437 + 7.98) \\
 &\quad + (-7.293 + 7.98) \\
 &= -7.98 - 0.334 + 2.543 + 0.687 \\
 &= -5.084 \text{ dB.}
 \end{aligned}$$

where η is the average value of S/N ratio. With this prediction, one could conclude that the machine creates the best S/N ratio value of surface roughness is - 11.228 dB.

4. Conclusions

Taguchi's robust design method and analysis of variance give similar results and it is suitable to optimize the tool life and surface roughness in turning inconel 718. The significant factors in turning of super alloys inconel 718 on tool life were cutting speed with contribution of 45.47%. In addition, the significant factors which influenced on the surface roughness were with contribution up to 93.61%. The optimal condition for the tool life is obtained at cutting speed of 60 mm/min, of 0.20 mm/rev and depth of cut of 0.30 mm, whereas the optimal condition for surface roughness at cutting speed of 70 mm/min, of 0.20 mm/rev and depth of cut of 0.40 mm.. Prediction of the optimum for signal to noise of tool life and surface roughness are 25,85 dB and -5.084 dB, respectively.

5. References

1. Arunachalam, R.M., Mannan, M.A., and Spowage, A.C. (2004), Surface integrity when machining age hardened Inconel 718 with coated carbide cutting tools, International Journal of Machine Tools and Manufacture, Vol. 44(14), pg. 1481-1491.
2. Dudzinski, D., Devillez, A., Moufki, A., Larrouquère, D., Zerrouki, V. & Vigneau, J. (2004), A review of developments towards dry and high speed machining of Inconel 718 alloy, International Journal of Machine Tools and Manufacture, Vol. 44(4), pg. 439-456.
3. Ezugwu, E.O., Booney, J., Yamane, Y. (2003), An overview of the machinability of aeroengine alloys, Journal of Material

- Processing and Technology, Vol. 134, pp. 233-253.
4. Gusri, A.I., Che Haron, C.H., Ghani, J.A. (2011), Tool Wear Performance of CVD-Insert during Machining of Ti-6%Al-4%V ELI at High Cutting Speed, Key Engineering Materials Vol. 443 (2010) pp 371-375.
 5. Gusri, A..I., Che Haron, C. H., and Ghani, J.A. (2009), Progression and Wear Mechanism of CVD Carbide Tools in Turning Ti-6Al-4V ELI, International Journal of Mechanical and Materials Engineering, Vol. 4 (1), pg. 35-41.
 6. Liu, C.H., Andrian, C. (2005), Grinding Force Control in Automatic Surface Finish System, Journal of Materials Processing Technology, Vol. 170, pp. 367 – 373.
 7. Loria, E.A. (1988), The status and prospects of alloy 718, Journal of Metal, pg. 36–41.
 8. Mohan, N.S., Ramachandra, A., Kulkarni, S.M. (2005), Influence of Process Parameters on Cutting Force and Torque During Drilling of Glass-Fiber Polyester Reinforce composite, Journal of Composite Structure, Vol. 71, pp. 407-413, 2005.
 9. Park, S.H. (1996), Robust Design and Analysis for Quality Engineering, (London, Chapman & Hall).
 10. Ranjit, R. (2001), Design of experiment Using The Taguchi Approach, (New York, John Wiley & Sons Inc).
 11. Phadke, M.S. (1998), Quality Engineering Using Design of Experiment, Quality Control, Robust Design and Taguchi Method (California, Warsworth & Books).
 12. Sharman, A., Hughes, J., Ridgway, K. (2006), Workpiece surface integrity and tool life issues when turning Inconel 718TM nickel based superalloy, Mechanical Science and Technology, Vol. 8 (3), pg. 399–414.
 13. Shaw, C.M. (1984), *Metal cutting principles* (Clarendon Press, Oxport).
 14. Trent, E.M., (1995), Metal Cutting (Third Edition, Butterworth-Heinemann, Oxford).
 15. Yang, W.H., Tarn, Y.S. (1998), Design Optimization of Cutting Parameters for Turning Operations based on Taguchi Method, Journal of Materials Processing Technology, Vol. 84, pp. 122-129.
 16. Kalpakjian, S., Schmid, S.R. (2001), Manufacturing Engineering and Technology (Fourth Edition. USA, Prentice Hall).

G 003

Bayesian Probability Approach on Troubleshooting on Computer System

Andri Eka Putra

Student Education and Vocational Technology (PTK) Padang State University (UNP),
Bukittinggi, West Sumatera, Indonesian

Abstract Troubleshooting is the existence of a problem or abnormality on our computer. There are several troubleshooting on computer that often occurs in troubleshooting on hardware and software. It is something that quite difficult to understand by vocational high school students, caused by indeterminacy diagnostic that happen on the computer. The vocational high school students on program expertise Computer Engineering and Information Technology the application in Industrial Work Practices will also find a variety of problems on the computer. To help them understand about this and see the possibility of a case and the diagnosis, it can be help through Bayesian probability of an approach. Various systems in the world are affected by the uncertainty as limitation censorship, environmental disturbances, and others. Indeterminacy can be defined as a lack of curse information fatherly make decisions. The results of this analysis are 0.000 means computers under normal circumstances, 0.001-0.999 means there are troubleshooting on computers and computer components means 1.000 damage.

Keywords: computer systems; troubleshooting; bayesian probability; approach; troubleshooting on computer.

1. Introduction

The program computer engineering and Informatics is the cursor of the three sections of the field of information and Communication Technology Skills. In the Curriculum of 2013, there is the unification of material from several competencies standards into one competency standards that is Assembly of the computer. Assembly of computers on this curriculum is a combination of standard of competence to assemble Personal Computer (PC), perform Basic operating system installation and implementing health, Safety and the environment, then the material that exists only on the Computer Engineering Program and a network that is implemented the PC and peripheral installation, diagnosis of the problem PC and peripherals, perform the repair and restart PC settings and do care PC. So with the more scaled down time on all the material, students demanded to understand independently all such material.

Quite difficult to understand by students on all material is on the diagnosis of the problem PC and peripherals. This competency standard that make it difficult to give picture about damage and problems that occur on your PC so that even though it's been dealing with PC in directly. This is caused by every PC has the same problem but with a different handling. To answer that to be done analysis of the problem. the problem was known for troubleshooting.

Troubleshooting is the existence of a problem of abnormality on your computer. Computer problem or troubleshooting divided in troubleshooting hardware and troubleshooting software [1]. So basically troubleshooting on computer is divided in two, namely hardware and software. Troubleshooting hardware is usually

marked with the computer is not turned on, the monitor is dead, and so on. While troubleshooting software is characterized by slow computer performance and others. Though not a possibility also the symptoms of slow computer happens not only in software but also hardware troubleshooting [1].

In another opinion, the computer is a machine that can be programmed to receive data (input), process it to generate information (output), and then save them to a storage medium (Secondary Storage) [2]. It is known with the Input-Process-Output Model as in the picture below:

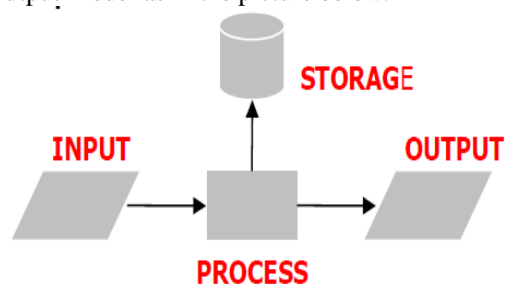


Figure 1.1 (Input-Process-Output-Model)

So basically the system consists of a Computer input device processing, output devices, and storage devices. All those things are part on the hardware. Then in doing the performance of a computer through the operating system and application programs. It is known for its software. So when the troubled computer system on a single component only can occur the troubleshooting.

On the many published many journals use the algorithm First Outrider Logic in the case computer troubleshooting. The type of First Order

Logic that is used i.e. Reasoning Forward Chaining and Backward Chaining.

Journal of Anif Farizi, i.e. expert system trying to find solutions as done an expert. Expert system can also provide an explanation against the steps taken and to give suggestions or conclusions it finds. Development of expert system aims to assist computer users (user) to resolve the problem or damage computer hardware (hardware) and the software on the computer (software). Computer damage case is a case that requires the assistance of an expert (engineer) in resolving the problems by relying on the knowledge that he has. This system was built using the method of forward chaining. Forward chaining is used to examine the factors that are included with the rules stored in the system to be drawn the conclusion [3].

Later in the journal of the Toto Sudiyanto and Nana Suarna, i.e. from a variety of experiments have been done with the conclusion that can be drawn backward chaining techniques (forward tracking) can solve the problem with the statement object that is quite a lot and this gives ease for lay people who even in the use of expert system does not present direct expert is concerned, and that is the basis of the creation of this system that is :

1. Limitations of technicians.
2. Not all users understand about computer hardware troubleshooting.
3. Consultation fees to experts who are relatively expensive and limited time [4].

