

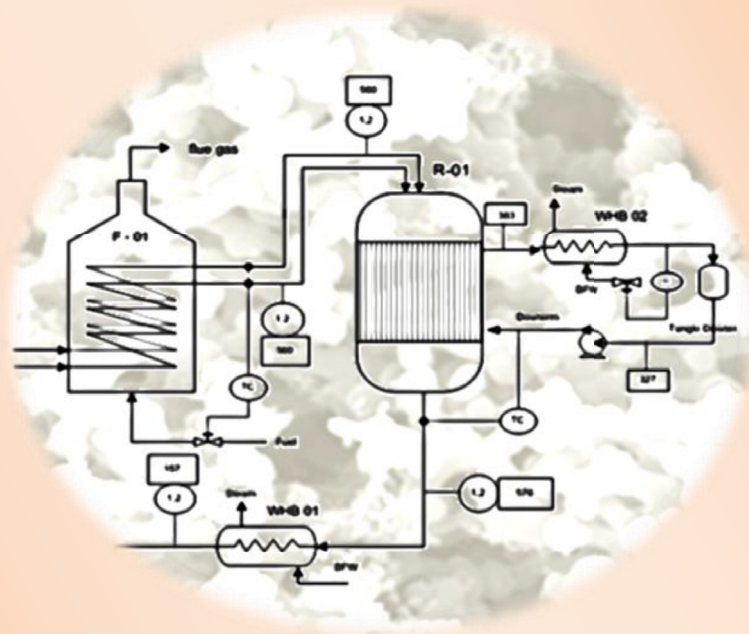


1st INTERNATIONAL CONFERENCE ON
CHEMICAL AND MATERIAL ENGINEERING



PROCEEDING of ICCME 2012

ISBN 978-602-097-281-7



Departement of Chemical Engineering,
Diponegoro University, Semarang – Indonesia
12 – 13 September, 2012



Penerbitan & Percetakan
UPT UNDIP Press
SEMARANG

Scientific Editorial Board Members

	Prof. Dr. Mathias Ulbricht
UDuE, Germany	
	Prof. Dr. Hadi Nur
UTM, Malaysia	
	Prof. Dr. Abdullah
UNDIP, Indonesia	
	Prof. Dr. Bakti Jos
UNDIP, Indonesia	
	Prof. Dr. Rochmadi
UGM, Indonesia	
	Dr. Nurul Taufiqurrohman
LIPI, Indonesia	
	Dr. Abdul Halim M. Yusof
UTM, Malaysia	
	Dr. M. A. Zazouli
MUMS, Iran	
	Assoc. Prof. Dr. Masturah Markom
UKM, Malaysia	
	Dr. Shahin Ghafari
UM, Malaysia	
	Dr. Yin Chun Yang
UiTM, Malaysia	
	Dr. Bryan Rey Oliveros
UP, Philippines	
	Dr Arie Arenst Andreas
Parahyangan Catholic University, Indonesia	
	Dr. Shahin Ghafari
University of Malaya	
	Dr. K Kusmiyati
UMS, Indonesia	
	Dr. Hadiyanto
UNDIP, Indonesia	
	Dr. M. Djaeni
UNDIP, Indonesia	
	Dr. Didi Dwi Anggoro
UNDIP, Indonesia	
	Dr Heru Susanto
UNDIP, Indonesia	

	Prof Bambang
UNDIP, Indonesia	Dr. Widayat
UNDIP, Indonesia	Dr. Budiyo
UNDIP, Indonesia	Dr. Istadi
UNDIP, Indonesia	Dr. Ratnawati
UNDIP, Indonesia	Dr. Andri Cahyo Kumoro
UNDIP, Indonesia	



Editor

	Dr. Widayat
UNDIP, Indonesia	Luqman Buchori, ST, MT
UNDIP, Indonesia	Noer Abyor Handayani, ST, MT
UNDIP, Indonesia	

Organizing Committee

The Responsible :	Ir. H. Bambang Pudjianto, MT (Dean of the Faculty of Engineering UNDIP)
Steering committee :	Prof. Ir. Abdullah, MS, PhD Dr.Ir. Ratnawati, MT Dr.Ir. Budiyo, MSi Dr.nat.tech. Siswo Sumardiono
Chair :	Dr. rer.nat. Heru Susanto
Co-chair:	Dr. Andri Cahyo Kumoro
Secretary and Secretariat :	Dr. Nita Aryanti Dessy Ariyanti, ST, MT
Treasurer :	Aprilina Purbasari, ST, MT Yuli Sugarti Erlina Sari Amd
Program :	Dr. Hadiyanto Ir. Diah Susetyo Ratnawati, MT Ir. Indro Sumantri, MSc Aji Prasetyaningrum, ST, MT Harry Permadi Paramarta Siwi R Abraham T Eka Putra Nadhila Sylvianti Herlina Sukmawati Favian Naviega Hamdani Olga Meta Jolanda Indra Hutama Defany Purnamasari Putri Fatkhiyatul Ulya Faris Gustomi Salim Satria Arif Wicaksono Bakrie
Paper and proceedings :	Dr. Widayat Luqman Buchori, ST, MT Noer Abyor Handayani, ST., MT M. Bachtiar Rifai Wahid Hasyim Mudzofar Sofyan Zeno Rizqy Ramadhan
Consumption (Food & drink) :	Dr. Dyah Hesti Wardani Ir. Kristinah Haryani, MT Indah Yuliana

Funding and sponsorship :

Dr. I Nyoman Widiasta
Prof. Ir. Abdullah, MS, PhD
Ir. Danny Soetrisnanto, MEng
Ir. Agus Hadiyanto, MT
Dr. Tutuk Djoko Kusworo
Ir. Nur Rokhati, MT

Publication and Information :

Dr. Istadi
Nur Widayarti

Equipment and Transportation :

Ir. Hargono, MT
Dr. ing. Suherman
Anik Kristi Rahayu, S.Sos
Darto A



PREFACE

This abstract book contains abstracts of research papers presented on International Conference on Chemical and Material Engineering (ICCME) 2012. The ICCME 2012 is organized by Department of Chemical Engineering Diponegoro University along with the opening of the doctoral program in the Department of Chemical Engineering. The conference took place at Grand Candi Hotel, Semarang Indonesia in September 12-13, 2012. It is designed as an international forum on fundamental and application of Chemical and Material Engineering among the researchers, students, industries and government. The ICCME offers a platform for extensive sharing and exchange of ideas, thoughts and discussions on all aspects of Chemical and Material Engineering.

The ICCME 2012 invited 65 keynote speakers from 84 and accepted 70 research papers. There are 4 (four) parallel sessions comprising 4 categories: Bioprocess and Renewable Energy (BRE), Material and Science Development (MSD), Separation and Process Engineering (SPE) and Process System Engineering (PSE). The full research papers can be obtained on the enclosed CD Proceeding with ISBN of 978-602-097-281-7

The organizing committee express our gratitude to the distinguished keynote speakers: Prof. M Ulbricht, Prof Hadi Nur, Prof Purwanto, Ir. Gunung Sardjono, Ir. Hardiono and Ichsan, MSc, PDEng for their participation to this conference. We thank to all participants for their contributions to the Conference Programme, abstract book and conference proceedings. We also express our sincere thanks to the scientific committee for reviewing and evaluating the abstracts.

It is very pleased to acknowledge to the conference sponsors: IKPT, Pertamina Gas, BP Migas, Pura Grup, C-BIORE, MER-C, D-WaRE, BCREC for their financial support to enable this conference to be accomplished.

