

PROCEEDING

19th Regional Symposium on Chemical Engineering (RSCE2012)



Strengthening the Role of ASEAN
Chemical Engineers in the world economy dynamic



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PREFACE

The Regional Symposium on Chemical Engineering (RSCE) has become an important annual forum for academicians, researchers and professionals from both public and private organizations in the South East Asia and the Asia-Pacific regions. It is organized to serve as venue to exchange knowledge and information of relevance to the chemical engineering.

The committee received 282 abstracts and accepted around 230 papers in which around 170 papers came from abroad such as Japan, Taiwan, Korea, Malaysia, Thailand, and Australia, Philipine, Vietnam, Saudi Arabia. All the papers have been reviewed with the help of experts in the areas.

The topics are classified into Chemical Reaction Engineering, New and Renewable Energy Technology, Fossil Fuel Technology, Polymer and Petrochemical Technology, Process Design and Control, Process Intensification, Separation and Purification Technology, Material Science and Technology, Food Science and Technology, Environmental and Science Technology, Transport Phenomena, Biochemical Engineering and Thermodynamics.

We wish to thank reviewers, plenary speakers, keynote speakers, and session moderators for their cooperation and valuable suggestions. We would like to extend our appreciation to members of organizing committees, International and National Scientific Committees for their valuable help and support.

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- [A-68](#) Co-processing of low rank coal/biomass-derived carbonaceous materials and low-grade iron ore
Eiki Nagai, Ryuichi Ashida, Kouichi Miura
Department of Chemical Engineering, Kyoto University Kyoto-daigaku Katsura, Nishikyo-ku, Kyoto 615-8510, Japan
- [A-69](#) Carbon fibers preparation by low-molecular-weight extracts obtained from low-rank coal or biomass by degradative solvent extraction
Kenshiro Okuda, Xian Li, Ryuichi Ashida and Kouichi Miura
Department of Chemical Engineering Kyoto University – Japan
- [A-70](#) Performance of Gasifier Stove With Variety Biomass Fuels in Riau
Sri Helianty, Zulfansyah, Darwis Damanik and Rio Sunarya
Department of Chemical Engineering, University of Riau, Pekanbaru 28293, Indonesia
- [A-71](#) Impact of High Electric Field Pulses on Apple Juice Extraction
Mohammad Naghi Eshtiaghi
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- [A-72](#) Application of High Electric Field Pulses for Fermentation of Red Beet
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Institute of Food and Bioprocess Technology, The Technical University of Berlin, 12159 Germany
- [A-73](#) Kinetics of Catalytic Cracking From Oleic Acid to Liquid Biofuel
Achmad Roesyadi, Danawati Hariprajitno, Nurjannah, Santi Dyah Savitri
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- [A-74](#) Development of Au/HZSM-5 Catalyst for Producing Biofuel

fromPalm Oil

Agus Budianto, Ignatius Gunardi, Achmad Roesyadi, Kusno Budhikarjono and Danawati Hari Prajitno

Chemical Engineering Department, Industrial Technology Faculty, SepuluhNopember Institute of Technology, Surabaya, Indonesia

[A-75](#) The Effect of Vessel Metal Contact Surface Area onOxidation Stability of Jatropha Biodiesel

Rina Mariyana, Chikaya Sakai and Tirto Prakoso

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[A-76](#) Liquid-Liquid Extraction In Packed Column Using *n-amyl alcohol* And *1-dodecanol* as Solvent to Separate Ethanol From Synthetic Broth

Tri Widjaja, Ali Altway, Setyo Gunawan, Achbarida Praba, and Ika Purwantiningsih

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[A-77](#) Utilization of Hemicellulose in Rice Straw For Production of Biofuel

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[A-78](#) Enzymatic Hydrolysis of Alkali-Pretreated Sugar Cane Bagasse ForProduction of Biofuel

Arief Widjaja, Timoteus Yuwono and Eduward Rolanda

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[A-79](#) Size Reduction, Steaming and Enzymatic Hidrolysis Of Palm Oil Empty Fruit Bunch

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[A-80](#) Integrated System for Underutilised Biomass Supply Chain

