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The 3rd International Conference of Chemical and Materials Engineering (ICCME) 2018

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Editors: Andri Cahyo Kumoro, Hadiyanto, Hong-Wei Yen, Abdul Latif Ahmad, Oki Muraza, Xosè Antòn Vàzquez Àlvarez, Ivan Salmeron Ochoa (Mexico)

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Preface

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Preface

International Conference on Chemical and Material Engineering (ICCME) 2018

The 3rd International Conference on Chemical and Material Engineering (ICCME) 2018 was held by the Department of Chemical Engineering - Universitas Diponegoro in conjunction with the 60th anniversary of Faculty of Engineering - Universitas Diponegoro. The event was conducted on September 19th 2018 in Grand Candi Hotel Semarang - Indonesia. This event was the continuation of the preceding conferences held in 2013 and 2015. The ICCME 2018 brought "Chemical and Material Engineering for Sustainable Foods, Energy, and Environment" as the grand theme. The objectives of this conference are:

- To disseminate and develop the most recent innovations, trends, and concerns as well as practical challenges encountered and solutions in the fields of chemical and material engineering.
- To encourage international collaborations and joint ventures
- To promote and facilitate the growth of scientific and technical development in • the field of chemical and material engineering development in Indonesia and the Asia region

Although the organizing committee received a total of 115 abstract papers, the scientific committee decided that only 97 papers were eligible for oral presentations which came from Indonesia, Malaysia, Myanmar, the Philippines, Taiwan, Japan and Austria. In addition, 3 keynote and 3 invited speakers from abroad were presented during this conference. This special issue proceeding presents 76 papers selected from the presented papers after being thoroughly peer reviewed.

Special thanks are due to all keynote and invited speakers for their participation, to the Organizing Committee members for all their hard work in making the conference to happen, especially Universitas Diponegoro Chemical Engineering Master Program students who generously supported the conference. The Scientific Committee members are also thanked for reviewing the submitted manuscripts and for assisting in the editorial process. Finally, all who travelled to Semarang, Indonesia for the meeting are acknowledged for deciding to attend and contribute to making this a successful conference.

We greatly hope that this proceeding will be advantageous in future implementations of chemical and material engineering, not only to the academia, but also to the industries by which broadening our scientific perspective.

Andri Cahyo Kumoro & Dyah Hesti Wardhani

Conference Scientific and Organizing Committee Chairs

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- 1. Prof. Dr. Andri Cahyo Kumoro, ST, MT (Chair-Indonesia)
- 2. Prof. Dr. Hadiyanto, ST, MSc (Indonesia)
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Peer review statement

All papers published in this volume of Journal of Physics: Conference Series have been peer reviewed through processes administered by the proceedings Editors. Reviews were conducted by expert referees to the professional and scientific standards expected of a proceedings journal published by IOP Publishing.

Table of contents

Volume 1295 **2019**

◆ Previous issue Next issue ▶

The 3rd International Conference of Chemical and Materials Engineering 19–20 September 2018, Semarang, Indonesia

Accepted papers received: 09 July 2019 Published online: 08 November 2019

Open all abstracts

Preface			
OPEN ACCESS			011001
Preface			
+ Open abstract	View article	PDF	
OPEN ACCESS			011002
Conference Phot	ographs		
	View article	PDF	
OPEN ACCESS			011003
Peer review state	ement		
+ Open abstract	View article	PDF	
Papers			
Heat and Mass T	ransfer		
OPEN ACCESS			012001
Applications of s	solar dryer for seawe	eed and cassava starch	
Suherman Suherma	an, Evan Eduard Susan	to and Abdullah Busairi	
+ Open abstract	View article	PDF	
OPEN ACCESS			012002
Performance stud	dy of hybrid solar di	yer with auxiliary heater for seaweed drying	
Suherman Suherma	an, Hafid Rizki, Nurfac	lilla Rauf and Evan Eduard Susanto	
This site uses sook see our Privacy and		se p stgryou agree to our use of cookies. To find out more,	8

OPEN ACCESS Optimization for Surface Methodo		tyl Glycoside Nonionic Surfactant Using Response	012003
Harsa Pawignya, T.	D. Kusworo and B. P.	ramudono	
	View article	PDF	
OPEN ACCESS			012004
	· · ·	l-1,3-dioxolane-4-methanol) from glycerol and c catalyst at the boiling temperature (preliminarry study)	
Mahreni, Tjukup M	arnoto and Muhamad	Maulana Azimatun Nur	
	View article	PDF	
OPEN ACCESS			012005
		biodiesel production from lard	
L Buchori, DD Ang	ggoro, F Tsaniya, MB	Elyasa and E Noviariyono	
	View article	PDF	
Separation and P	urification		
OPEN ACCESS			012006
-	ecious metals recove aching (HPOXAL)	ery from nickel smelter slag under high-pressure	
Khamdan Cahyari a	and Kholik		
	View article	PDF	
OPEN ACCESS Study of Plasma	Electrolysis Method	d on Starch-Based Hybrid Latex Synthesis	012007
•	nior, E Gustaf, S S R I		
	_	_	
+ Open abstract	Uiew article	PDF	
OPEN ACCESS Response surface propanediol deep	Ci 1	nization of α -mangostin extraction using betaine-1,2-	012008
Kamarza Mulia, Irf	an Faisal Pane and Els	a Krisanti	
	View article	PDF	
loaded with mang Kamarza Mulia, Di	gostins cki Rachman and Elsa		012009
	[≣]. View artičle Cookies policy.	se this site you agree to our use of cookies. To find out more, PDF	8