From both the journal that can be seen from both the reasoning that, recently got to see the conclusion of a case that happened on your computer in the form of conclusions. To be able to make the value of the probability of the case then known as bayes theorem or bayesian probability. A conditional probability is often gives the probability of an event (such as a failure) is given a condition (such as high or low contamination). But after random experiments produce results, we are naturally interested in the possibility that a condition now (high contamination) given an outcome (semiconductor failure). Thomas Bayes explores this question is important in the 1700 's and develop fundamental results, known as Bayes ' theorem [5].

Bayes theorem actually already much developed into algorithms in the system of decision making and expert systems. but this is new to many developed in the health sciences. On journal m. Khusnul Defensebaseactomp, concluding that is

1. Program on this final Project was able to diagnose the possibility of a person Suspect a Stroke is not to the average percentage of success is 99% for Neural Network methods and 97% for Naïve Bayes method and provide the advice of their risk factors relating to input and can be displayed on the Web.

2. Based on the results of a test that was done then the known accuracy of the comparison of the two methods that are used in applications that are created in which Neural Network method is more reliable than the Naïve Bayes method in terms of decision-making for new data as input with an average error of as much as 1% whereas Naïve Bayes method is more reliable than the method of Neural Network in terms of decision making for the same input data with data training with ratarata error as much as 3% [6].

From the results of analysis of a journal can be seen that this fairly accurate probability analysis in decision making. However, in existing journals, there are already made for the diagnosis of damage to car electronics and tools such as air conditioning, computer hardware as well as car Toyota Avanza. It is found in the journal of I Putu Putra Warma, Bayes method is a good method in machine learning based on data training, by using conditional probabilities as a base. This method can be used to make it easier to find damage to the Air Conditioning by predicting the probability based on experience in previous times. With the progress and the development of technology that is increasingly rapidly, developed a technology capable of implementing bayes theorem for analyzing damage to the Air Conditioner indoor-based android [7]

From the journals above, it can be seen that the bayes theorem can assess a large probabilitas of damage to the air conditioning With almost the same issue, Journal of Irvan Syahputra get results, namely:

1. Have been obtained as a result of using the bayes method in damage to computer hardware components.
2. The application of bayes method is quite efficient used as a way to make the data less definite data is sure to be in the identification of damage to computer hardware components [8]. So from this journal can be a problem in the development of guidelines on this journal.

Development of bayes theorem has been around a journal of Budiharto, Widodo. In this journal contained the conclusions "based on the results of the experiments and the evaluation of our proposed model, the car expert diagnosis system is able to diagnose the failure of the car. Bayesian approach to help in making more accurate decisions "[9].

2. Material and Methods

The main thing in bayes is uncertainty. The uncertainty was defined as can the lack of sufficient information to make a desperate. This can be a problem, because it can prevent us to the best decision or may even cause us to make a bad

decision [10]. So one way with bayes probability such as probabilitas.

There are several approaches in bayes probability that can be used are: (1) the certainty Factor (Factor Cartainty/CF), (1) Bayes Theorem, and (3) Bayesian Network.

The general formula from bayes theorem, i.e.

$$p(E_1|B) = \frac{p(B|E_1)p(E_1)}{p(B|E_1)p(E_1) + p(B|E_2)p(E_2) + \dots + p(B|E_k)p(E_k)}$$

for $p(B) > 0$ (1)

Methods of analysis used in this journal is

A. Factor Cartainty/CF

Certainty Factor (CF) expressed the belief in an event (or facts, or hypothesis) that are established to evidance, where: [10]

$$CF[P, E] = MB[P, E] - MD[P, E] \quad (2)$$

CF = Certainty Factor

MB = Measure of Belieft/degrees of belief

MD = Measure of Disbelief/degrees of unbelief

P = Probability

E = Evidence/Fact

B. Bayes Theorem

Bayesian Probability theory was used to menhitung the probability of occurrence of an event based on the influence of testing. Prbabilitas Bayes explains the relationship between the probability of occurrence of the hypothesis there with Hi facts (evidence) E has occurred and the probability of occurrence of ecidence E condition hypothesis Hi has occurred [10]. in theory, the ditulusmatematis theory equations Bayes Bayes, written

$$p(H_i|E) = \frac{p(E|H_i)*p(H_i)}{\sum_{k=1}^n p(E|H_k)*p(H_k)} \quad (3)$$

$p(H_i|E)$ = probability of the hypothesis Hi is true if given evidence (facts) E

$p(E|H_i)$ = probability of the emergence of evidence (facts) If E-known hypothesis Hi is true

$p(H_i)$ = probability of the hypothesis Hi regardless of any evidence (facts)

n = number of hypotheses which may

C. Bayesian Network

Bayesian networks or with so-called bayesian belief network/network is a probabilistic graphical model that is in charge of presenting the complete set of variables with the value of the dependency between varibel times. Specifically, each

node in the graph represents a random variable, while the ends between the nodes is probabulistik dependencies between random variables accordingly [10].

3. Results and Conclusions

Before to analysis using bayesian probability approach, changed all the results of the diagnosis of the existing table into multiple groups, namely:

Table 3.1 This Type of Troubleshooting

Code	Kind of Troubleshooting
T1	Hardware
T2	Software
T3	Hardware and Software

Table 3.2 Components of Troubleshooting

Code	Component
K1	Mainboard/ Motherboard
K2	VGA Card
K3	Memory/ RAM
K4	Harddisk
K5	Sound Card
K6	CPU/ Processor
K7	Power Supply
K8	CMOS
K9	Keyboard
K10	Mouse
K11	Monitor
K12	CD/ DVD ROM
K13	BIOS
K14	Operating System
K15	Software

Table 3.3 The symptoms that occur on computer systems

Code	Symptoms
G1	Komputer menyala tapi tidak ada tampilan di layar
G2	Komputer berbunyi TIT 3x pendek/cepat
G3	Komputer berbunyi TIT... TIT... TIT... TIT... terus dan tidak berhenti sebelum matikan
G4	Komputer keluar Tulisan "DISK BOOT FAILURE, INSERT SYSTEM DISK AND PRESS ENTER"
G5	Komputer tiba-tiba tidak bisa membaca flashdisk
G6	CD/DVD-ROM sulit terbuka/ terkunci
G7	Monitor berubah-ubah warna
G8	Flopy Disk menyala-nyala terus
G9	Komputer tidak mau hidup
G10	Komputer mau hidup tetapi tidak mau booting
G11	Komputer mau booting tetapi selalu "safe mode"
G12	Komputer sering hang
G13	Keyboard tidak dikenali oleh komputer

G14	Mouse tidak dikenali oleh komputer
G15	Komputer sering <i>crash</i>
G16	Bila produsen motherboard (MB) tidak diketahui
G17	Lupa password BIOS
G18	Jam dan setting tanggal BIOS selalu berubah-ubah
G19	Menambah perangkat hardware baru, tapi tidak terdeteksi oleh BIOS
G20	Melacak kerusakan Card pada MB
G21	Pasang processor baru tetapi tidak terdeteksi
G22	Crash setelah memasang RAM baru
G23	Menambah RAM tapi tidak terdeteksi
G24	Setelah menambah RAM proses komputer menjadi semakin lambat
G25	Monitor tidak menyala
G26	Monitor menjadi gelap saat leoding sistem operasi
G27	Tampilan tiba-tiba rusak dan komputer menjadi hang
G28	Ukuran tampilan monitor tidak sesuai keinginan
G29	Monitor seperti berkedip saat digunakan
G30	Sound card baru tidak terdeteksi

Table 3.4 The basic error in computer systems

G1	Komputer menyala tapi tidak ada tampilan di layar
G2	Komputer berbunyi TIT 3x pendek/cepat
G3	Komputer berbunyi TIT... TIT... TIT... TIT... terus dan tidak berhenti sebelum matikan
G4	Komputer keluar Tulisan “ <i>DISK BOOT FAILURE, INSERT SYSTEM DISK AND PRESS ENTER</i> ”
G5	Komputer tiba-tiba tidak bisa membaca flashdisk
G8	Flopy Disk menyala-nyala terus
G9	Komputer tidak mau hidup
G10	Komputer mau hidup tetapi tidak mau booting
G11	Komputer mau booting tetapi selalu “ <i>safe mode</i> ”
G12	Komputer sering hang
G15	Komputer sering <i>crash</i>
G17	Lupa password BIOS
G18	Jam dan setting tanggal BIOS selalu berubah-ubah
G27	Tampilan tiba-tiba rusak dan komputer menjadi hang