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- [A-81](#) Effect of Bread Yeast and Tempeh Yeast on Total Titrable acidity (TTA) and pH during Cassava Fermentation
Setiyo Gunawan, Ary Yusen Pratama, Rima Nur Febriani, Sri Rachmania Juliastuti, Tontowi Ismail, and Tri Widjaja
Department of Chemical Engineering, Faculty of Industrial Technology, Institut Teknologi Sepuluh Nopember, Surabaya 60111, Indonesia
- [A-82](#) Composition and Analysis of Calophyllum Inophyllum Seed and It's Oil
Setiyo Gunawan, Bayu Biru Chandra, Filan Setiawan, Mulyanto, Sri Rachmania Juliastuti, Arief Widjaja, Tri Widjaja
Department of Chemical Engineering, Faculty of Industrial Technology, Institut Teknologi Sepuluh Nopember, Keputih Sukolilo, Surabaya 60111, Indonesia
- [A-83](#) In-Situ Production of Biodiesel from Rice Bran and Its Effect on Carbohydrate Recovery in Defatted Rice Bran
Siti Zullaikah, M. Rachimoellah, Sumarno and Tri Widjaja
Department of Chemical Engineering, Sepuluh Nopember Institute of Technology, Surabaya 60111, Indonesia
- [A-84](#) Biodiesel Production from Cottonseed Oil via Transesterification Method Using Cao as Catalyst
M. Rachimoellah, Siti Zullaikah, Romanus K. T. N., Yulia Tri R., Nidya Santoso and Ferdy Pradana
Department of Chemical Engineering, Sepuluh Nopember Institute of Technology, Surabaya 60111, Indonesia
- [A-85](#) Natrium Hydroxide (Naoh) As Alkaline Hydrolysis On Pretreatment Of Water Hyacinth (*EichorniaCrassipes*) As Raw Material In Biogas Production
Sri Rachmania Juliastuti, Nuniek Hendrianie, Jaka Abdillah, Gawa Reza Mahadin
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- [A-86](#) Agent-based Modeling of Visible Light-Driven Hydrogen Production
Roy Vincent L. Canseco, Vena Pearl Boñgolan, Kristine R. Tolod, and Rizalinda L. de Leon
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B. Process System Engineering

- [B-01](#) Mathematical Modelling of a Solid Oxide Fuel Cell For The Thermal Modeling
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B-02 Thermal Conductivity Enhancement of Alumina Nanoparticles in an Aqueous [HMIM]LS Solution

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B-03 Discussion on Time Difference Models for Application of Soft Sensors

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B-04 A Statistical Approach for Selecting Control Components in Process Design

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B-05 The Treatment Of A Simulated Liquid Radioactive Waste Containing Tributyl Phosphate Using Ozone Followed By Adsorption

Noor Anis Kundari, Angga Kukuh Setya Hartato, Kartini Megasari, Kris Tri Basuki, Bangun Wasito

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B-06 PT Badak NGL Case: Optimum LNG Plant Operation

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B-07 PT Badak NGL Case : Optimization of Molecular Sieve Dehydration Regeneration

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- B-08** Process Failure Of The High Pressure CO₂ Stripper Urea Plant Pusri-IB
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- B-09** Next Generation in Biomass Processing: Extraction Process and
Depolymerization
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AVT-Thermal Process Engineering, RWTH Aachen University, Wüllnerstrasse 5,
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- B-10** Henry's Constant Of Polar Solutes In Polymer Solutions
Gede Wibawa, Rama Oktavian, Gema Cahya N, and Fadinsa Yudhistira
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Surabaya 60111 Indonesia
- B-11** Optimisation Of Ls54/Dx Aqueous Two Phase System Conditionsfor Cutinase
Recovery
*FarizaAkmal Abdul Mutalib, Jamaliah Md Jahima, Farah Diba Abu Bakar, Abdul
Wahab Mohamad and Osman Hassan*
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- B-12** Principal Component Analysis of Optimum Linear Estimator in Chemical
Processing System
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Marthen Luther Doko
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- B-14** A decision modeling approach to evaluate the climate change mitigation options
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Michael Angelo B. Promentillaa, Katrina C. Angelesa Carla Angeline M. De la Cruza, Kathrina G. Tana

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B-15 Esterification of Phthalic Anhydride
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B-16 Optimization of Hydroxylation Reaction For Synthesis of Polyol From Epoxidized Palm Oil Methyl Ester
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B-17 Design and Control of Alkali-Catalyzed Transesterification Reactors
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B-18 A Dynamic Model for Ultrasonic – Assisted Extraction of Bio-Active Compounds from Natural Products
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B-19 Study on Chemical Reaction Equilibrium of Methanol Synthesis in Liquid Phase
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B-20 Different Types of Observers Applied in Process Systems
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B-21 The Development of Pertamina Racing