OPEN ACCESS			012010
•	· / -	ced from semi-dull via melting spun using an erature on elongation of the POY	
Dulmalik, A Chafidz	, R Fernandi and Arc	lianto	
	View article	PDF	
OPEN ACCESS			012011
Enhancing the yiel feedstock	ld and quality of K	emiri Sunan crude oil by preliminary extraction of	
S Supriyadi, P Purwa	nto P and H Hermav	van	
	View article	PDF	
OPEN ACCESS			012012
Activation And Ch Of Lead (II) Metal		Andisol Soil And Fly Ash Composite In Adsorption	
Pranoto, T Martini ar	nd E P Anandita		
	Tiew article	PDF	
OPEN ACCESS			012013
Simulation of a Va	cuum Evaporator	for Propolis Production	
Y Muharam, M Sahla	an, Tiarrahman and S	S P Aletheia	
	Tiew article	🔁 PDF	
OPEN ACCESS			012014
		action using Microwave-Assisted Extractor	
L Kurniasari, Darma	nto and P Kusumo		
	View article	PDF	
OPEN ACCESS			012015
		Surfactant Sodium Ligno Sulfonate (SLS) From Of Enhanced Oil Recovery (EOR)	
S Priyanto, T D Kusv	woro, Sayyidah, B Pr	amudono, E Untoro and P Ratu	
	View article	PDF	
OPEN ACCESS			012016
Response Surface Natural Vanillin fr	•	licrowave Integrated-Rumen Based Extraction of Pods	
V Paramita and ME	Yulianto		
+ Open abstract	View article	🔁 PDF	
OPEN ACCESS	s. By continuing to u	se this site you agree to our use of cookies. To find out more,	012017

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Journal of Physics: Conference Series, Volume 1295, 2019 - IOPscience

The Effect of Ionic Strength on Protonation Constant of Monoethanolamine in Water at 303K

S Ma'mun, A	Chafidz, E	E Indrayanto	and	ΡK	Setiawan
-------------	------------	--------------	-----	----	----------

+ Open abstract	View article	🔁 PDF
• Open dobitaet		

OPEN ACCESS Production of natu	aral colorant powde	er from <i>Clitoria ternatea</i> l. using tray dryer which is	012018
dehumidified by z	eolite		
F Mauludifia, S D A	strinia, K A Meiranti	and M Djaeni	
	View article	PDF	
OPEN ACCESS A Kinetic study of Extract with Foan	-	on during Application of Dried Colorant from Roselle	012019
Mohamad Djaeni an	d Febiani Dwi Utari		
	View article	PDF	
Concentration for	Edible Film Produ	s, Stirring Speeds, and Lemongrass Oil ction Using Solvent Casting Method ati, A P Setiatun and Afriyanti	012020
-	_	_	
	View article	🔁 PDF	
OPEN ACCESS Comparison of the and zinc as an and		trocoagulation of dye (batik waste water) using iron	012021
S. Suhartana, P. Purv	vanto and Adi Darma	wan	
+ Open abstract	View article	PDF	
-		PVP blend membrane and UV irradiation treatment clove oil purification	012022
T D Kusworo, Wida	yat, Budiyono, A A S	iahaan, G K Iskandar and D P Utomo	
	Tiew article	PDF	
oncophyllus) Tube	*	Freshly Harvested Porang (<i>Amorphophallus</i> sion in Ascorbic Acid Solutions at Various Times i and R Ratnawati PDF	012023
OPEN ACCESS This site uses cookie Formulation of Na see our Privacy and <i>lappaceum L</i>) and	s. By continuing to us itural Dye Stock So Cookies policy. Evaluation of its (se this site you agree to our use of cookies. To find out more, olution Extracted from Rambutan's Peel (<i>Nephelium</i> Colour Fastness Properties on Cotton Fabric	012024

Rizka Amalia, Vita Paramita, Heny Kusumayanti, Wahyuningsih, Maranatha Sembiring and Dina Elvia Rani

+ Open abstract	View article	PDF	
• •	es the effect of onic on, silica gel and ze	on (allium cepa l.) drying using hot air dehumidified colite	012025
M Djaeni and A M	Perdanianti		
+ Open abstract	Tiew article	PDF	
OPEN ACCESS Ramie, Cotton, a Body Armor	nd Rayon Double P	ly Combination Composite for Bullet Proof Vests	012026
K Setyani and N A	ryanti		
	View article	PDF	
OPEN ACCESS The Ultrasound-A M Djaeni and Y L 1		of Rice Bran Oil with n-Hexane as a Solvent	012027
+ Open abstract	View article	🔁 PDF	
	Blocking Mechani Aryanti and D H War	sm in Ultrafiltration of Glycerin-Rich Solution dhani PDF	012028
Bioprocess Engin	eering		
OPEN ACCESS The effect of <i>Sac</i> production from	v	iae concentrations on second generation bioethanol	012029
A Ahmad, S R Mur	ria and M Dewi		
	View article	PDF	
OPEN ACCESS Production of Se Saccharomyces c		oethanol from Palm Fruit Fiber Biomass using	012030
A Ahmad, S R Mur	ria and M Tuljannah		
+ Open abstract	View article	PDF	
•	ies. By continuing to u inti, A B Wicaksono, F	eed Oil and Olive Oil With Tween 80 as Emulsifier se this site you agree to our use of cookies. To find out more, i Hermasnyah and A Wijanarko	012031

+ Open abstract	View article	PDF	
• •	roduction from Tap ious pH And Isome	bioca Solid Waste <i>(Onggok)</i> By Using Enzymatic erization Process	012032
F Yulistiani, Saripuc	lin, L Maulani, W S F	Ramdhayani, W Wibisono and A R Permanasari	
	View article	🔁 PDF	
OPEN ACCESS Process Fermenta Zymomonas Mob		nboo with Saccharomyces Cerevisiae and	012033
N K Sari and D Erna	awati		
	View article	🔁 PDF	
	-	ibacterial Toward Staphylococcus epidermidis	012034
R Firyanto, E Fatari	_		
	Uiew article	PDF	
Generation from S	• •	lysis (LTEH) and Fermentation for Bioethanol hallus campanulatus B) Starch	012035
+ Open abstract	View article	PDF	
	nrichment of dried 1 1 effort of food fort	noodles by using phycocyanin extracted from ification	012036
		Sa'adah, MS Putra, AM Filardli, H Sutanto and M Suzery	
	View article	PDF	
OPEN ACCESS Effect of KOH as	Deacetylation Age	ent on Physicochemical Properties of Glucomannan	012037
D H Wardhani, H Ca	ahyono, M F H. Dwin	nanda, P R Nabila, N Aryanti and D R Pangestuti	
+ Open abstract	View article	PDF	
Clean Production	Including Waste Di	isposal	
OPEN ACCESS Adsorption of Co	balt-60(II) on silica	a xerogel from rice husk	012038
		ri and G. Nurliati use this site you agree to our use of cookies. To find out more,	0