Table 3.5 Hardware error on the computer system

G16	Bila produsen motherboard (MB) tidak diketahui
G19	Menambah perangkat hardware baru, tapi

	tidak terdeteksi oleh BIOS
G20	Melacak kerusakan Card pada MB
G21	Pasang processor baru tetapi tidak terdeteksi
G22	Crash setelah memasang RAM baru
G23	Menambah RAM tapi tidak terdeteksi
G24	Setelah menambah RAM proses komputer menjadi semakin lambat
G30	Sound card baru tidak terdeteksi

Table 3.6 Errors in computer systems peripherals

G6	CD/DVD-ROM sulit terbuka/ terkunci
G7	Monitor berubah-ubah warna
G13	Keyboard tidak dikenali oleh komputer
G14	Mouse tidak dikenali oleh komputer
G25	Monitor tidak menyala
G26	Monitor menjadi gelap saat leoding sistem operasi
G28	Ukuran tampilan monitor tidak sesuai keinginan
G29	Monitor seperti berkedip saat digunakan

An example of bayesian probability analysis with

A. Factor Cartainty/CF)

Problems taken e.g. G1. G1 reads "the computer turns on but no display on screen". If note G1 enter the basic errors in the computer system. The value of the degree of trust is 0.005 and value the degree of distrust is 0.250. The value CF = 0.250, based on the calculation below:

$$CF[P, E] = MB[P, E] - MD[P, E] \quad (4)$$

$$CF[P, E] = 0,500 - 0,250 \quad (5)$$

$$CF[P, E] = 0,250 \quad (6)$$

B. Bayes Theorem

Still with the same problem later in the analysis of the use of Bayes Theorem. Known probability of emergence of evidence (facts) E if known Hypothesis Hi is true = 0.500, probability hypothesis Hi regardless of any evidence (facts) = 0.250, whereas for the value of the probability of the emergence of evidence (facts) E without looking hypothesis Hi = 1.000 and the probability of the hypothesis Hi salah = (1-0.250) = 0.750. More details formula can be seen below:

$$p(E) = p(E|H)p(H) + p(E|H')p(H') \quad (7)$$

$$p(E) = 0,500 \times 0,250 + 1,000 \times 0,750 \quad (8)$$

$$p(E) = 0,125 + 0,750 = 0,875 \quad (9)$$

$$p(H|E) = \frac{p(E|H)p(H)}{p(E)} \quad (10)$$

$$p(H|E) = \frac{0,500 \times 0,250}{0,875} = 0,143 \quad (11)$$

C. Bayesian Network

Solution to the problem, namely:

1. Remove and then reinsert the memory/RAM
2. Clean the legs with the eraser
3. Try to replace with a new memory/RAM

If viewed on a G3 i.e. Computer Beep ... TIT. .. TIT. .. TIT ... continue and not stop before switch off. There is an additional component of the diagnosis that is mainboard/motherboard. On augmented Solutions with: A faulty Mainboard For it must be completed with a Bayesian Network.

By using Bayesian Probabilities, we can see the value of the probabilities a component on the computer system. The results of this analysis are 0.000 means computers under normal circumstances, 0.001-0.999 means there are troubleshooting on computers and computer components means 1.000 damage.

4. Acknowledgement(s)

Bayesian Probability Approach. The experimental results presented and we obtained that the system has been able to perform diagnosis on car failure, giving solution and also gives the probability value of that solution and the application of Bayes method is quite efficient used as a way to make the data less definite data is sure to be in the identification of damage to computer hardware components

5. References

1. Kementrian Pendidikan dan Kebudayaan Republik Indonesia, Perakitan Komputer Untuk SMK/ MAK Kelas X Semester . Jakarta, Kementrian Pendidikan dan Kebudayaan Republik Indonesia, 2013.
2. Wijayanto, Heny Panca., Diktat Kuliah Sistem Komputer. Purwokerto, STIK Yos Sudarso, 2006.
3. Anif Farizi, “Sistem Pakar untuk Mendiagnosa Kerusakan Komputer dengan Menggunakan Metode Forward Chaining,” Edu Komputika Journal, vol. 2, pp. 21 – 32, Nov. 2014.
4. Sudionto, Toto, and Nana Suarna, “Sistem Pakar untuk Mendeteksi Kerusakan Hardware Menggunakan Metode Penyelusuran Backward Chaining” Jurnal Online ICT – STMIK IKMI, Vol. 1, pp 24 – 34, 2009.
5. Montgomery, Douglas C. and George C. Runger, Applied Statistics and Probability for Engineers 5ed. United State of America: John Wiley & Sons, Inc, 2011.
6. M. Khusnul Mukhlis, “Diagnosa Pasien Terkena Stroke dengan Menggunakan Metode Naïve Bayes dan Metode Jaringan Saraf Tiruan Berbasis Web” Jurnal Online

ICT – STMIK IKMI, Vol. 1, pp 24 – 34, 2009

7. I Putu Warma Putra, “Implementasi Teorema Bayes untuk Menganalisa Kerusakan pada Air Conditioner Rungan Berbasis Android” Seminar Nasional Teknologi Informasi dan Multimedia, pp 25 – 30, 2016
8. Irfan Syahputra, “Perancangan Aplikasi Sistem Pakar Identifikasi Kerusakan Komponen Hardware Komputer dengan menggunakan Metode Bayes” Pelita Informatika Budi Darma, Vol. V, pp 41 – 46, 2013
9. Widodo Budiharto, “The Development an Expert Car Failure Diagnosis System with Bayesian Approach ” Jurnal Computer Science , Vol. 9, pp 1383 – 1388, 2013
10. Budiharto, Widodo and Derwin Suhartono, Artificial Intelligence. Yogyakarta: Andi Offset. 2014.

G 005

Optimum Design of Two-Segment Crash Box under Frontal Load

Moch. Agus Choiron¹⁾ Sudjito²⁾

^{1,2} Mechanical Engineering Department of Brawijaya University
Malang, East Java, Indonesia
*Email: agus_choiron@ub.ac.id

ABSTRACT Crash box is one of the passive safety components used to absorb impact energy due to collisions result in deformation of the crash box itself to minimize human injuries. In this study, energy absorption performance of Two Segment Crash Box (TSCB) is investigated under frontal load. TSCB design shape is performed by using computer simulation. Crash test model components are impactor and two segment crash box with frontal crash velocity of 7.67 m/s are selected. Crash box material of Aluminum Alloy 6061-T6 is used. The Response Surface Method (RSM) is used to predict optimal design of TSCB. The four factors are diameter (D), upper length (L), upper thickness (Ut) and lower thickness (Lt). The result shows upper length has a stronger influence on the contribution to increase energy absorption. The optimum design of TSCB is a model with D = 81.8 mm, L = 52.6 mm, Ut = 2.5 mm and Lt = 2.2 mm..

Keywords: Two-segment Crash Box; Response Surface Method; Energy Absorption; Peak Load.

1. Introduction

In the recent years, numerous researchers have studied the behavior of crash box, considering the geometry, size, cross section and the loading condition to enhance energy absorption [1, 2]. It can be found that the energy absorbing capability of circular crash box is better than that of square [3]. Deformation mode on circular crash box expected is stable modes that it will be able to minimize the buckling phenomena [4]. Crash box will show plastic deformation during crushing by collapse and sequential folding process. Controlling plastic deformation process is often the primary design aspect of crash box and already many research has gone in the field and focus on behaviour of collapse and sequential folding process. The study of circular crash box modification design has been extensively studied within adding component. In previous study of multi crash box segments used are two segments, three segments with a sequence diameter and three segments with alternating diameter. From this result, it can be denoted that high increasing of energy absorbed was occurred in the middle of collision when the deformation flow started to penetrated into the second segment [5]. This crash box design can be produced by using different materials in each segment. Hybrid material of aluminium and steel crash box was investigated in order to reduce crash box weight up to 17.5% [6]. In other study, initiator folding design is commonly used in the design practice of energy absorbing structures. The trigger reduces the peak crushing load and induces progressive folding avoiding the global bending mode. The imperfection types corresponding to simplest collapsing mode are used by initial hole on crash box design [7-8].

Furthermore, optimization techniques have

been applied in structure design due to faster computers and better algorithms. In this paper, optimization of Two Segment Crash Box (TSCB) under frontal loading is undertaken using Response Surface Method (RSM). The parameters of the structures, such as the diameter, length and thickness of the double tubes, were optimized.

2. Methods

For the finite element analysis, the geometrical model is established and then frontal load analysis completed by using ANSYS ver 17.1 software. Crash test model components are impactor and two segment crash box with frontal crash velocity of 7.67 m/s are selected. Crash box material of Aluminum Alloy 6061-T6 is used. Crash box material is used for the shell element, and it corresponds to elastic-plastic isotropic thin shell material models. The Response Surface Method (RSM) is used to predict optimal design of TSCB. The design variable of crash box design is determined on variation of diameter (D), upper length (L), upper thickness (Ut) and lower thickness (Lt). Table 1 shows the optimum domain with lower and upper bound level. The geometry of TSCB design can be seen in the Fig. 1. By using Central Composite Design of Design of Experiment type, it can be set the response surface technique for 26 design sampling models [9]. The Screening optimization method uses a simple approach based on sampling and sorting. It supports multiple objectives and constraints as well as all types of input parameters. Configuration is set as default option (generate 1000 samples and find 3 candidates). Meta model is applied as full 2nd order polynomial.