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- [B-22](#) Design and Control of Biodiesel Production in Esterification Section
Apichat Saejio, and Kulchanat Prasertsit
Department of Chemical Engineering, Prince of Songkla University, Hatyai
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- [B-23](#) Dynamic Simulation the Influence of Gas Compressor Suction Pressure Control to Improve Anti Surge Control System Performance in Two Stages Centrifugal Gas Compression System
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- [B-24](#) Optimal Design Based RSM and ANN of High Vacuum Distillation for Beta-Carotene Recovery
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- [B-25](#) Dynamic Simulation of Optimization of Load Sharing Compressor and LinePacking Utilization
Bramasto Aryaka, Tri Partono Adhi
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- [B-26](#) Optimization Process of Biodiesel Production with Ultrasound Assisted by Using Central Composite Design Methods
Widayat, Hantoro Satriadi, Oki Yuariski and Djoko Murwono
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- [B-27](#) Dynamic Simulation and Control in A Non-Interacting-Tank System
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- [B-28](#) Technical and Economics study of biodiesel production by supercritical transesterification
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B-29 Modelling of Risk Assessment Using Layer of Protection Analysis (LOPA) on Enclosed Ground Flare at Onshore Facilities

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C. Chemical Engineering Fundamentals

C-01 Improvement of Antifouling Potential on Anion Exchange Membrane by Layer by Layer Deposition

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C-02 Effect of Coalescer Height to Oil Separation in Produced Water Using Gas Flotation Vessel Cell

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C-03 Comparison of Cutinase Separation in Different Chromatographic Media

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C-04 Hydrothermal Extraction of Valuable Compounds from Kikurage (*Auricularia auricula-judae*)

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C-05 PVT Properties for Mixtures of Ionic Liquid 1-Butyl-3-Methylimidazolium bis(Trifluoromethylsulfonyl)imide [C₄mim][NTf₂] with Anisole

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- [C-06](#) CFD Simulation and ERT visualization of Gas-Liquid Oscillatory Flow in a Baffled Column
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- [C-07](#) A Study on The Application of Orange Peel Waste as Low Cost Biosorbent for Dye Removal
Arenst Andreas, Jeremy Reinaldo, and Kelvin Tertira
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- [C-08](#) Simple Extraction Method of Galanthamine from *Narcissus pseudonarcissus* bulbs
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- [C-09](#) Incorporation of Fractional Surface Coverage on Extended Langmuir Isotherm: Binary Adsorption of Evans Blue and Malachite Green onto Organo-Bentonite
Suryadi Ismadji, Alfin Kurniawan, and Hogiartha Sutiono
Department of Chemical Engineering, Widya Mandala Surabaya Catholic University, Kalijudan 37, Surabaya 60114, Indonesia
- [C-10](#) Density Based Modeling of Epicatechin Solubility in Supercritical Carbon Dioxide Fluid
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- [C-11](#) Transesterification mechanism for PET recycle by molecular orbital method
Kazuki Hashimoto, Yusuke Aaskuma
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- [C-12](#) Kinetics of Amidation for The Synthesis of Diethanolamide From Methyl Ester and Diethanolamine by Using Sulfuric Acid Catalyst