OPEN ACCESS Betaine-based deep eutectic solvents with diol, acid and amine hydrogen bond donors for carbon dioxide absorption	012039
K Mulia, E Krisanti, Nasruddin and E Libriandy	
← Open abstract	
OPEN ACCESS The Reduction of COD Levels in Domestic Waste Water Using Combination of Activated Sludge Methode – Activated Carbon Continously	012040
G. Mukhtar, I Retno, T. M, N Fajar and A Satria	
+ Open abstract	
OPEN ACCESS Production of Fish Feed from Soy Residue and Shrimp Waste using Tapioca as Binding Agent	012041
S Sumardiono and Z D Siqhny	
OPEN ACCESS Recycling and processing of solid waste into products of the cosmetic packaging industry	012042
P. Purwanto and A.D. Permana-Citra	
← Open abstract	
OPEN ACCESS Design of Air Quality Monitoring System Based On Web Using Wireless Sensor Network	012043
P Purwanto, S Suryono and S Sunarno	
Energy Conversion and Development	
OPEN ACCESS Condensate water as a compressor discharge cooler to generate subcooling on the residential air conditioning using R32 as refrigerant	012044
K Sumeru, AS Margana and S Hidayat	
← Open abstract	
OPEN ACCESS Kinetics and Equilibrium Studies of Electro Adsorption of Remazol Red on Modified Stainless Steel Electrode	012045
P Purwanto and R Riska	
The BRE ASSESSED and Cookies. By Vinthilling to use this SRF you agree to our use of cookies. To find out more, see our Privacy and Cookies policy.	8

OPEN ACCESS	012046
Ultrasonic pretreatment on biogas production from wood-dust mahogany (swietenia mahagoni) with solid-state anaerobic digestion method: effect of time and pretreatment	
H Ardhiansyah, Budiyono and S Sumardiono	
+ Open abstract	
OPEN ACCESS Simular Lattice Device Method for the Optimization of New Editle Oils Misters	012047
Simplex Lattice Design Method for the Optimization of Non-Edible Oils Mixture Composition as Feedstock for Biodiesel Synthesis Using Reactive Distillation	
R D Kusumaningtyas, B Triwibowo, R A Ramadhani, D H S Riyadi and I Istadi	
+ Open abstract 🔄 View article 🄁 PDF	
OPEN ACCESS	012048
Preparation and Characterisation of Composite Sulfonated Polyether Ether Ketone for Direct Methanol Fuel Cells	
H Purnama, M Mujiburohman, M F Hakim and N Hidayati	
+ Open abstract 🔄 View article 🔁 PDF	
OPEN ACCESS	012049
Drying rate and efficiency energy analysis of paddy drying using dehumidification with zeolite	1
M Djaeni, F Irfandy and F D Utari	
← Open abstract	
OPEN ACCESS Co-Digestion of Bagasse and Waterhyacinth for Biogas Production with Variation of C/	012050 /N
and Activated Sludge	
A Hadiyarto, D Soetrisnanto, I Rosyidin and A Fitriana	
Sustainable Development and Higher Education In Chemical Engineering	
OPEN ACCESS	012051
Production Technology and Utilization of Nano Cellulose	
H. Herawati	
← Open abstract	
OPEN ACCESS	012052
Hydrocolloids to The Effects of Gluten Free Bakery Products	
H. Herawati	
← Open abstract	
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See our Privacy and Cookies policy.	

1, 6:03 AM	Jour	nal of Physics: Conference Series, Volume 1295, 2019 - IOPscience	
1 0		es of Polylactic Acid Bionanocomposite Film nit Bunch Nanocrystalline Cellulose	01205
E Indarti, Marwan a	and W D. Wan Rosli		
+ Open abstract	View article	PDF	
OPEN ACCESS			01205
Nano-ZnO impre content in clove c	•	acetate hybrid membrane for increasing eugenol	
T D Kusworo, Wida	ayat, Budiyono, A A S	iahaan, G K Iskandar and D P Utomo	
+ Open abstract	View article	PDF	
OPEN ACCESS Effect of nanocla	y loadings and repr	ocessing on dynamic mechanical thermal properties	01205
of polypropylene,	/nanoclay composit	es	
A Chafidz, S Ma'mı	un, Megawati, N Indal	n and C Tamzysi	
+ Open abstract	View article	PDF	
Micro & Nanoma	terials		
OPEN ACCESS			01205
Isolation of lignir	n from rice husk at	low temperature	
A Ma'ruf, B Pramuc	dono, N Aryanti and A	Usriyati	
+ Open abstract	View article	🔁 PDF	
OPEN ACCESS	4:	notion of each on momentum of the DECUD results of	01205
Gas permeation p using indene as p		ration of carbon membrane by PECVD method	
M Kyaw, N P. Dugo	os, S Mori, S A. Roces	and A B. Beltran	

🔁 PDF View article + Open abstract

OPEN ACCESS

Effects of Processing Temperature and Lignin on Properties of Starch/PVA/Lignin Film Prepared by Melt Compounding

Retno Wulandari and Ratnawati

View article 🔁 PDF + Open abstract

Smart/Intelligent & Functional Materials

OPEN ACCESS Study of Plasma Electrolysis Method on Starch-Based Hybrid Latex Synthesis

N Saksono, A B Junior, E Gustaf, S S R Dyasti and M Chalid

+ Open abstract View article PDF This site uses cookies. By continuing to use this site you agree to our use of cookies. To find out more, see our Privacy and Cookies policy.