Cover	1
Scientific and Editorial Board Members	2
Editor	3
Organizing Committee	4
Preface	6
Contents	7
Table of Abstracts	8
Programme Schedule	17
Abstract	
Invited Speakers	21
Oral Presentation	
Bioprocess and Renewable Energy (BRE)	27
Material and Science Development (MSD)	52
Process System Engineering (PSE)	80
Separation and Process Engineering (PSE)	92
Acknowledgement	

Table of Papers

Invited Speakers

- [IS – 01](#) **PROF. DR. MATHIAS ULBRICHT**
UDuE, Germany
- [IS – 02](#) **PROF. DR. PURWANTO**
Diponegoro University, Indonesia
- [IS – 03](#) **IR. R. GUNUNG SARDJONO HADI, MT**
PT Pertamina Gas, Indonesia
- [IS – 04](#) **DRS. HARDIONO, MComm**
BP Migas, Indonesia
- [IS – 05](#) **ICHSAN, MSC, PDENG**
PT Maris Sustainable Indonesia
- [IS – 06](#) **PROF. DR. HADI NUR**
UTM, Malaysia

Oral Presentation

BRE – BIOPROCESS AND RENEWABLE ENERGY

- [BRE – 01](#) **ENZYMATIC HYDROLYSIS OF ALKALINE PRETREATED COCONUT COIR**
Akbarningrum Fatmawati^a, Rudy Agustriyanto^a, Carolina Adhelia^a, Jovita Paulina^a, Yusnita Liasari^b
^a *Chemical Engineering Department, Faculty of Engineering, Surabaya University, INDONESIA*
^b *Faculty of Biotechnology, Surabaya University, INDONESIA*
- [BRE – 02](#) **OPTIMIZATION OF STREPTOMYCES SP.A11 MEDIUM CULTIVATION ON CYCLO(TYROSYL-PROLYL) PRODUCTION USING THE RESPONSE SURFACE METHODOLOGY**
Rofiq Sunaryanto
Center of Biotechnology, Badan Pengkajian dan Penerapan Teknologi (BPPT), INDONESIA
- [BRE – 03](#) **ENHANCEMENT OF BIOMASS PRODUCTION FROM SPIRULINA SP CULTIVATED IN POME MEDIUM**
Hadiyanto, Muhamad Maulana Azimatun Nur, Ganang Dwi H
Center of Biomass and Renewable Energy, Department of Chemical Engineering Diponegoro University, INDONESIA
- [BRE – 04](#) **ETHANOL PRODUCTION FROM NON FOOD TUBERS OF ILES-ILES (AMORPHOPHALLUS CAMPANULATUS) USING HYDROLYZES BY COMMERCIAL ENZYMES (A AND B AMYLASE) AND FERMENTATION BY SACCHAROMICES CEREVISEAE**
Kusmiyati^{a,b}, Asha Tridayana^a, Nurul Widya FP^a, Tri Utami^a
^a *Chemical Engineering Department, Faculty of Engineering, Muhammadiyah Surakarta University INDONESIA*
^b *Renewable Energy Research Centre, Muhammadiyah Surakarta University - Surakarta INDONESIA*
- [BRE – 05](#) **SYNTHESIS OF ZEOLITE PELLETS FROM NATURAL ZEOLITE AND STARCH AS ADSORBENT FOR FUEL GRADE BIOETHANOL PRODUCTION**
Anwar Ma'rif and Neni Damajanti
Chemical Engineering Department, Faculty of Engineering, Muhammadiyah University of Purwokerto, INDONESIA

- BRE – 06** **QUALITY IMPROVEMENT (FIBER CONTENT AND PROTEIN DIGESTIBILITY VALUE) OF CASSAVA PEEL BY FERMENTATION USING TAPE YEAST WITH VITAMIN B SUPPLEMENTATION**
 Wikanastri Hersoelistyorini^a, Cahya S. Utama^b
^a *Food Technology Study Program, University of Muhammadiyah Semarang, INDONESIA*
^b *Department of Animal Feed and Nutrition, Diponegoro University, INDONESIA*
- BRE – 07** **THE DETERMINATION OF SALINITY PROFILE AND NUTRITION (NAH₂PO₄) PROFILE IN UTILIZING NANNOCHLOROPSIS OCLATA TO GAIN MAXIMUM LIPID**
 Elida Purba, Kenjiro Parsaulian Siburian
Chemical Engineering Department, Faculty of Engineering, University of Lampung, INDONESIA
- BRE – 08** **DESIGN PROCESS OF ETHANOL PRODUCTION BY EXTRACTIVE -FERMENTATION TO INCREASE THE YIELD AND PRODUCTIVITY OF ETHANOL**
 Ayu Ratna Permanasari, Ririn Indriani AR, Tri Widjaja, Ali Altway
Chemical Engineering Department, Faculty of Industrial Technology, Sepuluh Nopember Institut of Technology, INDONESIA
- BRE – 09** **TRANSESTERIFICATION OF VEGETABLES OIL USING SUB-AND SUPERCRITICAL METHANOL**
 Nyoman Puspa Asri^{a,d}, Siti Machmudah^{a,b}, Wahyudiono^c, Suprpto^a, Kusno Budikarjono^a, Achmad Roesyadi^a, Mitsuru Sasaki^c, Motonobu Goto^b
^a *Chemical Engineering Department, Industrial Technology Faculty, Sepuluh Nopember Institute of Technology, Surabaya, INDONESIA 60111*
^b *Bioelectrics Research Center, Kumamoto University, JAPAN*
^c *Graduate School of Science and Technology, Kumamoto University, JAPAN*
^d *Chemical Engineering Department, Faculty of engineering, WR Supratman University, Surabaya, INDONESIA*
- BRE – 10** **THE INFLUENCE OF CATALYSTS TO SELECTIVITY OF PRODUCT OF PALM OIL CRACKING**
 Achmad Roesyadi, Danawati Hariprajitno, Nurjannah, Santi Dyah Savitri
Chemical Reaction Engineering Laboratory, Department Of Chemical Engineering Department Of Chemical Engineering, INDONESIA
- BRE – 11** **BIO-LUBRICANTS DEVELOPMENT: POTENTIAL USE OF BORON-CONTAINING ADDITIVES**
 Dicky Dermawan, Dyah Setyo Pertiwi
Chemical Engineering Department, Faculty of Industrial Technology, Itenas, INDONESIA
- BRE – 12** **UTILIZATION POTENCY OF EXTRACELLULAR POLYMERIC SUBSTANCE AS INDUSTRIALS BIOSORBENT AND ION EXCHANGE RESIN**
 Zainus Salimin^a, Pungky Ayu Artiani^a, Junaidi^b, and Wawan^b
^a *Radioactive Waste Technology Center, National Nuclear Energy Agency – BATAN, INDONESIA*
^b *Study Program of Environmental Engineering, Faculty of Engineering, Diponegoro University, INDONESIA*
- BRE – 13** **IMMOBILIZATION OF COW RUMEN FLUID CELLULASE BY ENTRAPMENT IN CALCIUM ALGINATE BEADS**
 Indah Hartati^a, Laeli Kurniasari^a, and Agnes Budiarti^b
^a *Department of Chemical Engineering, Faculty of Engineering, Wahid, INDONESIA*
^b *Department of Pharmacy, Faculty of Pharmacy, Wahid Hasyim University, INDONESIA*
- BRE – 14** **OPTIMIZATION PROCESS OF BIODIESEL PRODUCTION FROM NYAMPLUNG SEED (CALOPHYLLUM INOPHYLLUM L) USING IN SITU PROCESS AND ULTRASONIC ASSISTED**
 Widayat, Abdullah, Kanevi Octova Paradita and Elsanta Monaliza Tungga D
Department of Chemical Engineering Faculty of Engineering Diponegoro University, INDONESIA
- BRE – 15** **EFFECT OF PHENYLACETIC ACID ADDITION ON PRODUCTIVITY OF PENICILLIUM CHRYSOGENUM IN PENICILLIN G PRODUCTION USING PILOT SCALE REACTOR**
 Amila Pramisandi, Rofiq Sunaryanto, Suyanto
Center for the Application of Biotechnology, BPPT, INDONESIA
- BRE – 16** **STUDY OF ENZYMATIC HYDROLYSIS OF DILUTE ACID PRETREATED COCONUT HUSK**
 Rudy Agustriyanto, Akbarningrum Fatmawati, Maria Angelina, Raissa Monica
Surabaya Unversity, INDONESIA