Table 1. The optimum domain with lower and upper bound level

	Lower Bound	Upper Bound
Diameter (D)	65 mm	85 mm
Upper length (L)	50 mm	75 mm
Upper thickness (Ut)	1.6 mm	2.5 mm
Lower thickness (Lt)	1.8 mm	2.2 mm

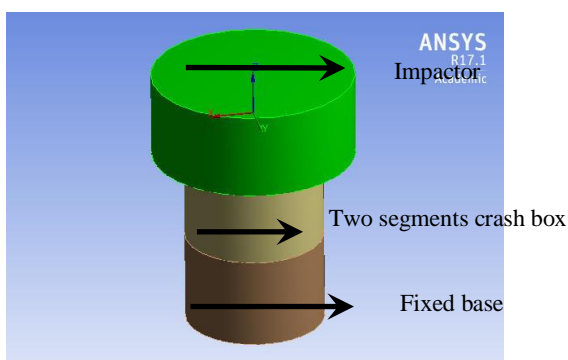


Fig. 1 Crash box modelling

3. Results and Discussion

Table 2 shows three candidates of optimum design. Candidate number 1 is chosen due to meet the requirement of higher energy absorption.

Table 2. Three Candidate Points

	Candidate Point 1	Candidate Point 2	Candidate Point 3
Diameter (D)	81,8 mm	77,9 mm	73,1 mm
Upper length (L)	52,6 mm	53,2 mm	54,1 mm
Upper thickness (Ut)	2,5 mm	2,39 mm	2,49 mm
Lower thickness (Lt)	2,2 mm	2,16 mm	2,12 mm
Internal Energy Maximum	9162,4 J	8839,4 J	8753,1 J

Fig. 2 shows sensitivities from optimum TSCB design; it can be determined stronger effect of input parameter for each output parameter. The result shows upper length has a stronger influence on the contribution to increase energy absorption. This condition is occurred due to the folding mechanism produced stable mode on this section.

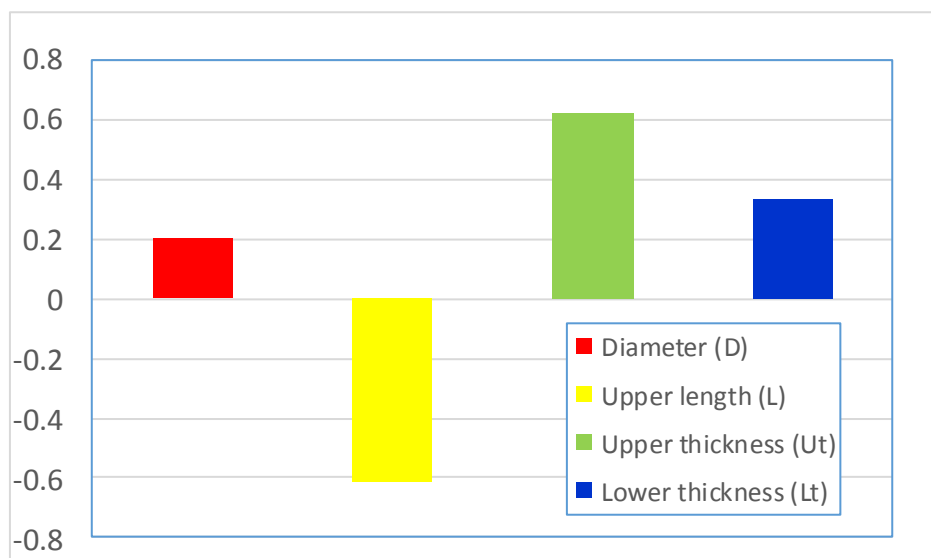


Fig. 2 Plot of sensitivities of TSCB design parameter

From the computer simulation result, it can be shown that deformation process occurred on optimum TSCB design is tends to axial mode (Fig. 3). The deformation pattern of circular cross

sectional of crash box is typically symmetry, and the final deformation produce different mode on lower section as triangular folding shape (Fig. 4).

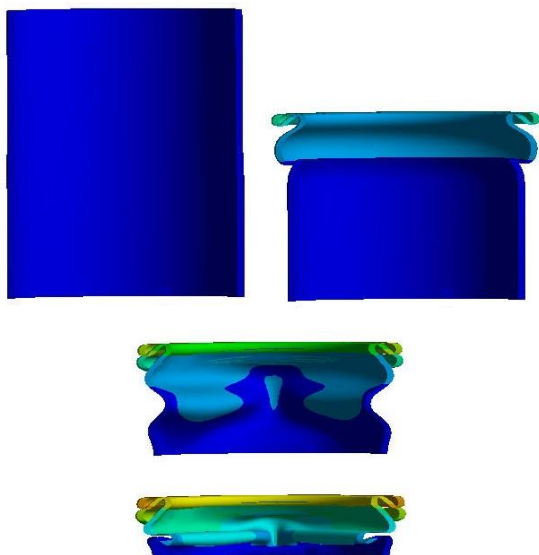


Fig. 3 Crash box Deformation Pattern

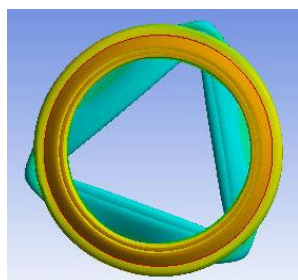


Fig. 4 Final deformation (upper view)

From deformation pattern connected with absorbed energy has showed that optimum design of TSCB absorbs increasing energy at the beginning of condition. Energy absorption start increased again at the boundary area of the first and second segments as a result of increasing inertia (Fig. 5). In the lower section, deformation mode change to triangular folding shape, but the number folding is increased correlated with increasing energy absorption occurred.

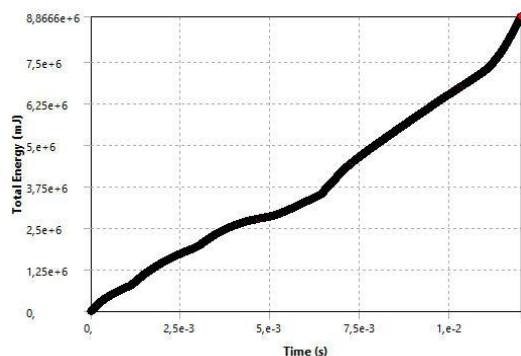


Fig. 5 Relation between absorbed energy and time function of optimum TSCB model

4. Conclusion

Optimization of Two Segment Crash Box (TSCB) under frontal loading is undertaken using Response Surface Method (RSM). The result shows lower thickness has a stronger influence on the contribution to increase energy absorption. The optimum design of TSCB is a model with $D = 81.8$ mm, $L = 52.6$ mm, $U_t = 2.5$ mm and $L_t = 2.2$ mm.

5. Acknowledgment

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6. References

- [1] Ogawa, Shigeru and Shigeyuki Haruyama. 2007. Axial Collapse of Square Tube with Short Length, Tokyo University of Science. Japan .
- [2] Kim, Lee and Yoo. 2008. Design of the Cross Section Shape of an Aluminium Crash Box for Crashworthiness Enhancement of a Car. School of Mechanical, Aerospace & System Engineering. Korea.
- [3] Velmurugan and Muralikannan. 2009. Energy Absorption Characteristics of Annealed Steel Tubes of Various Cross Sections in Static and Dynamic Loading. India.
- [4] Shigeyuki Haruyama, Aidil Khaidir Bin Muhamad, Ken Kaminishi, and Dai-Heng Chen. 2013. Modes of Collapse of Compress–Expand Member under Axial Loading, World Academy of Science, Engineering and Technology. Vol:7.
- [5] Moch. Agus Choiron, Anindito Purnowidodo, Eko Siswanto, Nafisah Arina Hidayati, Crash Energy Absorption Of Multi-Segments Crash Box Under Frontal Load, Jurnal Teknologi, 78:5 (2016) pp. 347-350
- [6] F. Ince, H.S. Türkmen, Z. Mecitoglu, N. Uludag, I. Durgun, E. Altinok, H. Örenel. 2011. A numerical and experimental study on the impact behavior of box structures, Procedia Engineering 10 pp. 1736–1741.
- [7] T. Dirgantara, L. Gunawan, I.S Putra, S.A Sitompul and A. Jusuf, Applied Mechanics and Materials. Vol. 393, pp. 447-452 (2013).
- [8]. Moch. Agus Choiron, Sudjito, and Nafisah Arina Hidayati, Crash energy absorption of two-segment crash box with holes under frontal load, AIP Conference Proceedings 1717, 050009

- (2016).
[9] ANSYS, Inc. 2015. *Design Exploration*.
Canonsburg USA

G 010

Performance Study of Sea Water Distillation by Solar Energy To Generate Salt and Fresh Water

Mulyanef, Duskiardi, Kaidir and M. Ikhsan

Department of Mechanical Engineering, University of Bung Hatta
Padang, Indonesia
*mulyanef@bunghatta.ac.id and *smulyanef@yahoo.com

Abstract Salt and fresh water is a very important need for the human body. Several regions in Indonesia are often shortages of salt and water at a certain times. It is anomalous for Indonesia as a maritime country that has the second longest beach in the world. Seawater distillation using solar power to be salt and fresh water is one of the alternative solutions. Utilization solar energy for seawater distillation into salt and fresh water is a utilization of alternative energy. The purpose of this study was to test the solar distillation performance to produce salt and fresh water. Distillation conducted by putting seawater into the basin, then heated using solar energy. The water will evaporate and condense on the surface of the cover glass distillation. Heating process carried out until the water evaporates and the depleted salt obtained. The research results showed 6,000 ml seawater processed by solar energy using reflector will produces salt 199.9 gr/3 days and fresh water 1,551 ml / day.