012058

012059

 $oldsymbol{\Theta}$

OPEN ACCESS Effect of iron and manganese concentration on the sulfate reducing process in acid mine	012060
Effect of iron and manganese concentration on the sulfate reducing process in acid mine drainage	
S Sudarno, N Hardyanti, K Serafina and A Oktaviana	
+ Open abstract 🔄 View article 🄁 PDF	
OPEN ACCESS Effect of pH on Depolymerization of κ-Carrageenan by Ultrasound, Ozone and Their Combination	012061
A Prasetyaningrum, B Jos, Y Dharmawan, R Ratnawati, S Riyandita and R Scesario	
← Open abstract	
OPEN ACCESS Effect of Temperature and Reaction Time on the Swelling Power and Solubility of Gadung (<i>Dioscorea hispida</i> Dennst) Tuber Starch during Heat Moisture Treatment Process A C Kumoro, D S Retnowati, R Ratnawati and M Widiyanti	012062
OPEN ACCESS Modelling of controlled drug release in gastrointestinal tract simulation I Permanadewi, A C Kumoro, D H Wardhani and N Aryanti + Open abstract Image: View article PDF	012063
OPEN ACCESS The Effect of pH and Current Density on Electrocoagulation Process for Degradation of Chromium (VI) in Plating Industrial Wastewater	012064
A Prasetyaningrum, B Jos, Y Dharmawan and I R Praptyana	
Polymer Synthesis and Modification	
OPEN ACCESS Effect of Storage towards Oxidation Stability and Physical Properties of Biodiesel from Palm Fatty Acid Distillate (PFAD)	012065
S Widarti, H Budiastuti, T Prasetyani and S Adhiawardana	
+ Open abstract 🔄 View article 🄁 PDF	
OPEN ACCESS Effect of Extraction Time on Tannin Antioxidant Level and Flavonoid on Pandan Wangi Leaf (<i>Pandanusamary llifolius Roxb</i>) Using Hydrothermal Extractor	012066
A L Dewi, V D Siregar and H Kusumayanti	
the Bree abstraction is by Vintering to use this She you agree to our use of cookies. To find out more, see our Privacy and Cookies policy.	0

Surface Engineeri	ng and Coating		
OPEN ACCESS			012067
	•	raction and Particle Size on Thermal Conductivity ropylene Composite	
N L E Wahyuni, B S	Soeswanto, H Aulia ai	nd R.A Fadhilah	
+ Open abstract	View article	PDF	
OPEN ACCESS Effect of ozone ex chicken meat	xposure time and o	zonated water replacement to control the quality of	012068
E F Karamah, S Z A	di and N Wajdi		
+ Open abstract	View article	🔁 PDF	
OPEN ACCESS Thermal Characte Kaolin	eristics of Geopoly	mer from Co-combustion Residuals of Bamboo and	012069
A Purbasari, T W Sa	amadhi, Y Bindar and	l W Wulandari	
+ Open abstract	View article	PDF	
	Rice Straw Additi	Development From Pulogadung Primary Sewage on By Hydrothermal PDF	012070
OPEN ACCESS Effect of process	technology and coa	ating material on the cassava stick characteristics	012071
H Herawati, E Kam	siati and Sunarmani		
	View article	🔁 PDF	
Material Forming			
OPEN ACCESS Scale-up simulati micelle using spra		valuation of encapsulated eugenol with casein	012072
A B Wicaksono, H I	Hermasnyah, A Wijan	narko and M Sahlan	
+ Open abstract	View article	PDF	
OPEN ACCESS			012073
-		nization of Starch-Based Bioplastic with Bamboo rcement Assisted by Potassium Chloride	
Shisishte Silesianookin see our Privacy and		se this site you agree to our use of cookies. To find out more,	8

	View article	PDF	
OPEN ACCESS A Comparative St at Low Energy O	•	oy and NiCrSi Alloy Materials as Heating Element	012074
Abdul Syakur, Veina	ard Vingtsabta, Fronth	ea Swastawati and Ima Wijayanti	
	View article	🔁 PDF	
OPEN ACCESS Application of an	Integrated Cooking	g Pan in Sambal Production	012075
D H Wardhani, N A	ryanti, L Buchori and	H Cahyono	
	View article	PDF	
•	uice as Crosslinker	-Based Biocomposite Reinforced Woven Bamboo and Epoxidized Waste Cooking Oil (EWCO) as Biopl	012076 asticizer
	View article	PDF	
modification of A D Swantomo, C A L	l current collector s	citor based PAni-GO-Cellulose-Lanthanum using surface and gamma irradiation	012077
	View article	PDF	
	ation Processes on of Coated Penute	Cassava Starch: Physichochemical Properties and	012078
S Sumardiono, A W	Z Putri, B Jos and I F	Pudjihastuti	
	View article	PDF	
JOURNAL LINK	S		
Journal home			
Journal Scope			
Information for orga	nizers		
Information for auth	iors		
Contact us			
Reprint services from	m Curran Associates		

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Simplex Lattice Design Method for the Optimization of Non-Edible Oils Mixture Composition as Feedstock for Biodiesel Synthesis Using Reactive Distillation

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Simplex Lattice Design Method for the Optimization of Non-**Edible Oils Mixture Composition as Feedstock for Biodiesel Synthesis Using Reactive Distillation**

R D Kusumaningtyas^{1,*,} B Triwibowo¹, R A Ramadhani¹, DH S Riyadi¹, I Istadi²

¹Chemical Engineering Department, Faculty of Engineering, Universitas Negeri Semarang.