- BRE – 17** **KINETICS OF ETHANOL PRODUCTION FROM WHEY BY FERMENTATION USING KLUYVEROMYCES MARXIANUS**
 Dessy Ariyanti^{ab}, Desiyantri Siti Pinundi^a, Apsari Puspita Aini^a, Hadiyanto^{ab}, Djoko Murwono^a
^a *Chemical Engineering Department, Faculty of Engineering, Diponegoro University, INDONESIA*
^b *Center of Biomass and Renewable Energy (C-BIORE), Faculty of Engineering, Diponegoro University, INDONESIA*
- BRE – 18** **POTENTIAL OF SO₄²⁻ / ZnO ACID CATALYST FOR HETEROGENEOUS TRANSESTERIFICATION OF VEGETABLE OIL TO BIODIESEL**
 I. Istadi, Didi D Anggoro, Luqman Buchori, Inshani Utami, and Roikhatus Solikhah
Laboratory of Energy and Process Engineering, , Chemical Reaction Engineering an Catalysis Group, Department of Chemical Engineering, Diponegoro University, INDONESIA
- BRE – 19** **A SIMPLE METHOD FOR EFFICIENT EXTRACTION AND SEPARATION OF C-PHYCOCYANIN FROM SPIRULINA PLATENSIS**
 Noer Abyor Handayani^{ab}, Hadiyanto^{ab}, Melinda^a, Inggar^a, Amin Nugroho^a
^a *Chemical Engineering Department, Faculty of Engineering, Diponegoro University, INDONESIA*
^b *Center of Biomass and Renewable Energy (C-BIORE), Faculty of Engineering, Diponegoro University, INDONESIA*
- BRE – 20** **STUDY ON SLAUGHTERHOUSE WASTES POTENCY AND CHARACTERISTIC FOR BIOGAS PRODUCTION**
 Budiyo^a, I Nyoman Widiasta^a, Seno Johari^b, Sunarso^c
^a *Department of Chemical Engineering, Diponegoro University, INDONESIA*
^b *Faculty of Animal Science and Agriculture, Diponegoro University, INDONESIA*
- BRE – 21** **STUDY ON PRODUCTION PROCESS OF BIODIESEL FROM RUBBER SEED (HEVEA BRASILIENSIS) BY IN SITU TRANSESTERIFICATION METHOD WITH ALKALINE CATALYZED**
 Widayat^{a,b}, Agam Duma Kalista Wibowo^a, Hadiyanto^{a,b}
^a *Magister of Chemical Engineering, Diponegoro University, INDONESIA*
^b *Central of Biomass and Renewable Energy, INDONESIA*
- BRE – 22** **THERMOGRAVIMETRY CHARACTERISTICS OF MSW CHAR BRIQUETTE COMBUSTION**
 Dwi Aries Himawanto^a, Indarto^b, Harwin Saptoadi^b, Tri Agung Rohmat^b
^a *Mechanical Engineering Department Faculty of Engineering, Sebelas Maret University, INDONESIA*
^b *Mechanical and Industrial Engineering Department Faculty of Engineering, Gadjah Mada University, INDONESIA*
- BRE – 23** **PERFORMANCE OF SULFONATED POLY ETHER-ETHER KETONE (SPEEK) AND NAFION MEMBRANE IN PALM OIL MILL EFFLUENT MICROBIAL FUEL CELL**
 Nur Dianaty Nordina Abdul Halim Mohd Yusof^{a,b,c}, Ahmad Fauzi Ismail^{a,d}, Mohd Noorul Anam Mohd Norddin^{a,d}
^a *Faculty of Chemical Engineering, Universiti Teknologi Malaysia, MALAYSIA*
^b *Advanced Membrane Technology Research Centre, Universiti Teknologi Malaysia, MALAYSIA*
^c *Department of Biology, Massachusetts Institute of Technology, UNITED STATES OF AMERICA*
^d *Faculty of Petroleum and Renewable Engineering, Universiti Teknologi Malaysia, MALAYSIA.*
- BRE – 24** **SURFACE MODIFICATION OF POLYETHERSULFONE WITH POLYVINYLPIRROLIDONE-IODINE VIA PHASE INVERSION AND UV PHOTOGRATING FOR ANTIBACTERIAL APPLICATIONS**
 Abdul Halim Mohd Yusof^{a,b}, Devanai Kannan^a
^a *Department of Bioprocess Engineering, Faculty of Chemical Engineering;Universiti Teknologi Malaysia, MALAYSIA*
^b *Department of Biology, Massachusetts Institute of Technology, UNITED STATES of AMERICA*
- BRE – 25** **ESTERIFICATION OF JATROPHA OIL TO BIODIESEL OVER SiO₂-PHOSPHOTUNGSTIC ACID HETEROGENEOUS CATALYST**
 Nur Hidayati, Aning Tri Aisyah, Ike Sambung Sari and Prinda Widayari
Chemical Engineering Department, Universitas Muhammadiyah Surakarta, INDONESIA

- [MSD – 01](#) **CHARACTERIZATION OF SAGO STARCH AND STUDY OF LIQUEFICATION PROCESS ON HIGH FRUCTOSE SYRUP PRODUCTION**
Anastasia Prima Kristijarti, Tony Handoko, Cindy Adelia, Lucy Andrea
Chemical Engineering Department, Faculty of Industrial Engineering, Parahyangan Catholic University, INDONESIA
- [MSD – 02](#) **POLYMER SOLAR CELLS: EFFECTS OF ANNEALING TREATMENT AND POLYMER BLENDS ON I-V CHARACTERISTICS**
Erlyta Septa Rosa and Shobih
Research Center for Electronics and Telecommunication, Indonesian Institute of Sciences (PPET-LIPI), INDONESIA
- [MSD – 03](#) **THE OPTIMIZATION OF DIPHENYL METHANE DIISOCYANATE POLYMERIZATION PROCESS WITH THE USED FRYING OIL POLYALCOHOL TO FOAM POLYURETHANE USING RSM**
Faleh Setia Budi^a and Didi Dwi Anggoro^b
^a *Food Science and Technology Department, Faculty of Agricultural Engineering and Technology, IPB, INDONESIA*
^b *Chemical Engineering Department, Engineering Faculty UNDIP, INDONESIA*
- [MSD – 04](#) **NUMERICAL ANALYSIS OF A JOURNAL BEARING WITH CHEMICAL ROUGHNESS**
Mohammad Tauviqirrahman^{a,b}, Muchammad^a, Jamari^b, and Dik J. Schipper^a
^a *Laboratory for Surface Technology and Tribology, Faculty of Engineering Technology, University of Twente, THE NETHERLANDS*
^b *Department of Mechanical Engineering, University of Diponegoro, INDONESIA*
- [MSD – 05](#) **INVESTIGATION ON CENTRIFUGAL PUMP SHAFT: A COMPARISON STUDY OF THE SME AND THE IMPORTED PRODUCT**
Rifky Ismail, Sugiyanto, Mohammad Tauviqirrahman and Jamari
Mechanical Engineering Department, Faculty of Engineering, Diponegoro University, Jl. Prof Sudharto, SH-Tembalang, Semarang INDONESIA
- [MSD – 06](#) **PREPARATION OF NANOPARTICLE SILICA FROM SILICA SAND AND QUARTZITE BY ULTRAFINE GRINDING**
Agus Wahyudi^a, Teguh Nurasi^b And Siti Rochani^a
^a *R&D Centre for Mineral and Coal Technology, INDONESIA*
^b *Department of Chemistry, University of Jenderal Achmad Yani, INDONESIA*
- [MSD – 07](#) **APPLICATION OF TIO₂ FOR SELF CLEANING IN WATER BASED PAINT WITH POLYETHYLENE GLYCOL (PEG) AS DISPERSANT**
Nining Kusmahetiningsih, Dyah Sawitri
Departement of Engineering Physics, Faculty of Industrial Engineering, Sepuluh Nopember Institute of Technology, INDONESIA
- [MSD – 08](#) **USING SELF CLEANING TIO₂ PHOTOCATALYST IN THE MAKING OF CERAMIC TILES TO DECREASE AMMONIUM CONCENTRATION AND BACTERIUM GROWTH**
Ana Hidayati M^a, Sri Darmawati^a, Muh. Amin^b
^a *Health Analyst Department, Nursing and Health Faculty, University of Muhammadiyah Semarang, INDONESIA*
^b *Mechanical Engineering Department, Engineering Faculty, University of Muhammadiyah Semarang, INDONESIA*
- [MSD – 09](#) **THE EFFECT OF POLYANILINE ADDITION ON THE PROPERTIES OF CARBON-BASED POLYPROPYLENE COMPOSITE**
Lies A. Wisojodharmo, Dewi Kusuma Arti, Niya Listiani Dewi
Center for Materials Technology, Agency for the Assessment and Application Technology (BPPT), INDONESIA