Keywords: Distillation; solar energy; salt; fresh water and seawater.

1. Introduction

Fresh water is a necessity of everyday society, especially for drinking and cooking. Whereas salt is an electrolytes source for human body. Governments are still unable to fulfill the society needs of salt and fresh water. Until now, Indonesia still has to import salt to meet domestic demand. It is anomalous for Indonesia as a maritime country that has the second longest beach in the world. The seawater within Indonesian waters is a potential raw material for fresh water and salt. There are several ways to process seawater into fresh water and salt, one of them is by using a solar energy distillation. Some of solar distillations advantages are included lower cost of manufacture and maintenance, and easy to operate as it does not require high technology. Generally, solar energy distillation is composed of absorber plate, which is used to absorbing solar radiation and converts it into heat energy that would heat the seawater on it to evaporate the water. Cover serves as a place to condense water vapor to produce fresh water. Solar distillation performance measured through the amount of fresh water and salt that can be produce per unit time.

There are several factors that influence the productivity of fresh water and salt, such as the plate ability to absorb solar energy, the ability of the glass to condense water vapor, the water level in the distillation apparatus, also solar radiation intensity. Absorber plate should be made of high thermal conductivity material and good solar absorption. Glass cover should not be too thick, because it will save a lot of heat so that the water vapor would be difficult to condense. The Water in the distillation equipment should not be too high because it will

prolong the water evaporation process. However, if the water in

the distillation equipment is too low, then the distillation equipment could be damaged due to overheating (usually cover glass will shatter). This study aimed to test the performance of solar distillation using a reflector and without reflector.

Some studies about processing seawater into fresh water and salt using solar distillation test equipment has been carried out, among other things by; Sumarsono M (2006) examines the performance analysis distillation-based solar power roof type tilt angle. Mulyanef et al (2012) conducted an experimental review to improve the performance of solar distillation basin three levels using multiple heat storage material, resulting in 1,407 ml of condensate at an average intensity of 425 W / m². Hidayat RR (2010) designed a separator of salt and fresh water using solar energy, with an area of the collector (220x120x5) cm², the type of cover glass collector two tilted at an angle of 400, using 20 liters sample of sea water, produced salt 621 grams for six days testing, and freshwater 3.186 liters / day. Dwi Setiadi F (2012) designed separator terraced salt and fresh water using solar energy, with a collector area (240x220) cm², and the angle of collector 400, can produce fresh water 2.603 liters / day of salt and 623 grams per six days of testing. Mulyanef et al (2014) also conducted an experiments of processing devices of sea water into salt and fresh water using solar distillation glass type cover a slope. From 10 liters of seawater, obtained 1,360 ml/day of fresh water and salt as much as 342 grams per five days of testing with an average intensity of 542 W / m².

2. Methodology

2.1. Place and Time Research

The study was conducted in May and June 2016. The tests were conducted every day from 7:00 to 17:00, next to Performance Engineering Laboratory, Department of Mechanical Engineering - University of Bung Hatta.

2.2. Materials and Test Equipment

This research material is seawater, that taken from the coast of Padang as much as 6 liters. Measuring instrument used is solarimeter, thermocouples, measuring cups, scales, and thermometer. There are two solar distillation used for testing, ie with reflector and without reflector. Each distillation has the size of (0,80 x 0,50) m².

2.3. The working Principle of Solar Distillation

Solar radiation get into collector through the transparent cover glass toward the absorber plate, solar radiation converted into heat at the absorber plate. The seawater in the basin will be hot; the water evaporates and attaches the inner glass cover, because of the temperature difference between inside the basin with condensation environment. Water condensation on the cover glass stuck inside, and flows down following the slope of the cover glass. Fresh water as the condensation product is collected. The salts produce through continuous heating of seawater and leave the salt crystals. Figure 1 displays a solar distillation to process seawater into freshwater and salt.

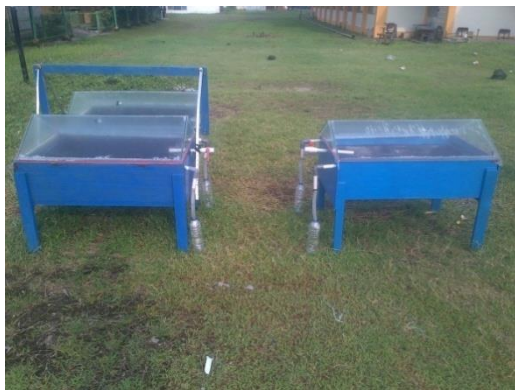


Figure 1. solar distillation to process sea water into freshwater and salt

3. Results And Discussion

The parameters of this study are the temperature of seawater, the glass temperature, the absorber plate temperature, evaporation temperature, environment temperature, solar intensity, productivity of fresh water and salt. Temperature is the external factors that affect the productivity of solar energy distillation.

In the analysis, the testing data and the calculation is shown in the chart performance solar sea water distillation, comprising; the relationship charts between solar intensity and freshwater productivity, the relationship graph between the solar intensity with absorber plate temperature, productivity charts of salt and fresh water.

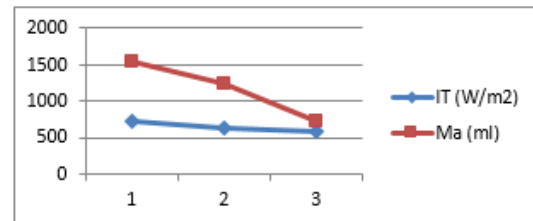


Figure 2 The relationship between solar intensity with Total Mean Condensate for Solar Distillation Using Reflector

Figure 2 shows the relationship between the averages of solar intensity with productivity of fresh water produced by solar distillation using a reflector. The above graph shows that the freshwater productivity produced increase by the increasing of intensity of the sun. The first day of testing showed the highest solar intensity, 720 W / m² and freshwater produce an average of 1,551 ml, while the lowest solar intensity occurred on the third day of testing 586 W/m² and produces 729 ml condensate. Thus it can be said that the higher the intensity of the sun, the faster the evaporation of seawater, and the more the productivity of freshwater solar distillation.

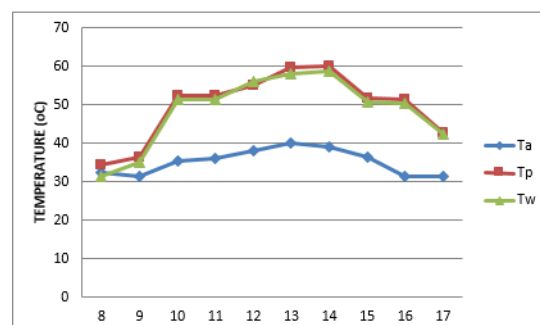


Figure 3. Variation of the absorber plate temperature, sea water temperature and ambient temperature

Figure 3. Showing the average temperature (the absorber plate temperature, sea water temperature, and environment temperature) of distillation using a reflector during testing. The above graph shows that the increasing of absorber plate temperature will also increase the sea water temperature in the basin and the environment temperature.

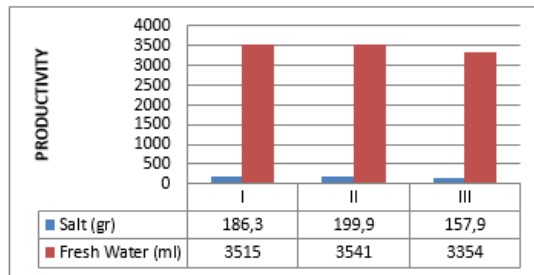


Figure 4. Productivity of Salt and Freshwater of Solar Distiller Using Reflector

Figure 4 showing the productivity of salt and fresh water solar distillation using reflectors for three times of testing. Second sample shows the highest amount of salt and freshwater of 199.9 grams of salt and 3,541 ml fresh water. Salt content is getting lower in the third sample testing, that is 157.9 grams and 3,354 ml of fresh water. The time required to produce a salt that is 3 days. The higher the solar intensity, the faster the evaporation, and the shorter time to produce the salt and fresh water in the solar distillation. Salt productivity is strongly influence by seawater sources used. The salt produced from solar distillation by 3.3%, whereas the salt levels standard in the sea water, which are far away from the coast and estuaries ranged between 3 - 3.5%.