²Chemical Engineering Department, Faculty of Engineering, Diponegoro University, Semarang, Indonesia

Email: ratnadewi.kusumaningtyas@mail.unnes.ac.id

Abstract. The diminished of fossil fuel becomes a critical issue today. Thus, it is essential to develop alternative energy resources which are renewable and environmental friendly. Among the prospective alternative is biodiesel. Biodiesel (fatty acid methyl ester) is produced by combining vegetable oils with alcohol via transestefication reaction. To avoid conflict between food and energy needs, the uses of non-edible oils as raw material is suggested. Commonly, biodiesel synthesis employs a single type of vegetable oil feed-stock. The dependency on a certain feed-stock could cause an increasing price due to the high demand and low supply. Thus, it is beneficial to apply diversification by employing multiple feed-stocks or mixture of non-edible oils as biodiesel feedstocks. However, the best composition of the multiple feedstocks is needed to obtain the optimum yield of biodiesel. In this work, mixture of non-edible oils, i.e. jatropha, nyamplung (Calophyllum inophyllum L.) seed, and used cooking oils were applied as biodiesel feedstocks. Non-edible oils are cheap but have high free fatty acid (FFA). The high FFA is not favorable for the alkaline-catalyzed transesterification since it will cause undesired saponification reaction and lower biodiesel yield. Hence, pretreatment to reduce FFA content is crucial prior to transesterification. In this work, esterification of FFA in vegetable oils mixture (jatropha, nyamplung, and used cooking oils) with methanol using reactive distillation in the presence of SnCl₂ catalyst was conducted as pretreatment step of biodiesel production. Various compositions of the oils mixture were employed. To determine the best formulation of feed-stocks, Simplex Lattice Design Method (SLDM) was used for the optimization of non-edible oils mixture composition as feedstock for biodiesel synthesis using reactive distillation. The prediction using SLDM was validated with the experimental data. It was found that the optimal composition of oil mixture was the mixture contains 37.291 v/v%jatropha oil + 37.709 v/v% nyamplung oil + 25 v/v% used cooking oil. This composition of feedstocks revealed the FFA conversion of 85.93% (prediction) and 86.03% (experiment). The desirability value was 0.937 which indicated the validity of the SLDM optimization method. The esterified oil mixture was then underwent transesterification reaction to produce biodiesel. The yield of biodiesel demonstrated 99.65 % purity and density of 884 kg/m³.

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1. Introduction

Fuel oil is indispensable in this modern as energy source for transportation, power plant, domestic activity, industry, and so on. Thus, the world dependency on fuel supply is high. Currently, the most utilized fuel is fossil based fuel. However, fossil fuel is a kind of non-renewable energy resource and the depleting reserves of fossil fuel turns into a critical issue in this decade. Besides, combustion and burning of fossil fuel also results in an environmental problem, especially in term of climate change. An abundant carbon dioxide emission produced by the vehicle or machine powered by fossil fuel will be entrapped in the atmosphere for a long time, enhancing the carbon dioxide concentration and leading to the world's temperature. This condition will cause climate change which provides negative impact to the ecosystem. Therefore, it is essential to develop alternative energy resources which have renewable characteristic and environmental friendly. Among the prospective renewable energy to replace or substitute fossil fuel is biofuel. *Biofuel is* energy resources derived from renewable plant and animal materials. Biofuel includes bioethanol, biodiesel, biogas, bio-oil, and green diesel [1].

To date, the most potential and economical biofuel for diesel machine is biodiesel. Biodiesel is priority is some country such as Indonesia. In Indonesia, the development of biodiesel as renewable energy resource is stated in the Regulation of the President of Republic of Indonesia Number 5 (2006) and presented in the Blueprint of the National Energy Management, formulizing the development of biodiesel technology for a period of 20 years (2005 – 2025) [2].

Biodiesel or fatty acid methyl ester (FAME) is produced by combining vegetable oils or animal fats with short chain alcohol, such as methanol or ethanol through transestefication reaction. In Indonesia, the most used feed-stocks for biodiesel production are crude palm oil (CPO) and jatropha oil. However, the employment of CPO as edible oil for biodiesel raw material will cause side problem in terms of the conflict between food and energy need. The huge consumption on CPO for biodiesel production potentially initiates the problem on food security. Therefore, utilization of non-edible oil is more suggested [3].

Jatropha oil is a type of non-edible oil, which is more suitable to be consumed as biodiesel feedstocks. In spite of this, dependency on one type of feed-stocks will bring about the fluctuation of such the commodity price. Even, the price could tend to increase when there is high disparity between the jatropha oil's demand and its market supply. This unbalanced situation will imply the higher price this kind of vegetable oil due to the limited supply availability. Thus, to avoid the problem caused by the low supply and high demand of a certain vegetable oil, it is beneficial to apply diversification strategy on biodiesel feed-stocks. In this case, utilization of multiple feed-stocks or mixture of non-edible vegetable oils as raw material for biodiesel production is a prospective alternative [4].

There are several future non-edible vegetable oils for biodiesel production. In Indonesia, there are nyamplung (*Calophyllum inophyllum L.*) seed oil, rubber-seed oil, kemiri sunan (*Aleurites trisperma Blanco*) oil, waste cooking oil, etc. The combination of various types of non-edible oils as feedstocks for biodiesel is interesting to ensure the security and stable price of vegetable oils raw material. However, the best composition of the multiple feed-stocks is needed to obtain the optimum yield of biodiesel. Thus, this research studied the optimization of non-edible oils mixture composition which is utilized as biodiesel raw material. Non-edible oils usually cheap but have low quality and high free fatty acid (FFA). The high amount of FFA content is not favorable in the transesterification reaction between vegetable oils and alcohol in the presence of alkaline catalyst since it will cause saponification as undesired side reaction, consume the catalyst, and lower biodiesel yield. Hence, pretreatment to reduce the FFA content in the vegetable oils feedstock is crucial prior to the main transesterification reaction. In this work, esterification of FFA in vegetable oils mixture with methanol in the presence of solid acid catalyst (tin (II) chloride) using reactive distillation was conducted. FFA

was converted into methyl ester to decrease the FFA content in the feedstock and in the same way added the amount of methyl ester (biodiesel) [5].