- MSD – 10** **COMPUTATIONAL ANALYSIS OF WALL SLIP AND CAVITATION IN LUBRICATED SLIDING SYSTEMS**
 Muchammad^a, M. Tauviquirrahman^a, J. Jamari^b, and D.J. Schipper^a
^a *Laboratory for Surface Technology and Tribology, Faculty of Engineering Technology, University of Twente, THE NETHERLANDS*
^b *Department of Mechanical Engineering, University of Diponegoro, INDONESIA*
- MSD – 11** **FRICTION ANALYSIS ON SCRATCH DEFORMATION MODES OF VISCO-ELASTIC-PLASTIC MATERIALS**
 Budi Setiyana^a, I. Syafaat^a, J. Jamari^b, and D.J. Schipper^a
^a *Laboratory for Surface Technology and Tribology, Faculty of Engineering Technology, University of Twente, THE NETHERLANDS*
^b *Department of Mechanical Engineering, University of Diponegoro, INDONESIA*
- MSD – 12** **PREDICTION OF SLIDING WEAR OF ARTIFICIAL ROUGH SURFACES**
 Imam Syafa'at^a, Budi Setiyana^a, Rifky Ismail^a, Eko Saputra^a, J. Jamari^b, D.J. Schipper^a
^a *Laboratory for Surface Technology and Tribology, Faculty of Engineering Technology, University of Twente, THE NETHERLANDS*
^b *Department of Mechanical Engineering, University of Diponegoro, INDONESIA*
- MSD – 13** **THE APPLICATION OF B-CYCLODEXTRIN AND POLYETHYLENE GLYCOL 6000 IN THE MICRONISATION OF DRUG – POLYMER COMPOSITE WITH PARTICLE FROM GAS SATURATED SOLUTIONS (PGSS) METHOD**
 Putu Riani Pradnyandari, Rizky Tetrisyanda, Prida Novarita Trisanti, Firman Kurniawansyah, and Sumarno
Chemical Engineering Department, Faculty of Industrial Technology, Institute of Technology Sepuluh Nopember (ITS), INDONESIA
- MSD – 14** **THE EFFECT OF SONICATION ON THE CHARACTERISTIC OF CHITOSAN**
 Azra Yuliana, Linggar S. Pradeckta, Emma Savitri, Anita R. Handaratri, Sumarno
Chemical Engineering Department, Faculty of Industry Technology, Sepuluh Nopember Institut of Technology Surabaya, INDONESIA
- MSD – 15** **EFFECTS OF CHAIN EXTENDER TO THE STRUCTURE OF CASTOR OIL-BASED POLYURETHANE FOAM**
 Edhi Pratondo, Adityo Wahyu Hanggoro, Eva Oktavia Ningrum, Sumarno
Chemical Engineering Department, Faculty of Industrial Technology, Sepuluh Nopember Institute of Technology, INDONESIA
- MSD – 16** **THE SYNTHESIS OF CARBOXYMETHYL AMYLOSE GRAFTED POLYACRYLAMIDE AND ITS APPLICATION IN DRUG RELEASE ASPIRIN**
 Noor Hidayati, Naila Amanda, Karsono Samuel Padmawijaya, Firman Kurniawansyah, and Sumarno
Chemical Engineering Department, Faculty of Industry Technology, Sepuluh Nopember Institut of Technology Surabaya, INDONESIA
- MSD – 17** **EFFECT OF TWEEN 80'S EMULSIFIER CONCENTRATION WITH SPONTANEOUS DIFFUSION METHOD ON STABILITY SOLUTION TEGERAN'S NANOEMULSION NATURAL DYES**
 Heny Herawati^a, Sri Yuliani^a, Meika Syahbana Rusli^b, Ratih Purnamasari^b
^a *Indonesia Center For Agricultural Postharvest Research and Development, INDONESIA*
^b *Bogor Agricultural University, Agricultural Technology Faculty, IPB, INDONESIA*
- MSD – 18** **NANO CRYSTALLINE STARCH AND ITS ALTERNATIF IMPLEMENTATION**
 Heny Herawati
Indonesia Center For Agricultural Postharvest Research and Development, INDONESIA
- MSD – 19** **COMPOSITE SPEEK WITH NANOPARTICLES FOR FUEL CELL'S APPLICATIONS: REVIEW**
 Arief Rahman Hakim
Department of Chemical Engineering, Diponegoro University, INDONESIA
- MSD – 20** **COMPARISON ON MODELLING OF DRYING KINETICS OF GRANULAR POLYMERS PA6 BY DIFFUSION MODELS AND NORMALIZATION METHOD**
 Suherman^a, Mirko Peglow^b, and Evangelos Tsotsas^b
^a *Chemical Engineering Department, Faculty of Engineering, Diponegoro University, Jl. Prof Sudharto, SH-Tembalang, Semarang, INDONESIA*
^b *Thermal Process Engineering, Otto-von-Guericke-University, Universitätsplatz 2, 39106 Magdeburg, GERMANY*

- MSD – 21 **CURRENT DENSITY PERFORMANCES IN POLY ETHER ETHER KETON MEMBRANE FOR DIRECT METHANOL FUEL CELLS**
Tutuk Djoko Kusworo^a, E. L. Dewi^b, D. K. Arti^a, A. Dhuhita^a, A. Fauzi Ismail^c and M.N.A. Mohd Norddin^c
^a *Chemical Engineering Department, Engineering Faculty, Diponegoro University, INDONESIA*
^b *Agency of Assessment and Application of Technology*
^c *Advanced Membrane Technology Research Centre, Faculty of Chemical and Natural Resources Engineering, Universiti Teknologi Malaysia, MALAYSIA*
- [MSD – 22](#) **PREPARATION AND CHARACTERIZATION OF ZEOLITE MEMBRANE**
Aprilina Purbasari^a, Titik Istirokhatun^b, Heny Kusumayanti^a, Ariestya M. Devi^a, Lulluil Mahsunah^a, Heru Susanto^a
^a *Chemical Engineering Department, Faculty of Engineering, Diponegoro University, INDONESIA*
^b *Environmental Engineering Department, Faculty of Engineering, Diponegoro University, INDONESIA*
- MSD – 23 **EFFECT OF SOIL BURIAL ON THE MECHANICAL PROPERTIES OF HEAT TREATED AND UNTREATED RED BALAU SAW DUST FILLED LDPE COMPOSITES.**
Ruth Anayimi Lafia-Araga, Aziz Hassan, Rosiyah Yahya, Normasmira Abd. Rahma
Chemistry Department, Faculty of Science, University of Malaya, Malaysia
- MSD – 24 **IMPACT AND DSC PROPERTIES OF HEAT TREATED AND UNTREATED RED BALAU (SHOREA DIPTEROCARPACEAE)/LDPE COMPOSITES**
Aziz Hassan, R.A. Lafia-Araga, R. Yahaya and N.A. Rahman
Department of Chemistry, University of Malaya, Malaysia
- MSD – 25 **COMPUTATION OF INTERFACIAL SHEAR STRENGTH AND OTHER TENSILE RELATED PROPERTIES OF INJECTION MOULDED CARBON FIBRE/POLYAMIDE 6,6**
Rosiyah Yahya, Aziz Hassan, Zulkifli Abu Hasan
Department of Chemistry, University of Malaya, 50603 Kuala Lumpur, MALAYSIA.
- MSD – 26 **IMPACT PROPERTIES OF INJECTION MOULDED ARAMID/CARBON HYBRID FIBRE REINFORCED POLYPROPYLENE COMPOSITES**
MIM Rafiq and Aziz Hassan
Department of Chemistry, University of Malaya, MALAYSIA
- MSD – 27 **HARDNESS OF CONTINUOUS HARD ANODIZING OF ALUMINIUM 6061 AFFECTED BY VOLTAGE AND TIME PROCESS USING TITANIUM CATHODE**
Endi Sutikno, Ellen Desta Purwanendra, Putu Hadi Setyarini
Mechanical Engineering Department, Brawijaya University, INDONESIA
- MSD – 28 **SURFACE CHARACTERISTICS OF ALUMINIUM HARD ANODIZING USING TITANIUM CATHODE**
Putu Hadi Setyarini, Riviero Givenchy, Endi Sutikno
Mechanical Engineering Department, Brawijaya University, INDONESIA
-

PSE – PROCESS AND SYSTEM ENGINEERING

- [PSE – 01](#) **THE PROCESS TRANSPORT OF DRYING CORN WITH MIXED-ADSORPTION DRYING**
Mohamad Djaeni, Luqman Buchori
Chemical Engineering Department, Faculty of Engineering, Diponegoro University, INDONESIA
- [PSE – 02](#) **SIMULATION OF DUPLEX HEAT TREATMENT NB3SN COMPOUNDS IN CU-NB-SN SUPERCONDUCTING MULTIFILAMENTARY WIRE**
Andini Nur Vania Swari, Arimaz Hangga, Doty Dewi Risanti
Department of Engineering Physics, Faculty of Industrial Technology, ITS, INDONESIA