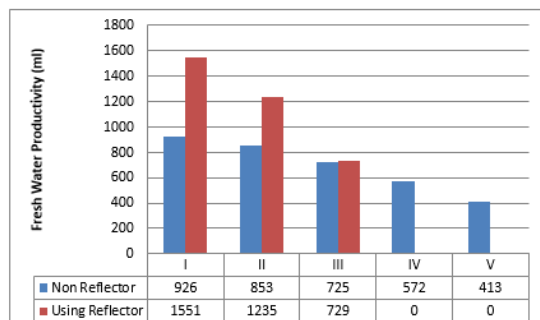


Figure 5 Comparison of Fresh Water Productivity Produced by Both Solar Distiller

Figure 5 showing the productivity of fresh water produced by both solar distillations. Solar distiller with reflector needs 3 days to produce fresh water (3,541 ml), while distillation without reflector takes 5 days to produce fresh water (3,489 ml). This is due to the solar distillation with reflector produces higher heat. Thus, the seawater in the basin can evaporate more quickly to produce more fresh water.

4. Conclusions

- Distiller with reflectors generate higher productivity, with a 6 liter volume of sea water in the basin, spacious collector 0,80m x 0,50m and an average solar intensity of 656 W/m² can produce condensate or fresh water as much as 1,551 ml per day and salt 199.9 grams for 3 (three) days of testing.

- Salt and fresh water productivity of can be improve by increasing the distiller area and reducing heat loss.

5. References

- [1] Duffie, J.A., Beckman, W.A, Solar Engineering of Thermal Processes, Jon Willey & Sons, Canada (1991).
- [2] Dwi Setiadi F, Rancang Bangun Alat Pemisah Garam dan Air Tawar Bertingkat Menggunakan Tenaga Surya, Skripsi Departemen Ilmu dan Teknologi -IPB 2012
- [3] Hidayat R.R, Rancang bangun alat pemisah garam dan air tawar menggunakan energy matahari. Skripsi Departemen Ilmu dan Teknologi-IPB (2011).
- [4] Mulyanef, Dianviviyanthi, Oktavianus, Sistem desalinasi tenaga surya untuk menghasilkan air bersih bagi masyarakat pesisir pantai Padang. Proseding Seminar Nasional SNMI 2006 Universitas Tarumanagara. Jakarta (2006).
- [5] Mulyanef, Dianviviyanthi dan Masfan, *Studi Eksperimental Destilasi Surya Tripel Basin Menggunakan Kolektor Plat Datar*. Proseding Seminar Nasional RESATEK I, FTI Universitas Bung Hatta (2010).
- [6] Mulyanef, Melda Sari, Mario W, dan N Henry, *Kaji Eksperimental untuk meningkatkan performasi destilasi surya basin tiga tingkat menggunakan beberapa bahan penyimpan panas*. Jurnal Teknik Mesin ITP (2012) P 7-12.
- [7] Mulyanef, Burmawi dan Muslimin, Pengolahan Air Laut Menjadi Air Tawar dan Garam Menggunakan Destilasi Surya. Jurnal Teknik Mesin ITP (2014) P 25-29.
- [8] Sumarsono M, *Analisis kinerja destilator tenaga surya tipe atap berdasar sudut kemiringan*. Proseding Seminar Nasional SNMI 2006 Universitas Tarumanagara, Jakarta (2006)

E 011

Relayout Warehouse of Finished Products Based on the Frequency of the Movement of Products

Lestari Setiawati¹, Aidil Ikhsan¹, Krisna Nova²

¹ Department of Industrial Engineering, Faculty of Industrial Technology, Universitas Bung Hatta

² Alumni Department of Industrial Engineering, Faculty of Industrial Technology, Universitas Bung Hatta

*lestarisetiawati@bunghatta.ac.id

Abstract PT.XYZ is a pharmacy company and produce various medicines . For last 3 years the sales of the product had been significantly increased , so to cover all demands, the company added some machine in production section. This condition the increasing production target do not followed by relayout of the warehouse, so it cause the disorder warehouse to cover all production over its capacity. Beside that the arrangement or relayout this warehouse was not in good plan. As the result this warehouse was in disorder, narrow paths, even there were products that placed outside of the warehouse and those factors were obstacles to gain successful perform. This final task conducted the relayout warehouse of finished products by using ABC layout. It is a relayout that used classification ABC approach , based on product movement frequency . The type of the relayout warehouse was straight line current or simple current with criteria to minimize the back and forth movement that focus on effective product movement. Based on the research obtained that relayout warehouse of finished product by applied simple current was better applied in this company because the arrangement of the products had been settled based on product movement frequency . The products with significant movement was placed near to shipping area, and the product in less frequency movement was placed in reception area of the product, From that setting, it can minimize the back and forth movement about 71.21%

Keywords: Relayout; warehouse; finished products; movement of frequency; ABC layout.

1. Introduction

Facility plan has a broad subject and able to apply in manufacture industry or service. Thus, all of the facilities are able to use through good plan and make them become effective and efficient. A warehouse is needed facility for a manufacture company. During these period of time function of a warehouse is to storage the products. Generally, a manufacture company is differentiating between storage of raw materials and the products. The available of good storage area and the arrangement of layout are necessary to support the smoothness of production. The purpose of the arrangement to minimalist back and forth movement, to ease the movement of the products and reduce time processing.

Engaged to re layout of the products facility, there are some related researches. Those researches are limited on the border of re layout of work area and arrangement of machines layout in production. Some criteria of performances that often to use in re layout are optimum usage of wide floor, minimize the frequency of movement material and cost of movement material.

PT.XYZ is a pharmacy company that produce medicines. Based on last 3 years data the entire sales of the products that produced by PT. XYZ had significantly increased. The increasing of the amount of the product do not followed by the plan of re layout of the warehouse to storage the products. As the result the condition of the warehouse become in disorder with narrow paths and the in-out of products' movement become interrupted (picture 1). Frequently, a warehouse officer has trouble while sending the products to the consumers that applied FIFO system (First In First Out). To overcome this problem, this research employed relayout warehouse of finished products based on the frequency of the movement products.



Picture 1. ExistingCondition

2. Material and Methods

The information about this research, as follows:

- Finished products by PT.XYZ is medicines that consist of 30 items. Based on it form of the

medicines are liquid, powder, and ointment. Meanwhile, the kinds of medicine consist of OTC drugs (over the counter) and free unlimited drugs (in W list). The entire of finished products items saved in warehouse of finished product in carton wrapping in several sizes.

- b. The area of warehouse of finished product that will be designed do not change which is width 162m², length 18m and breadth 9m.
- c. Speed assumption of operator Is 80,45 m/ mins

The steps of re layout warehouse of finished products processes, as follows:

- Frequency of calculation products movement
Movement frequency is an identification toward a line of in- out product from one production area in certain time. In this research the calculation of the frequency of the movement in 3 periods of time for 30 items of finished products
- Finished product grouping into ABC classification
Whole finished products item grouped by using ABC method. Classify A is product with faster movement, classify B for a medium product movement, and classify for slow movement product.
- Determination of Inventory Level
Determination inventory level in plan of re layout warehouse of finished product used Throughput diagram. This diagram show the line of input and output. It shows the supply of the finished product in every time, whether maximum supply, average supply and supply in the end of period time.
- Re layout warehouse of finished product
Perform the re layout warehouse of finished products used straight current line method. This method is compatible with available facility which does not use belt conveyor and area of acceptance and the area of finished product shipment in different side of areas.

3. Results and Conclusions

- a. Frequency of product movement

The first step that must do in re layout warehouse by pay attention to product movement theory is know the frequency of product movement. This frequency of product is an identification process toward line of input and output products/materials from hean area production in once certain time. By employed the calculation of frequency of product movement, and it shows the product or material which has faster frequency movement, medium, and slow. Thus, in re layout warehouse the finished product which has faster movement frequency placed in close part of shipment area. And the product which has slow movement is

placed in acceptance area. In this research the calculation of frequency product movement calculate for each product item in 3 period of time. Period 1 is 31 days, period 2 is 31 days and period 3 is 30 days. The data of total product that become the subject of this research was 30 finished product items which consist of liquid, powder and ointment medicine.