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- [C-13](#) Effect of Agitation on the Metastable Zone, Nucleation and Growth of Struvite Crystals in a Batch Crystallizer
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- [C-14](#) Shock Loads and Revival of Activity after Shutdown in Single Stage Stirred Tank Anaerobic Reactors fed Continuously and Intermittently
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- [C-15](#) Bioproduct-Based Solvents for Dissolving Styrofoam and Comparison of its Solubility with Thermodynamic Model
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- [C-16](#) Isolation and Physicochemical Properties of Starches from Vietnamese *Limnophila aromatic*
Quy Diem Do, Lien Huong Huynh and Yi-Hsu Ju
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- [C-17](#) Mass Transfer of stevioside in stevia rebaudiana extraction
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- [C-18](#) Thermophysical Characterization of Glycol (DEG/TEG/T₄EG) + TRIS + Water: Measurements and Correlation
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- [C-19](#) Liquid-Liquid Equilibrium of Acetonitrile + Water in the Presence of Biological Buffer MOPS
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- [C-20](#) Analysis of Flux Decline during Microfiltration of Different Types of Feed
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- [C-21](#) The Use of Ion-Exchange Resin in The Production of Clean Biodiesel
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- [C-22](#) Co-solvent Selection for Supercritical Fluid Extraction of Essential Oil and Bioactive Compounds from *Polygonum minus*
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- [C-23](#) Vegetable oil reforming for high-temperature PEMFCs
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- [C-24](#) Novel heterogeneous monolithic catalyst in biodiesel production: A review
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- [C-25](#) Comparison of Pyrolysis Products between *Jatropha Curcas L* Waste and *Jatropha Curcas L* Nut
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- [C-26](#) Enhancing CO₂ Adsorption Using Strong Base Anion Exchange Resin
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- [C-27](#) Liquefaction of low-molecular-weight extracts obtained from low-rank coal and biomass by degradative solvent extraction under mild condition
Dedy Eka Priyanto, Xian Li, Ryuichi Ashida, Kouichi Miura
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- [C-28](#) Effect of Paraffins on Benzene Photocatalytic Oxidation of Clean Room in Semiconductor Fab
Yi-Ting Wu, Yi-Hui Yu, Jeffrey Chi-Sheng Wu, Angela Yu-Chen Lin, Luh-Maan Chang, and Ming-Hao Hsu
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- [C-29](#) Kinetic Evaluation of the Graft Copolymerization of Acrylic Acid onto Starch Based on Concentration Measurements and on Torque Observation
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- [C-30](#) Identification of Potential Dyes and Developing Methods to Improve Dye-sensitized Solar Cell's Efficiency
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- [C-31](#) Separation of Aromatic Hydrocarbons from Cracked Oils by Solvent Extraction
Yoshihisa Yoshimura, Hiroaki Habaki, and Ryuichi Egashira
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- [C-32](#) Prediction of Solubilities of CO, H₂ and Its Mixture in Various Solvents
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- [C-33](#) Optimizing Lipase Immobilization by Entrapment Method on Chitosan as Biocatalyst for Biodiesel Synthesis
Heri Hermansyah, Merisa Bestari Faiz, Intan Afridawaty Sipangkar and Renly James Yosua
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- [C-34](#) Miscibility Development Calculation in Model Oil Injection by Flare-Flue Gas Mixtures
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- [C-35](#) Adsorption of copper(II), cadmium(II) and zinc(II) ions by SDS-functionalized mesoporous silica
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- [C-36](#) Dye Adsorption on Silica-filled ENR/PVC Beads
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- [C-37](#) Phase Behaviour Of CH₄-CO₂ Mixture in Cryogenic Heat Exchanger Process
Ardila Hayu Tiwikrama, Syahipul Rachman Hidayat, Gede Wibawa, Sumarno, and Setiyo Gunawan
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- [C-38](#) Optimization research into the ultrasonic-assisted extraction to separate polyphenol from green tea waste
Lan Huong Phung, Trung Kien Tran, The Cuong Nguyen, Hong Quang Do, Thu Tra Phan, Hong Son Vu, Tien Huy Nguyen

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[C-39](#) Kinetic Reaction Comparison of CO₂ Absorption Into Promoted Potassium Carbonate (K₂CO₃)

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[C-40](#) Supercritical CO₂ Extraction and Micronization of Carotenoids

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[C-41](#) Kinetic studies on the removal of reactive blue 19 and reactive yellow 145 by
Putsan(tiwi) clay

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Department of Chemical Engineering, Bicol University

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[C-42](#) Activation of Mesoporous Carbon Synthesized from SBA-16 for CO₂ Storage

Nguyen Van Dung and Nguyen Ngoc Hanh

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Technology, Vietnam

[C-43](#) Transient Heat Transfer Analysis of Latent Heat Thermal Energy Storage System
Using Phase Change Material

Panut Mulyono and Denny Andriatno Pribadi

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University Yogyakarta 55281, Indonesia

[C-44](#) A Review on CFD Modeling of Fluidization Bed Gas Phase Reactor For
Polyolefin Production

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Malaya, 50603, Kuala Lumpur, Malaysia