- PSE – 03** **INVENTORY ANALYSIS OF RADIOLOGICAL FOR GRAPHITE THERMAL COLUMN FROM TRIGA MARK II REACTOR, BANDUNG**
Mulyono Daryoko
Radioactive Waste Technology Center, BATAN, INDONESIA
- PSE – 04** **DYNAMIC SIMULATION AND COMPOSITION CONTROL IN A 10 L MIXING TANK**
Yulius Dedy Hermawan
Chemical Engineering Department, Faculty of Industrial Technology, UPN “Veteran” Yogyakarta, INDONESIA
- PSE – 05** **THE EFFECT OF LOADING ON THE CONTACT STRESS OF UHMWPE MATERIAL FOR ARTIFICIAL HIP JOINT BEARING**
Eko Saputra^a, Rifky Ismail^a, Jamari^a and Iwan Budiwan Anwar^b
^a *Laboratory for Engineering Design and Tribology, Department of Mechanical Engineering, University of Diponegoro, INDONESIA*
^b *Orthopaedic Hospital dr. Soeharso, Solo, INDONESIA*
- PSE – 06** **SIMULATION OF COUNTER BLOW PROCESS OF PBL QUARTZ BOTTLE FABRICATION**
Arimaz Hangga, Lizda Johar Mawarani, Doty Dewi Risanti
Department of Engineering Physics, Faculty of Industrial Technology, Institut Teknologi Sepuluh Nopember, INDONESIA
- PSE – 07** **CADMIUM METALS PARTICLES-COVERED POLYSTYRENE NANOSPHERES THIN FILM MATERIAL:FABRICATION, ANALYSIS AND MODEL**
Pratama Jujur Wibawa^{a,b,c}, Hashim Saim^d, Moh^d. Arif Agam^d and Hadi Nur^e
^a *Microelectronic and Nanotechnology-Shamsuddin Research Center (MiNT-SRC), Universiti Tun Hussein Onn Malaysia, MALAYSIA*
^b *Department of Chemistry, Faculty of Science, Technology and Human Development Universiti Tun Hussein Onn Malaysia, MALAYSIA*
^c *Department of Chemistry, Faculty of Sciences and Mathematics (formerly Faculty of Mathematics and Natural Sciences), INDONESIA*
^d *Department of Physics, Faculty of Sciences, Technology and Human Development, Universiti Tun Hussein Onn Malaysia, MALAYSIA*
^e *Ibnu Sina Institute for Fundamental Science Studies, Universiti Teknologi Malaysia, MALAYSIA*
- PSE - 08** **DISTRIBUTION TEMPERATURE OF ANALYSIS ON CH4-CO2 GAS MIXED IN DOUBLE PIPE HEAT EXCHANGER BY CONTROLLED FEEZE OUT AREA METHODE**
Fatma Y. Hasyim, Novi E. Mayangsari, and Sumarno
Material of Laboratory
Chemical Engineering Department, Faculty of Industry Technology, Sepuluh Nopember Institut of Technology Surabaya, INDONESIA
- PSE – 09** **SIMULATION ON THE ACTIVITY OF BIOMASS IN ACTIVATED SLUDGE IN THE PERFORMANCE OF NON IDEAL FLOW MEMBRANE BIOREACTOR SUBMERGED**
Aisyah Endah Palupi
Mechanical Engineering Department, Engineering Faculty, State University of Surabaya 60231 – INDONESIA
- PSE – 11** **EFFICACY AND HEAT TRANSFER EFFECTS OF ARTOCARPUS ALTILIS MALE INFLORESCENSE AS MOSQUITO VAPORIZING MATS**
Muhammad Khamim Asy’Ari^a, Nadhifa Maulida^a, Wilujeng Fitri Alfiah^a, Aisyiah Nur Isaneni^a Titin Yulia Riska^a, and Doty Risanti^b
^a *Metrology and Instrumentation Diploma III Dept. of Engineering Physics Faculty of Industrial Engineering Institut Teknologi Sepuluh Nopember Surabaya, INDONESIA* .
^b *Dept. of Engineering Physics Faculty of Industrial Engineering Institut Teknologi Sepuluh Nopember Surabaya, INDONESIA* .

- [PSE – 12](#) **SELECTION OF NATURAL DYE PHOTOSENSITIZER FOR QUASI-SOLID STATE DYE-SENSITIZED MESOPOROUS TiO₂ SOLAR CELL (DSC) FABRICATION**
Ruri Agung Wahyuono, Doty Dewi Risanti
Department of Engineering Physics, Institut Teknologi Sepuluh Nopember Surabaya, INDONESIA
- [PSE – 13](#) **AN INVESTIGATION OF CHAR FORMATION AND SHRINKING VOLUME BY VISUALIZATION TECHNIQUE INDUCED BY PYROLYSIS**
Widya Wijayanti
Mechanical Engineering Department, Brawijaya University, INDONESIA
-

SPE – SEPARATION PROCESS ENGINEERING

- [SPE – 01](#) **UTILIZATION OF COAL FLY ASH AS CO GAS ADSORBENT**
Ayu Lasryza, Dyah Sawitri
Department of Engineering Physics, Faculty of Industrial Technology, ITS, INDONESIA
- [SPE – 02](#) **PHENOL REMOVAL FROM AQUEOUS SOLUTIONS BY ELECTROCOAGULATION TECHNOLOGY USING IRON ELECTRODES: EFFECT OF SOME VARIABLES**
Mohammad Ali Zazouli^a, Mahmoud Taghavi^b
^a *Department of Environmental Health Engineering, Faculty of Health and Health Sciences Research Center, IRAN*
^b *Department of Environmental Health Engineering, Faculty of Health and Health Sciences Research Center, IRAN*
- [SPE – 03](#) **THE OFF GAS TREATMENT IN THE PROCESS OF VITRIFICATION AND INCINERATION OF NUCLEAR WASTE**
Herlan Martono, Aisyah
Radioactive Waste Technology Centre, BATAN, INDONESIA
- [SPE – 04](#) **ESSENTIAL OIL EXTRACTION OF FENNEL SEED (FOENICULUM VULGARE) USING STEAM DISTILLATION**
Astrilia Damayanti and Eko Setyawan
Chemical Engineering Department, Faculty of Engineering, Semarang State University, INDONESIA
- [SPE – 05](#) **PREPARATION AND CHARACTERIZATION OF NANOFILTRATION MEMBRANE FOR WATER TREATMENT**
Tutuk Djoko Kusworo, Eka Cahya Muliawati and Ardian Dwi Yudhistira
Department of Chemical Engineering, Diponegoro University, INDONESIA
- [SPE – 06](#) **THE APPLICATION OF NITROGEN LASER ON EXTRACTION OF URANIUM IN THE LONG LIFE OF HIGH LEVEL RADIOACTIVE LIQUID WASTE USING TBP-KEROSENE SOLVENT**
Gunandjar
Radioactive Waste Technology Center, National Nuclear Energy Agency of Indonesia (BATAN), INDONESIA
- [SPE – 07](#) **EFFECT OF PH AND STIRRING SPEED ON THE COLLAGENOUS PROTEIN EXTRACTION FROM CHICKEN BONE WASTE IN A WELL AGITATED EXTRACTION SYSTEM**
Andri Cahyo Kumoro, Beatrice L. M. Tanjung, Fadilla H. Utami, Diah Susetyo Retnowati and Catarina Sri Budiayati
Department of Chemical Engineering, Diponegoro University, INDONESIA
- [SPE – 08](#) **DRYING OF CURCUMA (CURCUMA XANTHORRHIZA ROXB) USING DOUBLE PLATE COLLECTOR SOLAR DRYER**
Tjukup Marnoto, Mahreni, Wasir Nuri, Bayu Ardinanto, Ratna E. Puspitasari
Chemical Engineering Department, Faculty of Industrial Technology, UPN "Veteran" Yogyakarta University, INDONESIA