- b. Grouping of ABC classification

After the frequency of input and output had been known for whole finished product, then the finished product arrange based on the output frequency of the warehouse and grouped used ABC classify method. The products that included in classification A is the faster movement product, classification B is medium, and C is slow movement frequency. In period 1st had 6 product items that include into classification A, 7 item into B, and 17 into C. meanwhile for period 2nd and 3rd in sequences the total of product item that include into classify ABC were 6,10,14 and 5,7,18 product item.

In item sequencing based on output frequency in ABC classification, the sequence was from higher to lower frequency. If the value is equal, so it will concern from weight of the finished product per box, which has heavy weight will be on top than smaller one.

- c. Determination of Inventory Level

To determine the inventory level in warehouse design, used Throughput Diagram which a diagram that shows the input and output line that occur in a work station. The input and output in warehouse is the finished product for every time, whether maximum supply, average and in the end supply in once period of time. Picture 1 is the example of calculation for level determination of product supply AKL 200ml in Throughput Diagram.

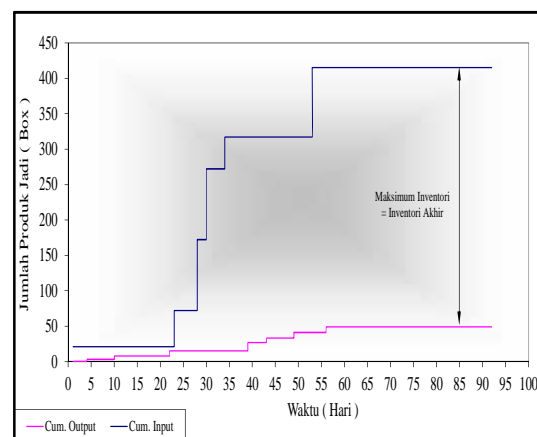


Figure 2. Throughput Diagram of product supply AKL 200ml

d. Re layout warehouse of finished product
Setting of re layout warehouse of finished product was based on product movement theory which consist of 3 kinds, they were re layout in straight line or simple current, re layout U current and the last one was re layout L current.

Generally, Re layout U current based on the use of belt conveyor with line pattern start with input product until output that shape U. then, for re lay out straight line and L current does not use belt conveyor. Based on the warehouse condition in the company, so the reception area is on different side of the building. For that reason the re layout warehouse is executed based on the kind of layout straight line/ simple current.

The determination of the total product that storage in the warehouse, refers to average of each product per day that had been in calculating process. Average of per day inventory for each product had been grouped based on ABC s' classification, that become the reference to do re layout warehouse where the product in classification A the product is placed near to shipping area of finished product, so the finished product in classification B is placed in back of classification A, and finished product that include in classification C is placed near to reception area.

Beside, determine the total finished product will storage in warehouse and there are some consideration in arrangement finished product in warehouse, as follows:

- Weight of the product/box
- The wrapping form of finished product
- The position placement for finished product
- Labeling / sign on racks

Based on the result of the research, it can be concluded that the proposal of re layout warehouse give significant contribution in searching product because code and products location are clearly seen when placement or taking of the product. The result of the design is able to minimize back and forth movement about 71.2% it can be seen from output frequency of the products that comes from the warehouse, since in 3rd period was 365 times than 1268 times than beginning of placement.

4. References

1. Apple, James., (1990), *Tata Letak Pabrik & Pemandangan Bahan Edisi ke-3*, ITB, Bandung.
2. Heragu, Sunderesh., (1997), *Facilities Design*, PWS Publishing Company, Boston.
3. Meyers, Fred. E., (1999), *Motion and Time Study For Lean Manufacturing Second Edition*, Prentice Hall, Inc., New Jersey.
4. Meyers, Fred. E.,(1993), *Plant Layout And Material Handling*, Prentice Hall, Inc., New Jersey.

5. Setiawati, Lestari, dkk., (2009), Re-layout Tata Letak Produksi dengan Penerapan Algoritma Rank Order Clustering 2 (ROC-2) untuk Meminimasi Total Jarak Perpindahan Bahan, *Jurnal Sains dan Teknologi*, Vol.8 No.2.
6. Setiawati, Lestari, dkk., (2007), Penentuan Prioritas Produksi dengan Pendekatan Theory Of Constraint (TOC) untuk Memaksimalkan Throughput, *Jurnal Sains dan Teknologi*, Volume 6 No.1.
7. Thompkins, James.A.(2003), *Facilities Planning Edisi 3*, Jhon Willey and Sons.
8. Warman, John., (2004), *Manajemen Pergudangan*, Pustaka Sinar Harapan, Jakarta.

E 012

Redesign Facility Layout of Thresher Machine to Minimize Material Handling Cost

Noviyarsi¹, Lestari Setiawati², Eva Suryani³

^{1,2} Industrial Engineering Department, Universitas Bung Hatta
Email : noviyarsi@bunghatta.ac.id

Abstract The common problem faced on small and medium industry is the ability to produced product with good quality and competitive price. This is because of production process not standardized yet. Beside that production area not arranged well which effect to waste in production area. One way to solve this problem is made improvement in production area and rearrange production layout. The purposed of research was to improved line production of thresher machine to increased production lean using line balancing concept 5S method and layout design approach. Result of improvement production line shows decreased in balanced delay from 63.89% on existing condition to 15.14% on proposed condition with line efficiency about 84.86%. Proposed layout design shows that efficiency on working space area about 15.4%. Reduced on space area gave an effect to efficiency on material handling cost (MHC) about 24.17%.

Keywords: Lean concept; line balancing concept; 5S; material handling cost; systematic layout planning.

1. Introduction

The most industry growth in Padang city is small and medium sized industries which based on agriculture and forest, metal, machine and electrical industry, chemical industry and others. The common problem faced on small and medium industry is the ability to produced product with good quality and competitive price. This is because of production process not standardized yet. Beside that production area not arranged well which effect to waste in production area. Waste on shopfloor is defined as all things which not give value added and disturb production process such as waiting time, defect, unnecessary activities and not optimal in using production area. In some cased, waste occurred when facilities layout not design well which cause back tracking in production flow, high cost on material handling and unused space area.

Good design on facilities layout will give positive contributes to optimization on production process and at the end can keep company sustainability (Purnomo, 2004). Because of that, it is important to make a good design of facilities layout, so that can minimize cost of production. According to Wignjosoebroto (2003), 50%-70% of all production system activities is material handling activities, which efficiency rate determined by production facilities layout. Material handling activity that design well, positively will increased company profit as well as increased production capacity, working condition and quality of product.

Research on production facilities layout had been conducted by some researcher with different approached. Hojjati (2011) and Zhenyuan (2011) conducted research on production layout with integrated lean production and 5S method without considered facilities layout concept. Abdalla (2013)

used some tools on decision analysis such as Analytical Hierarchy Process (AHP) to choose the best alternative layout. Otherwise, Shahin (2011) integrated some tools such as Fuzzy Analytical Hierarchy Process (FAHP) and Quality Function Deployment (QFD) for layout design.

Based on previous research, this research had been conducted to design production facilities layout that integrated with line balancing concept and 5S methods. The 5S methods had been used to arrange working area and line balancing concept had been used to improve production line. Final step, systematic layout planning (SLP) method had been used to design all facilities layout. At the end, this improvement will increased production lean, so that can minimized material handling cost.

2. Material and Methods

In order to achieve research objective, this research had been conducted following some steps, which are :

1. Balancing of production line activities with line balancing method.
2. Arrangement production area with 5S method.
The 5S concept was design to reduced waste through arrange, clean and maintains routine activities in order to working properly (Osada, 2002). This is because implementation of 5S in organization can keep sustainability and flow efficiency of activity and give an effect to reduced material, motion, time and space area to do activities (Al-Aomar, 2011; Pusporini and Andesta, 2009; Robinson and Schoederer, 2009).
3. Design facilities layout with systematic layout planning (SLP) approach which developed by Muther. Criteria to get the best proposed facilities design was efficiency of total space area, material handling cost and total movement.

3. Result and Conclusions

3.1. Balancing of Production Line

The objective of balancing of production line was to distributed work units on work stations to minimize delay time, so that can maximized utility of machine and operator. Performance of line balancing is pointed out by balance delay (D) and balance efficiency (Eb). Balance delay and balance efficiency of existing layout were about 63,89% and 36,11%. This is mean that overall delay time in production line was 63.89% with utility about 36,11%. This is

pointed out that production line of existing layout was not balance. This was because difference of cycle time for all work station. For that reason, it was need to improved production line to increased utility of work station and reduced delay time by used line balancing methods. There were 3 methods used to improved production line, that were heuristic method by ranked positional weight (RPW), Optimal best bud search and COMSOAL. Result of line balancing used WinQSB 2.0 software are presented in Table 1.