- [C-45](#) Growth of Carbon Nanotube from Banana Peel Activated Carbon with Simple Pyrolysis Methode and Methane Decomposition
Praswasti Pembangun Dyah Kencana Wulan and Najma
Department of Chemical Engineering, Department Faculty of Engineering
Universitas Indonesia, Kampus Baru UI Depok 16424, Indonesia
- [C-46](#) Mass Transfer Model for Basic Blue Adsorption onto Pillared Bentonite Clay by Taking Into Account the Intra Particle Concentration Gradient
Hadiatni Rita Priyantini, Wahyudi Budi Sediawan, Rochmadi and Imam Prasetyo
Department of Chemical Engineering, University of Surabaya, Surabaya 60292, Indonesia
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- [C-47](#) Removal of Terpenes from Citrus Oil Model Compounds with Supercritical CO₂ Fractionation
Siti Machmudah, Wahyudiono, Motonobu Goto, and Ryuichi Fukuzato
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Department of Chemical Engineering, Sepuluh Nopember Institute of Technology, Surabaya 60111, Indonesia
SCF Technolink, Kobe, Japan
- [C-48](#) Flow instabilities in Agitated Tanks with Side Entering Mixers
Sugeng Winardi, Tantular Nurtono, Widiyastuti,
B.Gustiayu Sukmawedha, A. Ratna Sari, Bayu Triwibowo
Department of Chemical Engineering, Sepuluh Nopember Institute of Technology
Surabaya, Indonesia
- [C-49](#) A Computational Fluid Dynamics Study into Turbulent Characteristic that Affect the Combustion Process
T. Nurtono, W. Widiyastuti, R.K.T. Nenu, I.S. Arief and S. Winardi
Department of Chemical Engineering, Institute of Technology Sepuluh Nopember, Surabaya 60111, Indonesia
Department of Marine Engineering, Institute of Technology Sepuluh Nopember, Surabaya 60111, Indonesia
- [C-50](#) Liquid-Liquid Equilibria of Ternary System Eugenol + Isopropanol + Water at 303.15, 313.15, and 323.15 K
Zuhriyyah R.A, Rachma F., and Nur Andriani P.K, Kuswandi
Department of Chemical Engineering, Sepuluh Nopember Institute of Technology, Surabaya 60111, Indonesia
- [C-51](#) Bitumen Extraction from Asbuton Rock Using Pertasol
Susianto, Ali Altway, and Suprpto

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D. Polymer, Petrochemical and Material Science and Technology

D-01 Investigation of Rice Husk Loading on The Characterization and Water Permeation of ENR/PVC Composite Membrane

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D-02 One step synthesis of hybrid single-wall carbon nanohorns with metallic nanoparticles using arc discharge in water with nitrogen gas injection

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D-03 Preparation of Amine-Grafted Mesoporous Material MCM-48 Using Geothermal Solid Waste Silica

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D-04 Synthesis of Furfural from Locally Available Agricultural Residues in the Philippines

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D-05 Granulation of Organic and Inorganic Mixtures

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- [D-06](#) Thermal Compression Effects on Hybrid Poplar Wood: Lignin Analysis
Noridah B. Osman, Armando G. McDonald, and Marie-Pierre G. Laborie
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Renewable Materials Program, Department of Forest, Range and Fire Sciences,
University of Idaho, USA
Institute of Forest Utilization and Work Sciences, University of Freiburg,
Germany
- [D-07](#) Preparation of CO Gas Sensor from WO₃ Nanomaterial Synthesized via Sol-Gel
Method Followed by Calcination
*Diah Susanti, A.A. Gede Pradnyana Diputra, Lucky Tananta, Hariyati
Purwaningsih, George Endri Kusuma, Chen-Hao Wang, Shao-Ju Shih and Ying-
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Department of Materials Science and Engineering, National Taiwan University of
Science and Technology (NTUST), Taipei, Taiwan
Department of Electronic Engineering, National Taiwan University of Science
and Technology (NTUST), Taipei, Taiwan
- [D-08](#) Green Synthesis of Zinc Oxide Nanoparticles via Simple Precipitation Method
Nur Hanis Hayati Hairoma, Abdul Wahab Mohammad
Universiti Kebangsaan Malaysia
Universiti Tun Hussein Onn Malaysia
- [D-09](#) Differential Scanning Calorimetry (DSC) analysis of PP/Organoclay
Nanocomposites: Isothermal Crystallization Study
*Achmad Chafidza, Mohammad Al-haj Ali, Rabeh Elleithya and Saeed M. AL-
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SABIC Polymer Research Center, King Saud University, Riyadh, Saudi Arabia
Research and Development Department, Printpack Inc., Williamsburg, USA
- [D-10](#) Shape Memory Polymer Based on Benzoxazine-modified Epoxy
Sarawut Rimdusit and Montha Lohweratham
Polymer Engineering Laboratory, Department of Chemical Engineering
Faculty of Engineering, Chulalongkorn University, Bangkok 10330, Thailand
- [D-11](#) Highly Filled Graphite Based Benzoxazine Composites for an Application
as Bipolar Plates in Fuel Cells
Anucha Pengdam and Sarawut Rimdusit