- SPE – 09 SOLUBILITY EXAMINATION OF PALM KERNEL OIL IN SUPERCRITICAL CO₂ AND ITS CORRELATION WITH SOLVENT DENSITY BASED MODEL**
 Wahyu Bahari Setianto^a, Priyo Atmaji^b and Didi Dwi Anggoro^b
^a Center for Agroindustrial Technology, Agency for the Assessment and Application of Technology, INDONESIA
^b Department of Chemical Engineering, Diponegoro University, INDONESIA
- SPE – 10 Oil Extraction Process From Solid Waste Rubber Seed By Soxhletation and Extraction Solvent by Stirring Methods**
 Achmad Wildan, Devina Ingrid A, Indah Hartati
 Sekolah Tinggi Ilmu Farmasi “Yayasan Pharmasi” Semarang
 Jl. Sarwo Edhie Wibowo Km. 1 Plamongansari, Pucanggading Semarang INDONESIA
- SPE – 11 FOULING AND REJECTION BEHAVIOUR OF ULTRAFILTRATION FOR OIL IN WATER EMULSION SEPARATION**
 Nita Aryanti^a, Agus Hadiyanto^a, Wiharyanto Oktiawan^b
^a Chemical Engineering Department, Diponegoro University, INDONESIA
^b Environmental Engineering Department, Diponegoro University, INDONESIA
- SPE – 12 THE EFFECT OF CHEMICAL ADDITIVES ON MOBILITY OF HEAVY METALS (PB, CD AND ZN) IN SOIL**
 Abdoliman Amouei^a, Amirhossein Mahvi^b, Masoumeh Tahmasbizadeh^b, Mohammad Ali Zazouli^c
^a Department of Environmental Health Engineering, Babol University of Medical Sciences, IRAN
^b Department of Environmental Health Engineering, Tehran University of Medical Sciences, IRAN
^c Department of Environmental Health Engineering, Faculty of Health and Health Sciences Research Center, Mazandaran University of Medical Sciences, IRAN
- SPE – 13 CHARACTERISTICS OF HOSPITAL WASTEWATER IN BABOL UNIVERSITY OF MEDICAL SCIENCES AND EFFECTS ON THE ENVIRONMENT**
 Abdoliman Amouei^a, Hosseinali Asgharnia^a, Hourieh Fallah^a, Aliakbar Mohammadi^a, Mohammad Ali Zazouli^b
^a Department of Environmental Health Engineering, Babol University of Medical Sciences, IRAN.
^b Department of Environmental Health Engineering, Faculty of Health and Health Sciences Research Center, Mazandaran University of Medical Sciences, Sari, IRAN
- SPE – 14 QUANTITY AND QUALITY OF SOLIDWASTES IN THE HOSPITALS OF BABOL UNIVERSITY OF MEDICAL SCIENCES, NORTH OF IRAN**
 Abdoliman Amouei^a, Masoumeh Tahmasbizadeh^b, Hosseinali Asgharnia^a, Hourieh Fallah^a, Aliakbar Mohammadi^a, Mohammad Ali Zazouli^c
^a Department of Environmental Health Engineering, Babol University of Medical Sciences, IRAN
^b Department of Environmental Health Engineering, Tehran University of Medical Sciences, IRAN
^c Department of Environmental Health Engineering, Faculty of Health and Health Sciences Research Center, Mazandaran University of Medical Sciences, IRAN
- SPE – 15 EVALUATION OF PHENOL REMOVAL FROM AQUEOUS SOLUTIONS BY AZZOLA**
 Davaud Balarak^a, Mohammad Ali Zazouli^b
^a University Mazandaran – Sari, IRAN
^b Department of Environmental Health Engineering, Faculty of Health and Health Sciences Research Center, Mazandaran University of Medical Sciences, IRAN
- SPE – 16 SILICA EXTRACTION FROM BAGGASE FLY ASH WITH ALKALI FUSION METHOD**
 Galuh Pinayungan, Arif Hidayat, Chandra Wahyu Purnomo, Arief Budiman
 Process System Engineering Research Group, Chemical Engineering Department, Gadjah Mada University, INDONESIA
-

Enhancement of Biomass Production from *Spirulina* sp Cultivated in POME Medium

Hadiyanto, Muhamad Maulana Azimatun Nur, and Ganang Dwi Hartanto

Center of Biomass and Renewable Energy
Department of Chemical Engineering Diponegoro University,
Jl. Prof Soedarto Tembalang Semarang. Phone: (024) 7460058
E-mail : h.hadiyanto@undip.ac.id

Abstract :

Indonesia is the largest producer coconut palm oil in the world. As increasing in production, the palm oil mill effluent are also produced in about 66% by FFB (Fresh Fruit Bunch). Palm oil mill effluent is usually processed by a traditional aerobic open lagoon or by anaerobic digestion. POMED (palm oil mill effluent digested) has a high nutrient content and it can be used as medium for microalgae cultivation. *Spirulina* sp is a kind of cyanobacteria contains high protein and a potential product for animal feed. This research purpose is to find optimum saving synthetic nutrient of *Spirulina* sp cultivated in POMED and to find optimum POMED concentration used for algae cultivation. Research was done in two steps. First step, *Spirulina* sp was cultivated in 20% POMED concentration with different saving nutrient (0%, 20%, 50%, 70%, and 90%). At second step, *Spirulina* sp was cultivated in different POMED concentration (10%, 20%, 30%, 40%, 50%, 60% v/v) for 16 days. At first 8 days, nutrient was added to medium. At second 8 days, the nutrient was not added to medium.. Optical density was monitored every day using spectrophotometer with wave length 680nm. At the end of cultivation, medium was filtered to obtain wet biomass (10% Total suspended solid). *Spirulina* sp can grow well in 20% POMED, save 50% from synthetic nutrient, and produced 5.93gr/l wet biomass for 9 days. Research was continued without adding nutrient and produced optimum biomass 9.8gr/l in 40% POMED for 13 days.

Keywords: optimum biomassa, POMED, saving synthetic nutrient, *Spirulina* sp

1. Introduction

Indonesia is the largest producer coconut palm in the world. In 2008, Indonesia produced 44% coconut palm shared demand from around the world [1]. At 2005 to 2008, the production obtained up to 8.88%. It is predicted that the production will grow in about 5.22% per annum (about 28.439 thousand tons) at 2010 to 2014. The fresh fruit bunch has a potentio to be a palm oil mill effluent converted from FFB 66% along in process of palm oil.

Table 1. Commodities of Indonesia agriculture 2010-2014

Comodities	Year					Growth rate (%) / annum
	2010	2011	2012	2013	2014	
Coconut Palm	23.200	24.429	25.046	27.046	28.439	5.22
Rubber	2.681	2711	2741	2771	2801	1.10
Coconut	3.266	3290	3.317	3.348	3.380	0.86

Source: deptan, 2009 [2]

Almost of waste water coconut palm oil industries in Indonesia is processed in traditional open lagoon aerobic to decrease COD and BOD content. POME (Palm mill oil effluent) has organic matter, nitrogen, phosphorus, and minerals [3, 4]. This waste water can be used as source of microalgae medium after treated using bacteria activity in aerobic or anaerobic process [5].

The research in POMED (Palm Mill Oil Effluent Digested) as medium of *Chlorella vulgaris* was done by Habib et al [5] for Zoo plankton *Moina micrura* at 10% concentration of POMED and the product contains high PUFA, EAA and essential mineral. Another research, Mayangsari [6], was reported that *S. platensis* will need more time to obtain optimum growth if higher POME concentration is used as medium cultivation. Optimum growth *S. platensis* was obtained in 50% POME concentration and needs 134 days. The research was not purposed to obtain high biomass and save synthetic nutrient substituted with POME.

Research of POMED as medium substitution for synthetic nutrient is still low. Last research, Permatasari [7], reported that *S. platensis* can grow in 90% POME and use 10% synthetic nutrient in photobioreactor and produces 0.267gr/l dry biomass in two weeks. The biomass is still low. In another related research, *S. platensis* was cultivated in soybean waste and obtain 0.9gr/l dry biomass in 5% concentration by modified CNP ratio of synthetic

medium [8]. This research is potential if applied in POME, but there is problem in using low waste concentration. This research is purposed to find optimum saving synthetic nutrient as substituent of POMED medium and to obtain optimum biomass using different POMED.

Table 2. Characteristic POME and POMED (*All in ppm except pH [4,5])

Parameter*	POME	POMED
pH	3.91-4.9	4-6
COD	83356	21227.5
TSS	49233.57	4798.5
Total N	1494.66	456
NH ₃ -N	50.42	34.2
PO ₄ -P	315.36	68.4
C:N:P Ratio	99.12: 4.74:1.0	116.37: 6.67:1.0

2. Material and Methods

2.1. POMED Waste

POMED waste was collected from PTPN 7 Lampung in 4th open pond lagoon. The waste then filtered to separate impurities.