Table 1. Comparison of Actual Production Line and Line Balancing Result

No	Criteria	Actual Line	Line Balancing		
			Heuristic (RPW)	Opt. Best Bud Search	COMSOAL
1	No of work station	12	4	4	5
2	Cycle time (second)	7750,58	7750,58	7750,58	7750,58
3	Balanced Delay (%)	63,89	15,14	15,14	32,12
4	Efficiency (%)	36,11	84,86	84,86	68,88

Result of line balancing methods as shown in Table 1 pointed out that line balancing methods gave a better balance delay than actual condition. Among three methods of line balancing, there were two methods which gave same result, that were heuristic method and optimal best bud search. The results show that balance delay of production line about 15.14% with efficiency about 84.86%. This is mean that utility of production line increased about 48,75% from actual condition. Result of line balancing then has been used to design proposed facility layout of thresher machine.

3.2. Arrangement of Working Area with 5S Concept

First step of 5S implementation is sort (seiri) for all working area. Existing condition and sort of one work station show in Table 2. Table 2 shows that in rolling machine area, there were some unnecessary item such as empty tins and unused material. Those unnecessary items are waste for rolling machine area. It is mean that, reduced those items will give an efficiency to total space area. In order to reduced unnecessary items, proposed of working area for rolling machine had been design as shown in Figure 1.

Table 2. Existing Condition and Sorting of Rolling Machine

	
Necessary	Unnecessary
<ul style="list-style-type: none"> • Big and small rolling machine • Material before process • Material after process • Working instruction display 	<ul style="list-style-type: none"> • Unused material (corrosion, reject, not used in rolling process, scrap) • Empty tins

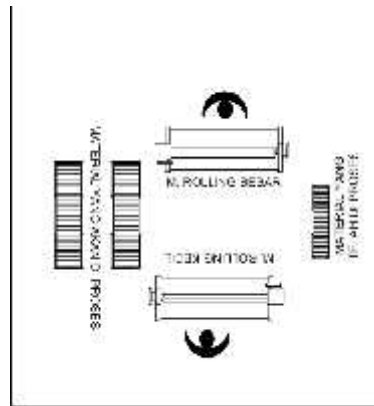


Figure 1. Proposed Design of Rolling Machine Area

3.3. Proposed Facility Layout Design

First step in redesign of facility layout is examined existing layout condition. Result of line balancing for existing condition shows high delay time on production line, which is overall delay time about 63,89%. Using line balancing method, proposed production line can reduced delay time about 48,75%. This proposed production line was input to design new layout facility. Besides balancing of production line, existing condition also examine with 5S concepts. The 5S result shows all necessary items for all working area. This necessary item had been used to arrange working area, so that can optimize in using space area for all work station. The next step was determined material handling cost for existing layout. Material handling cost is cost that occurred in manufacturing because of movement activity such as material movement between two working area. Result of total movement distance of

existing layout was 26.471,4 m with total material handling cost about Rp.316.135,-.

The next step was design proposed facility layout with systematic layout planning approach which develop by Muther and FLAP software to choose best layout alternative. FLAP is a quantitative method that used length and width of working area, number of working area and matrix flows between machines as input. Result of line balancing method show that there are 4 work stations and layout of every work station will design by FLAP. The last step was design overall layout which consist of work station, storage and warehouse. Result FLAP for overall layout shown in Figure 2. Based on FLAP result, total movement distance and material handling cost of proposed design had been determined. Comparison of existing layout and proposed layout has shown in Table 3.

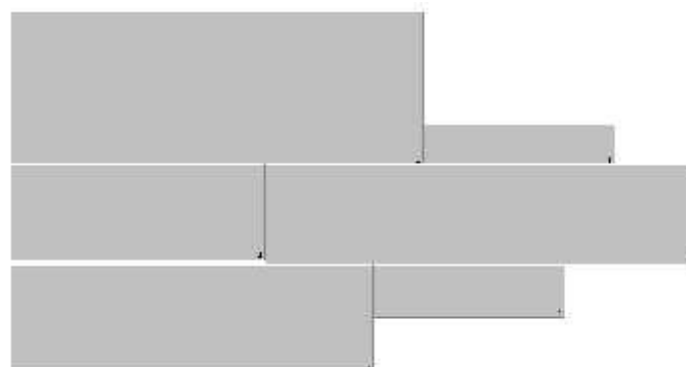


Figure 2. Overall Proposed Facility Layout using FLAP

Table 3. Comparison of Existing and Proposed Layout

	Existing	Proposed	U	Efficiency
Work Station Efficiency (%)	36.11	84.86	48,75	-
Total Space Area (m ²)	754	637,954	116,046	15,40 %
MHC (Rp/month)	316.135	239.739	76.396	24,17 %
Total movement distance (m)	26.471,5	19.860	7.211,4	24,98%

Total movement distance with FLAP about 19.860 m with total space area about 637,954 m with length 23,3 m and width 27,38 m. table 3 shows that efficiency on space area about 15.4% from existing layout. Proposed layout also shows efficiency on total movement distance about 24.98%. Efficiency on space area because of on proposed layout unnecessary items are reduced from area, so that waste on space area can reduce and impact to minimize of total space area. Minimized of total space area then affect to minimize of material handling cost about 24.17%. Beside, efficiency also shows on time efficiency as impact of reduces on total movement distance. Time efficiency because of reduces on total movement distance is equal to 0.5 unit product per month. If examine from production cost, it will cause saving about Rp.2.100.000,- from 0.5 product per month. So that total efficiency because of proposed layout about Rp.2.176.396,-.

3.4. Conclusion

Result on balancing of production line shows reduce on balance delay from 63,89% to 15,14%. It is mean, improvement on production line balance can reduced delay time about 48,75%. 2. Using of 5S concept, all working area can arrange more efficient because every working area only has material, tools and activities which necessary. 3. Proposed layout design show efficiency on total space area about 15,40% which impact to reduced on material handling cost about Rp. 76.396 per month. Overall, proposed layout give cost efficiency about Rp. Rp.2.176.396,- per month.

4. Acknowledgment

Thank you to Lembaga Penelitian dan Pengabdian Masyarakat (LPPM) Universitas Bung Hatta, Kopertis Wilayah X and DIKTI for research grant 2014, so that this research can accomplish well.

5. References

- Abdalla, Shaima, Mehmet S. Kizil, Ismet Canbulat, 2013, Development of a Method for Layout Selection Using Analytical Hierarchy Process, *13th Coal Operators Conference, University of Wollongong, The Australian Institute of Mining and Matallurgy & Mine Managers Association of Australia*, pp. 27-37.
- Al-Aomar, Raid A., 2011, Applying 5S Lean Technology: An Infrastructure for Continuous Process Improvement, *World Academy of Science, Engineering and Technology* 59, pp. 2014-2019
- Hojjati, Seyed Mohammad Hossein, 2011, Implementing 5S System in Persia Noor Factory, *International Journal of Industrial Engineering, Vol. 18 No.8 pp.425-431*.
- Osada, Takashi, 2002, *Sikap Kerja 5S Seri*

- Manajemen Operasi*, PPM, Jakarta.
- Purnomo, Hari (2004). *Perencanaan & Perancangan Fasilitas*. Yogyakarta: Penerbit Graha Ilmu.
- Pusporini, Pregiwati dan Andesta, Deny, 2009, Integrasi Model Lean Sigma untuk Peningkatan Kualitas Produk, *Jurnal Teknik Industri Universitas Muhammadiyah Malang Vol. 10 No. 2, pp. 176-183*
- Robinson, Alan G. & Schoederer, Dean M., 2009, The Role of Front-Line Ideas in Lean Performance Improvement, *Quality Management Journal, Vol. 16 No. 4 pp. 27-40*.
- Shahin, Arash dan Mehdi Poormostafa, 2011, Facility Layout Simulation and Optimization: an Integration of Advanced Quality and Decision Making Tools and Techniques, *Modern Applied Science, Vol 5. No 4, August 2011, pp. 95-111*.
- Thomkins, James.A, White, John.A, Bozer, Yavuz.A, Tanchoco,J.M.A and Trevinom Jaime (1996). *Facilities Planning Second Edition*. New York: Jhon Willey And Sons.
- Wignjosoebroto, Sritomo (2003). *Tata Letak Dan Pemindahan Bahan*. Surabaya: Penerbit Guna Widya.
- Zhenyuan, Jia, LU Xiaohong, Wang Dei, Jia Defeng, Wang Lijun, 2011, Design and Impelemtation of Lean Facility Layout System of A Production Line, *International Journal of Industrial Engineering Vol. 18 No.5 pp. 260-269*.



**FAKULTAS TEKNOLOGI INDUSTRI
UNIVERSITAS BUNG HATTA**



Kampus III : Jl. Gajah Mada No. 19 Olo Nanggalo Padang 25143
Telp. 0751-7054257 Fax. 0751-7051341
<http://www.fti.bunghatta.ac.id>