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- [D-12](#) Synthesis and Characterization of Zeolite Monolith
by Ice-Templating and Steam-Assisted Crystallization
Hajime Tamo, Takuya Akatsuk, Hiroki Mori, and Noriaki Sano
Department of Chemical Engineering, Kyoto University, Katsura, Kyoto 615-8510, Japan
- [D-13](#) Modeling of Gas Phase Propylene Polymerization in Fluidized Bed reactors Using Aspen Polymer Plus and Two Phase Models
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Process Design and Simulation Research Center, School of Chemical Engineering, College of Engineering, University of Tehran, P.O. Box 11365/4563, Tehran, Iran
- [D-14](#) In-situ observation of convection and phase separation behavior under microwave radiation
Yusuke Asakuma, Yutaka Koh
Department of Mechanical and Systems Engineering, University of Hyogo, 2167 Shosha Himeji 671-2280 Japan
- [D-15](#) Production and Characterization of Polyethylene-Clay Nanocomposites through in situ Polymerization using Montmorillonite Supported Metallocene Catalyst
Hyung Woo Lee, Johnner P. Sitompul, and Yeung Ho Park
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Department of Materials and Chemical Engineering, Hanyang University, Ansan, Gyeonggi-do 426-791, South Korea
- [D-16](#) Thermomechanical Properties of KevlarTM Reinforced Benzoxazine-Urethane Alloys
Okhawilai M., Kasemsiri P., and Rimdusit S.
Department of Chemical Engineering, Chulalongkorn University, Bangkok 10330 Thailand
Department of Chemical Engineering, Khon-Kaen University, Khon-Kaen 40000 Thailand