2.2. *Spirulina sp*

Spirulina sp was collected from BPPT Jepara and cultivated in Bioprocess laboratory UNDIP. Algae was acclimated in 20% POME medium for 14 days. *Spirulina sp* is used as inoculum at 0.5 OD₆₈₀.

2.3. Growth Condition

Control synthetic nutrient was modified from Bangladesh synthetic nutrient No.3 [9] : 1gr/l NaHCO₃, 50 ppm Urea, 10 ppm TSP and 50mcg/l B12 Vitamin. *Spirulina sp* was cultivated in 1L flask disk and agitated using aquarium water pump aeration. pH was adjusted in 9-10.5. Source of light was from flourescent lamp 4000-6000 lux intensity.

2.4. First Experiment

First experiment is purposed to cultivate *Spirulina sp* using 20% POMED at different saving synthetic nutrient (0%, 20%, 50%, 70%, 90%). The cultivation was done in 7 days.

2.5. Second Experiment

Second experiment is purposed to cultivate *Spirulina sp* in different POMED concentration (10%, 20%, 30%, 40%, 50%, 60%) and using optimum nutrient obtained from first experiment. The research was done in 16 days. At first 8 days, nutrient was added to medium. At second 8 days, the nutrient was not added to medium.

2.6. Measurement

Measurement was started from 0 day using spectrophotometer SP-300 wave length 680nm. Medium was measured in every day. Biomass was collected in second experiment, from first 8th days and 16th days by using filter cloth. Wet Biomass was recorded as 90% moisture content (10% Total Suspended Solid). Carbon, Nitrogen, and Phosphor was measured by Benfield and Randal method [10]

3. Result and Discussion.

3.1. Saving Syntheric Nutrient

At first experiment, *Spirulina sp* was cultivated in 20% POMED using different nutrient composition. Control medium is medium I, using fresh water and without reduce synthetic nutrient. The medium is measured by using optical density OD₆₈₀ and obtained optimum growth rate from IV medium (50% reduction), followed by V medium (70% reduction) III (20% reduction), VI (90% reduction) and II (without reducing nutrien).

Habib et al. [4] explained that raw POME contains CNP ratio (weight) 99,12:4,7:1,0. Algae needs CNP ratio to grow 56:9:1 [3]. POMED used as 20% medium contains CNP ratio 19.2:1.68:0.2. To reach ideal CNP ratio, medium needs additional nutrient with CNP ratio 36.8:7.32:0.8. The ratio is taken from bicarbonate as source of carbon, urea as source of nitrogen, and triple super phosphate as source of phosphorus.

Medium IV used 50% nutrient with 2 day addition as accumulated in one week i.e: 290ppm C, 38ppm N, and 5.2ppm P, respectively. This composition is already reach teoritical nutrition demand in medium. Assumed that air agitation from aquarium pump also contains C and N, so medium will complete to reach ideal CNP.

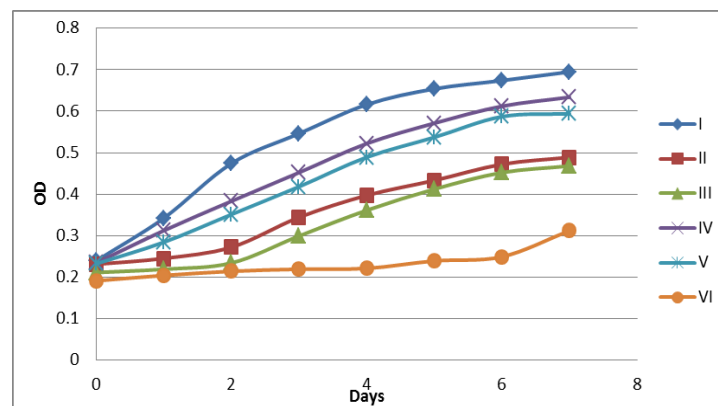


Figure 2. Growth phase Spirulina sp cultivated in 20% POMED under different saving synthetic medium

Next high growth rate is medium V with 70% reduction. This composition is little far from medium demand (36ppm C, 73ppm N, 7.8ppm P), but the growth rate is higher than medium III (30% reduction) with CNP contains in medium 400ppm C, 53ppm N, 72ppm P, and medium II (0% reduction). Along CNP in medium reach ideal condition, algal growth become stable. But exces nutrient in medium (i.e. medium III and II) and lack nutrient (medium VI) will influence growth condition.

Table 3. Result in different nutrition addition

No	Media	Nutrien			Nutrien Reduction	Growth Rate /day
		NaHCO ₃	Urea	TSP		
I	Fresh water	1.2 gr/l	60ppm	20ppm	0%	0.152
II	POME 20%	1.2gr/l	60ppm	20ppm	0%	0.070
III	POME 20%	0.96 gr/l	40ppm	16ppm	20%	0.114
IV	POME 20%	0.6gr/l	25ppm	10ppm	50%	0.142
V	POME 20%	0.24gr/l	15ppm	6ppm	70%	0.134
VI	POME 20%	0.12gr/l	5ppm	2ppm	90%	0.107

Mun, et al. [11] explained that excess nutrient can lowering growth rate because not all nutrient can be absorbed to algae cell and nutrient could be converted to toxic mater. Chilmawati and Suminto [12] reported that medium contain excess nutrient or lack of nutrient can influence algal growth. Microalgae tend to need more time in adaptation phase, cells need enzym and substrate concentration to grow. Nutrient is diffused by algae because of different concentration in algae cell and medium. At medium IV, Spirulina sp has as higher concentration nutrient as algae concetration needed so the adaptation time become faster.

3.2. Optimum POMED Concetration

The research was splitted in two steps. Step one (8 days 1st), Spirulina sp was cultivated in different POMED concentration but same synthetic nutrient 50% reduction. (500ppm NaHCO₃, 15ppm urea, 5ppm TSP) to obtain optimum biomass. Step two (8 days 2nd), microalgae cultivation was continued without adding synthetic nutrient to determine optimum biomass produced from excess nutrient contained in medium.

At first 8 days measurement, optimum OD_{680} was recorded from medium II, followed by medium III and I. Optimum specific growth rate was recorded from medium II, I, and III. Different OD and specific growth rate occurred in medium I and III. Another medium remained specific growth rate decreased along OD value, respectively.

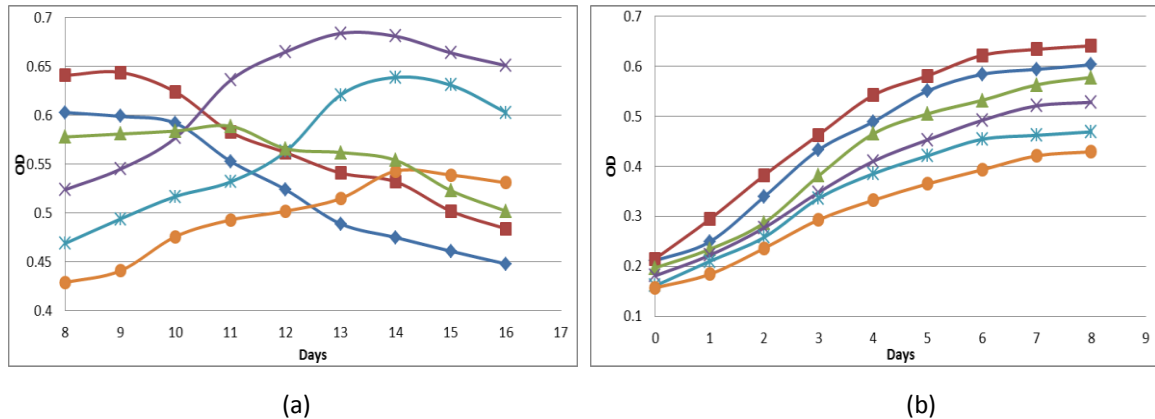


Figure 3. Graphic of *Spirulina sp* growth phase in different POME concentration. (a) growth phase at first step. (b) growth phase at second step. \blacklozenge =10% POME, \blacksquare =20% POME, \blacktriangle =30% POME, \times =40% POME, \ast =50% POME, \bullet =60% POME.

At medium I, total CNP ratio reached 48.2:6.8:1. This ratio almost near CNP ideal algae 56:9:1 [3]. But the biomass and growth rate has little lower than medium II (CNP total ratio 31.9:4.6:1). According to CNP total weight (in ppm), medium I has little source than medium II. Based from calculation, assumed that algae produced 7gr/l in 8 days, algae needs 3920 ppm C, 630 ppm N, and 70ppm P. Medium I only contained 823ppm C, 125,9ppm N and 17ppm P, nutrient supply is lower than medium II, although it has better CNP ratio.