Continuous process using reactive distillation process was applied for biodiesel production since this technology provides many advantages. Reactive distillation is frontier intensification process in biodiesel production since it integrates reaction and separation in one unit column. Hence, it offers benefit compared to sequential process, namely: 1) reduces equipment investment and operating cost, 2) decreases consumption of utility, 3) results in higher conversion and selectivity, and 4) possibility to shift equilibrium towards product formation. On the other hand, catalyst employed in this FFA esterification is tin (II) chloride solid acid catalyst (SnCl₂.2H₂O). This catalyst can result in high conversion in esterification reaction and easily to separate from the reaction mixture [5].

In this work, combination of jatropha, nyamplung seed, and waste cooking oils were used as feedstocks of biodiesel production using reactive distillation process. Various compositions of the oils mixture were employed. Since the mixture of vegetable oils have high FFA, then esterification reaction of non-edible oil feedstock was conducted to reduce the FFA prior to transesterication reaction. To determine the best formulation of feed-stocks, Simplex Lattice Design Method (SLDM) of Design Expert Software was used for the optimization of non-edible oils mixture composition. The prediction using SLDM was validated with the experimental data of FFA esterification reaction using reactive distillation in the presence of tin (II) chloride catalyst. The best formulation of feed-stocks is the composition of crude jatropha oil (CJO), crude nyamplung seed oil (CNO), and waste cooking oil (CJO) which provides best conversion of reaction (FFA reduction). The optimal composition of feedstock was furthermore employed for biodiesel production trough transesterification reaction in the presence of NaOH catalyst in reactive distillation column.

2. Methods

2.1. Materials

Raw materials utilized in this study was a mixture of non-edible oils consisting crude jatropha oil (CJO), crude nyamplung seed oil (CNO) and waste cooking oil (WCO). WCO oil was obtained from home industry in Kebumen, Jawa Tengah, Indonesia with the density, FFA content, and molecular weight of 0.954 g/mL, 1.32%, and 865.24 g/gmol, respectively. CJO with density, FFA content, and molecular weight of 0.940 g/mL, 9.4%, and 868.3074 g/gmol, respectively, was supplied by PT Jatropha Green Energy, Kudus, Indonesia. CNO with the density, FFA content, and molecular weight of 0.97 g/mL, 16.14%, and molecular weight of 884.8144 g/gmol was provided by Koperasi Jarak Lestari, Cilacap, Indonesia. Methanol (99 %v/v) and solid acid catalyst tin (II) chloride (99% purity) were obtained from Merck. The average molecular weight of the oil mixture was 884.2100 g/gmol.

2.2. Experimental Work of Esterification Reaction.

Prior to the esterification reaction, degumming process using 20% phosphoric acid was carried out to remove gum from the oils. Esterification reaction of the mixture of non-edible oils and methanol was then conducted in reactive distillation column as described in the previous work [6]. The reaction was performed at constant temperature of 60°C and molar ratio of oil to methanol of 1:60. Catalyst employed in this work was tin (II) chloride with the amount of 5% w/w oil. Analysis of FFA conversion was performed using titrimetric analysis [7]. The initial oil mixture composition on the feed-stock was varied. Oil feed-stock composition variation was determined using Design Expert Software by applying Simplex Lattice Design Method. Based on this method, the different initial formulation of oil feed-stocks composition on 100 mL total mixture basis is depicted in Table 1. The feed-stocks formulation revealed the FFA content ranging from 8.42 to 12.26%.

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Dum	CJO	CNO	WCO
Run	(mL)	(mL)	(mL)
1.	51.9	31.9	16.2
2.	27.5	50.0	22.5
3.	49.6	25.4	25.0
4.	70.5	10.0	19.5
5.	77.3	12.8	10.0
6.	40.0	50.0	10.0
7.	43.1	40.4	16.5
8.	35.0	40.0	25.0
9.	69.2	20.8	10.0
10.	59.9	15.1	25.0
11.	59.8	23.6	16.6

2.3. Optimization and Validation.

Optimization was carried out based on the data of reaction conversion of FFA (the decreasing of FFA content on the esterification reaction) on various oil feed-stocks composition. Simplex Lattice Design Method (SLDM) was applied for optimization process to determine the most appropriate composition of feedstock which provided the best FFA reduction through esterification reaction using reactive. Optimization was then validated by comparing the FFA reduction prediction using design expert software with the experimental data. The best composition was then used for biodiesel synthesis through transesterification reaction. Ethyl ester content in biodiesel produced from transesterification reaction was instrumentally determined using Gas Chromatography-Mass Spectroscopy (GC-MS).

3. Result and Discussion

3.1. Esterification Reaction

The FFA Esterification reaction of the non-edible oil mixture was accomplished based on the experimental design, in which the feed-stocks composition was determined using SLDM in Design Expert Software. The FFA conversion of each experiment was demonstrated in Figure 1. The FFA conversion achieved in this work was ranging from 70-85%, in which the FFA content could be reduced from 8.24-12.26% to 1-2%.