- [D-17](#) Effectiveness of Tannin as Corrosion Inhibitor for Carbon Steel in Chloride Solutions
I.M. Nurdin, Stephanie, P.S. Ayudiani, W.K. Effendy, E.A. Pravasta
Department of Chemical Engineering, Bandung Institute of Technology, Bandung 40132, Indonesia
- [D-18](#) Polymer Flooding for Improving Oil Recovery
Suryo Purwono, Bardi Murachman, Rochmadi, Wahyu Hasokowati, Dodi Irawan and Yudha Endriadi
Department of Chemical Engineering Gadjah Mada University, Yogyakarta, Indonesia
- [D-19](#) Evaluation of micro-catalytic reactor with *in situ* UV microscopy
Tomohiko TAGAWA, Lee Yi Fuan and Hiroshi YAMADA
Department of Chemical Engineering, Nagoya University, Chikusa, Nagoya, 464-8603, Japan
- [D-20](#) Innovation process and equipment in the traditional tempe industries without pollution
Ign. Suharto
Department of Chemical Engineering, Faculty of Industrial Technology, Parahyangan Catholic University (UNPAR), Jalan Ciumbuleuit 94-96, Bandung 40141, Indonesia,
- [D-21](#) Fluorimetric Determination of Boron Levels in Semiconductor Cleanroom
Ming Hao Hsu, Yi Hui Yu, Yi Ting Wu, Angela Yu-Chen Lin, Jeffrey Chi-Sheng Wu, Luh Maan Chang
Graduate Institute of Environmental Engineering, bDepartment of Civil Engineering,
Department of Chemical Engineering, National Taiwan University, Taipei 10617 Taiwan
- [D-22](#) Bimodality Criterion for Sequence Length Distribution of Ethylene/1-olefin Copolymers
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Center of Excellence for Petroleum, Petrochemicals and Advanced Materials (PPAM), Department of Chemical Engineering, Faculty of Engineering, Kasetsart University, 50 Phaholyothin Rd., Jatujak, Bangkok, Thailand 10900
- [D-23](#) Simulation of Morphological Development during Crystallization of Syndiotactic Polypropylene in a Temperature Field
Chatpong Pornpiriyayotha, Siripon Anantawaraskul
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- [D-24](#) Effect of Ethylene-Vinyl Acetate Copolymer on Properties of Acrylonitrile-Butadiene-Styrene/Zinc Oxide Nanocomposites
Sirirat Wacharawichanant, Lalitwadee Noichin, and Sutharat Bannarak
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- [D-25](#) Developing Anti-Fogging Visor Using Titania Nanoparticle Coating
Dien Nurfathi, Ulfa Hardyanti, Agus Purwanto
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- [D-26](#) Synthesis and in vitro Characteristics of Sintered Hydroxyapatite
Kha Minh Nguyen, Ha Ky Phuong Huynh, Phu Xuan Nguyen and Tram Thi Ngoc Pham
Department of Chemical Engineering HoChiMinh City University of Technology, VNU-HCM, Vietnam
- [D-27](#) Stable aluminum oxide/water nanofluids with ionic liquid dispersant
Stephen S. Doliente, Glaiza E. Tanguilan, Rizalinda L. de Leon and Susan D. Arco
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Insitute of Chemistry University of the Philippines Diliman, Quezon City 1101 Philippines
National Sciences Research Institute University of the Philippines Diliman, Quezon City 1101 Philippines
- [D-28](#) Predicting of parameters effect on PE wax powder size distribution and shape in atomization process
Ubonwan Madua, Kulchanat Prasertsit, Paiboon Innachitra, Tanakorn Keatkhunboot.
Department of Chemical Engineering, Faculty of Engineering, Prince of Songkla University, Hat Yai, Songkhla 90112
- [D-29](#) Investigation of Thermal and Mechanical Properties of Highly Filled Polybenzoxazine Composites
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- [D-30](#) Preparation of Activated Carbon from Extraction Residue of Low-Rank Coal
Dedy Eka Priyanto, Xian Li, Ryoichi Ashida, Kouichi Miura
Department of Chemical Engineering, Kyoto University Japan
- [D-31](#) Electrochemical Characterization of Cathode For MCFC (Molten Carbonate Fuel Cell) Produced By Dry Casting
Ribka Priscilla Sinaga, Muhammad Ardian Nur, and Hary Devianto
Department of Chemical Engineering, Institut Teknologi Bandung, Bandung 40132, Indonesia
- [D-32](#) Activation of polymer supported catalysts using atmospheric non-equilibrium plasma
H.Sekiguchi, S.Kodama, and Y.Kawashima
Department of Chemical Engineering Tokyo Institute of Technology, Tokyo 152-8552 Japan
- [D-33](#) Study of Structure and Properties of Nano Composite Poly(Acrylic-co-Acrylamide)/Bentonite
A. Z. Abidin, I. Noezar, R. Irawan, and W. A. Nugroho
Department of Chemical Engineering Faculty of Industrial Technology, Institut Teknologi Bandung Jl Ganesa 10 Bandung 40132 INDONESIA
- [D-34](#) Synthesis technique and applications of carbon nanotubes directly grown on stainless steel surfaces
Noriaki Sano, Suguru Yamamoto, Takeshi Kodama, Satoru Matsuoka, and Hajime Tamon
Department of Chemical Engineering, Kyoto University, Kyoto 615-8510, Japan
- [D-35](#) Effect of Temperature and Type of Inorganic Acid in Acidolysis of Epoxy and Polyurethane Thermosetting Resins
Jonas Karl Christopher N. Agutaya, Zarlou M. Bernardo, Lorenz Anthony T. Fernando, Timothy David T. Salmo, Terence P. Tumolva
Department of Chemical Engineering University of the Philippines, Diliman, Quezon City 1101 Philippines
- [D-36](#) Synthesis of Proton Exchange Membrane from SO₃H-Grafted Silica Membrane in Production of Electrolyzed Oxidized Water (EOW)
Zarra Miantina Putrie, Rizki Pratama, Vania Mitha Pratiwi, Minta Yuwana and Heru Setyawan
Department of Chemical Engineering, Sepuluh Nopember Institute of Technology, Surabaya 60111, Indonesia
- [D-37](#) Coating Steel With Nanosilica By Electrophoresis For Corrosion Protection
Ni Made Intan P. Suari, Heru Setyawan, Samsudin Affandi, Rian Intan Saputra, Ririn Kurniasari

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[D-38](#) The Effects of Silica Addition on The Characterization and Gas Permeation of ENR/PVC Membrane

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[D-39](#) Purification of Silica Recovered from Dieng's Geothermal Sludge

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[D-40](#) Validation of a Base-Extraction γ -Al₂O₃ Catalyst Support Synthesis Route