Table 4. Result in Second Experiment

No.	Composition	1 st step		2 nd step		Optimum Growth Time (day)
		Total Biomass (g/l)	Growth rate (/day)	Total biomass (g/l)	growth rate (/day)	
I	10%	5.38	0.1313	4.43	-	8
II	20%	5.953	0.1365	5.28	-	9
III	30%	5.685	0.1305	5.55	-	11
IV	40%	4.697	0.1338	9.8	0.0314	13
V	50%	4.662	0.1336	8.7	0.0271	14
VI	60%	2.826	0.1257	6.83	0.0267	14

Comparing from medium III, medium I has lower biomass but has higher growth rate. It indicates that medium I has better adaptation time from the medium because of CNP ratio has better than medium III. But it has lower biomass because of nutrition supply is lower than medium III. In another point, medium III has more dark color than medium I, high intensity can not penetrate well in medium and interrupt cultivation. Habib et al. [4] reported that POME above 20% interrupt in *Chlorella vulgaris* growth to reach stationary phase.

Dark color in POME could also change medium become heterotrophic or mixotrophic condition. Meanwhile medium with lower dark color (i.e 10% or 20% POME concentration) tend to form mixotrophic condition. *Spirulina platensis* had been found to utilize organic carbon substrates for heterotrophic and mixotrophic growth [13]. When microalgae grow in mixotrophic condition, light and organic carbon can be utilized as carbon source, but when microalgae grow in heterotrophic condition, organic carbon only the main of carbon source. Several researcher [14,15] also reported that microalgae has higher growth rate under mixotrophic condition (i.e *Chlorella*

minutissima and *Chlorella vulgaris*) than heterophic and autotrophic condition. Another research, Anton et al. [16] also reported that algae can grow in optimum 14% POME, followed by 10%, 20% and 30%.

3.3. *Spirulina* sp Growth without Synthetic Nutrient

At second 8 days, cultivation continued without adding sythetic nutrition. Optimum biomass was collected from medium IV, with POMED 40% concentration and biomass 9.8gr/l, followed by medium V and VI. Another medium (I,II, and III) tend to reach death phase little faster than medium IV, V, and VI, respectively, based by specific growth rate. Along with higher excess nutrient containing in medium, algae still grow well and it can prolong from entering death phase.

Chilmawati and Suminto [12] reported that death phase occurs when algae cell reach optimum production, culture can not maintain cell body because lack of nutrient in medium, and slowly lysis or dissapear into medium [17]. Biomass from 2nd step experiment has lower weight than biomass 1st step. (see table 4).

Medium IV, V, and VI still have growing activities but slowly decrease from day 13, and 14. Medium IV has optimum biomass because there is balanced with nutrient supply and CNP ratio is better than medium V and VI. According to CNP excess, medium V and VI still much high nutrient in medium but biomass is low. There is could be dark color containing in medium prevent light to enter and lowering growth rate of *Spirulina* sp. Mayangsari [6] also reported that *Spirulina platensis* cultivated in higher POME concetration also needs more time to reach optimum production. Based by theotrical literature, *Spirulina* sp at medium V and VI could reach higher biomass and still needs more time to reach optimum production (more than 14th day), but excess of nutrient could be toxic in medium and prevent spirulina to grow.

4. Conclusion

Research was done by cultivating *Spirulina* sp under different saving synthetic nutrient and different POMED concentration. *Spirulina* sp can grow well in 20% POMED, save 50% from synthetic nutrient, and produced 5.93gr/l wet biomass for 9 days. Research was continued without adding nutrient and produced optimum biomass 9.8gr/l in 40% POMED for 13 days.

Acknowledgement

This work was supported by Maris Consortium and Bioprocess Laboratory Chemical Engineering Diponegoro Univeristy.

References

- [1] Rupani PF, Singh RP, Ibrahim, MH, and Esa N.2010.Review of Current Palm Oil Mill Effluent (POME) Treatment Methods:Vermicomposting as a Sustainable Practice. World Applied Sciences Journal, 11: 70-81.
- [2] Deptan. 2009. Rancangan Rencana Strategis Kementrian Pertanian : 2010-2014 www.deptan.go.id
- [3] Phang SM, and Ong KC.1988. Algal biomass production in digested palm oil mill effluent. Biol. Wastes, 25: 177–191.
- [4] Habib, MAB, Yusoff FM, Phang SM, Kamarudin MS, and Mohamed, S. 1998. Chemical characteristics and essential nutritients of agroindustrial effluents in Malaysia. Asian Fisheries Science, 11(3): 279-286.
- [5] Habib MAB, Yusoff, FM, Phang, SM, Kamarudin MS, and Mohamed, S .2003.Growth and Nutritional Values of *Moina micrura* Fed on *Chlorella vulgaris* Grown in Digested Palm Oil Mill Effluent. Asian Fisheries Science 16 : 107-119.
- [6] Mayangsari, Yunika. 2011. Produksi dan Karakterisasi Fikosianin dan Lipid Mengandung Asam Lemak Tidak Jenuh Majemuk dari *Spirulina platensis* yang Dibiakkan dalam Limbah Cair Pengolahan Kelapa Sawit. Master Thesis Jurusan Teknologi Pangan dan Hasil Pertanian. UGM Yogyakarta.
- [7] Permatasari, Shinta. 2011. Production of *Spirulina* for Decreasing Pollution Level of Palm Oil Mill effluent in Contionus Photobioreactor. Department of Agricultural Technology. IPB.

-
- [8] Jongkon P, Siripen T, and Richard DL. 2008. The optimum N: P ratio of kitchen wastewater and oil-extracted fermented soybean water for cultivation of *Spirulina platensis*: pigment content and biomass production. *Int. J. Agric. Biol.*, 10: 437–441.
- [9] Khatum R, Hossain MM, Begum SMS, Majid FZ. 1994. *Spirulina* culture in Bangladesh V. Development of simple, inexpensive culture media suitable for rural or domestic level cultivation of *Spirulina* in Bangladesh. *J. Sci. Ind. Res.*, 29: 163-166.
- [10] Benefield, LD, and Randall, CW. 1980. *Standard Methods for The Examination of Water and Wastewater*. 18th Ed American Public Health Association, New York.
- [11] Mun MD, Osborne LL, and Wiley MJ. 1989. Factors influencing periphyton growth in agricultural streams of central Illinois. *Hydrobiologia* 174:89-97.
- [12] Chilmawati, Diana and Suminto. 2008. The Used of Different Culture Medium on the Growth of *Chlorella* sp. *Jurnal Saintek Perikanan*, 4(1): 42-49.
- [13] Lodi, A., Binagi, L., De-Faveri, D., Carvalho, JCM., Converti, A., and Borghi, MD. Fed-batch mixotrophic cultivation of *Arthrospira platensis* with carbon source pulse feeding. *Annals of Microbiology* 55(3), 181-185.
- [14] Bhatnagar, A., Chinnasamy, S., Singh, M., Das, KC. Renewable biomass production by mixotrophic algae in the presence of various carbon source and wastewater. *Applied Energy*. Elsevier.
- [15] Kong W, Song H, Cao Y, Yang H, Hua S, and Xia, C. 2011. The characteristic of biomass production, lipid accumulation, and chlorophyll biosynthesis of *Chlorella vulgaris* under mixotrophic cultivation. *African Journal of Biotechnology* Vol.10(55), 11620-11630.
- [16] Anton A, Kusnan M, and Hussin, ARM. 1994. Effects of palm oil mills effluent on algae. *Proceedings of the Conference on Algal Biotechnology in the Asia-Pacific Region, Algal Biotechnology in the Asia-Pacific Region, Universiti Malaya, Kuala Lumpur, Malaysia*:320-323. *Biological Wastes* 25: 177-191.
- [17] Fogg GE and Thake B. 1987. *Algal cultures and phytoplankton ecology*. University of Wisconsin Press.



This is to certify

Hadiyanto
as presenter

at the International Conference on
Chemical and Material Engineering

September 12 - 13, 2012

Semarang, Central Java, Indonesia

Department of Chemical Engineering
Diponegoro University

Dr. Ir. Budiyo, MSi
Head

Organizing Committee



Dr. Ir. Heru Susanto
Chairman