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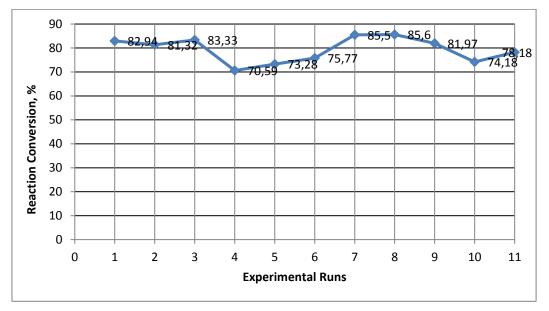


Figure 1. Conversion of Esterification Reaction at Reaction Temperature of 60°C, Ratio Molar of Oils to Methanol of 1:6, and Tin (II) Chloride Catalyst Concentration of 5% w/w oil for Various Feed-Stock Composition

3.2. Response Analysis

Each Response variable subsequently went through Analysis of Varians (ANOVA). The ANOVA model for variable analysis selected in this work was the model suggested by Design Expert Software 10.0, which provided highest level and significance. Based on ANOVA (Table 2), it was revealed that the selected model for each oil mixture respose was quadratic model. This model has shown the highest value of R^2 (0.944) compared to the other models. This model also demonstrated significance with the p value of p <0,0001 (<0,05). The ANOVA revealed that the CJO dan CNO provided significant effect on the response of FFA conversion. Lack of Fit (F-Value) was 4.46 (>0.05) indicating insignificant Lack of Fit. Insignificant value of Lack of Fit is a requirement for a good model since it indicates the suitability of the response data with the model [8].

Table 2. Method Analysis for the Response of FFA Reduction of Non-Edible Oil Mixtures

Response	Model	Significance (p<0.05)	Information	
AB	Quadratic	0.7807	Insignificant	
AC	Quadratic	0.0716	Insignificant	
BC	Quadratic	< 0.0001	Significant	

A = Waste Cooking Oil (WCO)

B = Crude Jatropha Oil (CJO)

C = Crude Nyamplung Seed Oil (CNO)

Design Expert Software 10.0 also offers facility of normal plot residual which indicates whether the residual (the difference between the actual response and the predicted response value) fulfills the normal line/ straight line [9]. The residual plot was shown in Figure 2.

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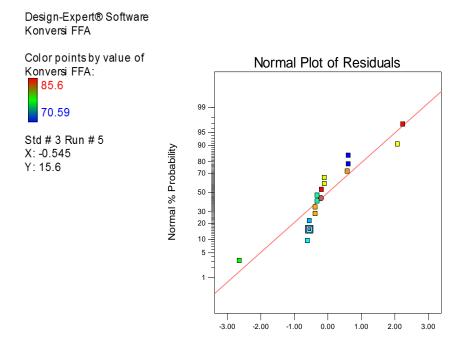


Figure 2. Residual Normality Response of FFA Reduction

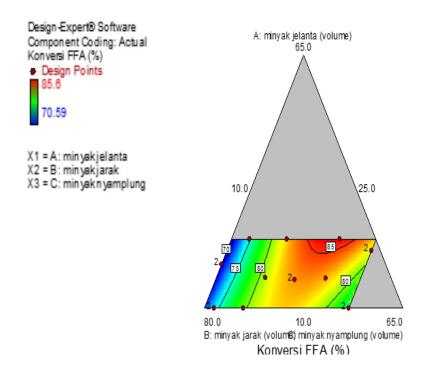


Figure 3. Contour Plot of Response Test of FFA Conversion

Contour plot in Figure 3 denotes how the combination of composition component affects the response of FFA conversion. The different colour on the contour plot specifies the value of FFA conversion. Blue colour indicates the response of the lowest conversion (70.59%). Red colour shows the response of the highest conversion (85.6%). The lines consisting of dots on the contour plot demonstrates the combination of the three components with the different composition which results in the similar yield. The surface shape of the interaction relationship between these components is depicted more clearly on the three-dimensional graph shown in Figure 4. The result of response analysis was then combined to obtain optimum composition of CJO, CNO, and WCO which yields the best FFA conversion.

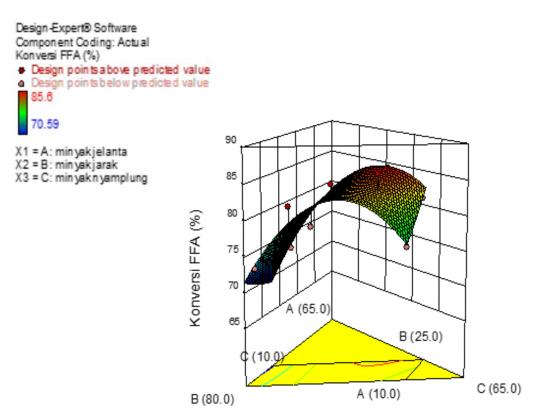


Figure 4. The Three Dimensional Response Test on the FFA Conversion

3.3. Response Analysis

Optimization was performed using Simplex Lattice Design Method (SLDM). This Method is able to carried out optimization according to the variable data and response measurement data inputted. Output of the optimization step is the recommendation of the new optimal formulation of the oil mixture. The optimal formulation is the composition which demonstrated the maximum desirability value. Desirability value is the function value for optimization purpose, indicating the ability of the program to fulfill the need based on the criteria specified on the final product.

In this work, optimization was conducted by determining the criteria (goal) of the desired FFA conversion which was ranging from 70.59% to 100%, thus the final FFA content resulted by the esterification reaction achieved the value as low as possible. Optimization using SLDM brought about the optimum FFA conversion of 85.938% with the formulation as shown in Table 3 and the desirability value of 0.937. The closer value of desirability to 1.0 denotes the reliability of the program to develop the desired result [11].

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Composition	Prediction (mL)
CJO	37.291
CNO	37.709
WCO	25

 Table 3. Hasil Formula Optimum dari Metode Simplex Lattice Design

The predicted value as shown in Table 3 was furthermore validated using experiment. Validation was carried out by evaluating the difference of the reaction conversion obtained by the predictive program and the empirical value obtained by experimental work for the similar non-edible oils feed-stock composition. The proximity between the predictive and empirical value indicates the validity of the model as demonstrated in Table 4.

 Table 4. Comparison Between Predictive and Experimental Data of FFA Conversion Using the Optimal Composition of Feed-Stocks

Optimal Composition	Predictive FFA Conversion	Experimental FFA Conversion (Validation)
37.291 mL CJO + 37.709 mL NCO + 25 mL WCO	85.938%	86.03%

The validated optimum composition was then utilized as the feed-stocks for the transesterification reaction to produce biodiesel using reactive distillation process at the temperature of 60°C, molar ratio of oil to methanol of 1:6, and catalyst concentration of 1% NaOH catalyst [6]. Biodiesel produced contained 99.65% alkyl ester based on GC-MS analysis. The density of product was 884 kg/m³, which meets the biodiesel standard.

4. Conclusion

Optimal composition of non-edible oil mixture which consists of crude jatropha oil, nyamplung seeds oil, and waste cooking oil can be predicted using Simplex Lattice Design Method (SLDM). The optimization resulted in the best composition of 37.291 mL CJO, 37,709 mL CNO, and 25 mL WCO which revealed in the optimum FFA conversion of 86.03%. Biodiesel produced after the oil mixture underwent transesterification reaction has the density of 884 kg/m³ and alky ester content of 99.65%.

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References

[1.]Oh Y K, Hwang K R, Kim C, Kim, J R, and Lee J S 2018 *Bioresource Technology* 257 pp 320-333

[2.] Aisyah L and Wibowo C S 2011 Scientific Contributions Oil & Gas 34 (3) 177 – 188

Balat M. 2011 Energy Conversion and Management 52 1479-92

- [3.] Thapa S, Indrawan N, and Bhoi PR 2018 Environmental Technology & Innovation 9 210-219
- [4.]Kusumaningtyas R D, Purwono S, Rochmadi, Budiman A 2014 Int. J. Exergy 15 (4) 447-467
- [5.]Kusumaningtyas R D, Aji I N, Hadiyanto H, Budiman A 2016 Bulletin of Chemical Reaction Engineering & Catalysis 11 (1) 66-74

[6.] Ozbay N, Oktar N, Tapan N A 2008 Fuel 87 (10-11) 1789-98

IOP Conf. Series: Journal of Physics: Conf. Series **1295** (2019) 012047 doi:10.1088/1742-6596/1295/1/012047

- [7.]Keshani S, Chuah A L, Nourouzi M M, Russly A R, and Jamilah B 2010 International Food Research Journal 17 733–742
- [8.] Kumari K S, Babu I S, and Rao G H 2008 Indian Journal of Biotechnology 7 (4) 496–501
- [9.] Raissi S, and Farzani R E 2009. World Academy of Science, Engineering and Technology 51,267–271.

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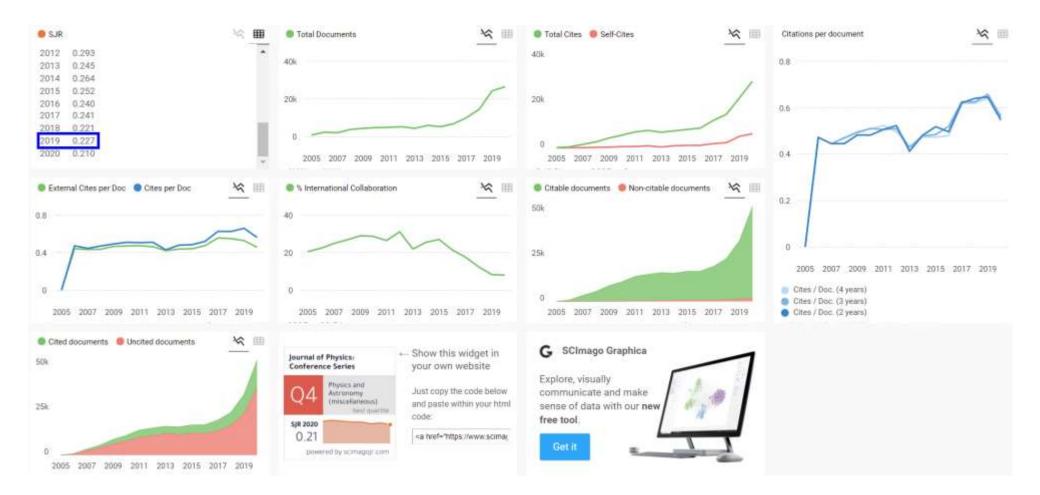
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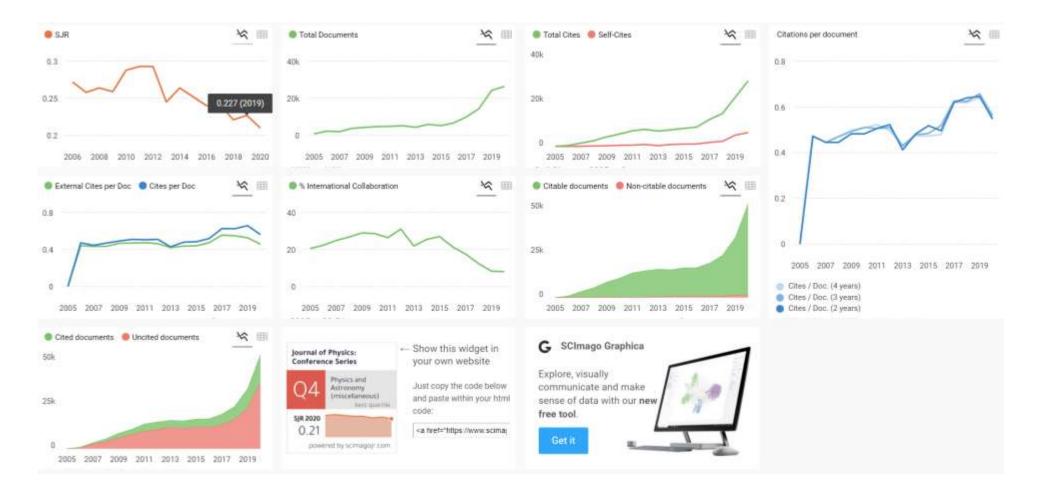
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