Tjokorde Walmiki Samadhi, Novita D.P. Nugraheni, Herpurna A. Futaqi, and Khasin Fuadi

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[D-41](#) Lifetime Prediction of Furan Resin using Thermal Analysis

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[D-42](#) Thermal Degradation Kinetics of Orthophthalic Unsaturated Polyester

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[D-43](#) A protocol to detect chemical residues using a nanoparticle-based sensor combined with a Raman spectroscopic method

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Kanagawa Industrial Technology Center, Ebina, Kanagawa 243-0435, Japan

- [D-44](#) Stable non-fouling polymeric nanofilms for biomaterial applications
Bidhari Pidhatikaa, Mathias Rodenstein, Yin Chena, Marcus Textora, and Rupert Konradia
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Now at Department of Materials, Academy of Leather Technology, Ministry of Industry, Indonesia
Now at Bioengineering Program, The Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong
- [D-45](#) The Effect of Plasticizer on Mechanical Properties and Chemical Structure of Chitosan-Starch Film Composites
Natalia S. , Emma S., Andrew L.
Chemical Engineering Department, University of Surabaya, Indonesia
- [D-46](#) Diffusivity of Methanol in Modified Nafion and PolyAcrylonitrile-Acrylamide Membranes
Rochmadi, Eniya Dewi Listyani, and Dani Endar Purwanto
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The Agency for The Assessment and Application of Technology ,Jakarta, Indonesia
- [D-47](#) Effect of NaCl and Seed Crystal on Induction Time for Struvite Precipitation
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- [D-48](#) Preliminary Study on Degradation of Chitosan with Sonication
Emma Savitri, Azra Yuliana, Linggar Septy Pradeckta, Anitarakhmi Handaratri, Sumarno and Achmad Roesyadi
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- [D-49](#) Effect of Reaction Time to Production of Nanocarbon by Catalytic Decomposition of Methane From Banana Peel Activated Carbon
Praswasti PDK WulanI, Imia Ribka
Teknik Kimia, Teknik, Universitas Indonesia, Kampus Baru UI Depok, Jawa Barat, 16424, Indonesia
- [D-50](#) Synthesis of gold/iron-oxide composite nanoparticles by ultrasonic spray pyrolysis for magnetic separation of biomolecules
Shuji Watanabea, Toshiyuki Tania, Takuya Kinoshitaa, and Motoaki Adachia

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- [D-51](#) Characterization and UV Photocatalytic Activity of Nano-TiO₂ Co-doped with Iron and Niobium for Lindane Removal
Nhat Minh Doan, Carl Renan Estrellan, Anton Purnomo, Susan Gallardo, Chris Salim, Hirofumi Hinode, Pailin Ngaotranwivat
Chemical Engineering Department, De La Salle University, Philippines
Tokyo Institute of Technology, Japan
Burapha University, Thailand
- [D-52](#) Preparation and characterisation of carbon nanotube buckypapers synthesized from SWNTs and MWNTs in different dispersants
Son Q.T Pham, Jenny Boge, Luke Sweetmanb, Leighton Alcock, Anthony Wise, Mohamed Mostafa, Jing Cai, Stephen Ralph, Marc in het Panhui, Hanh N. Nguyen
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University of technology of HCMC, 268 Ly Thuong Kiet, HCMC, Vietnam
- [D-53](#) Effect of Metal Oxide on Electrical Properties of Tapioca/Metal Oxide Composites
Nuryetti, Heri Hermansyah, Mohammad Nasikin
Departement of Chemical Engineering, Universitas Indonesia, Depok 16424, Indonesia
- [D-54](#) Low Molecular Weight Chitosan Production by Hydrolisis Using Commercial α -amylase Hypertermophilic
Nur Rokhati, Bambang Pramudono, Heru Susanto, Prita Issolikha Wijayanti
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- [D-55](#) Fabrication of Dye-Sensitized Solar Cell using Spray Coating Method
Agus Purwanto, and HendriWidiyandari
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Department of Physics,Diponegoro University,Jl. Prof. H. Soedarto SH, Semarang, Central Java 50275, Indonesia
- [D-56](#) The Influence of Urea as Additive on the Particle Characteristics of Hydroxyapatite Synthesized by Flame Spray Pyrolysis Method
Abdul Halim, Widiyastuti, Tantular Nurtono and SugengWinardi
Department of Chemical Engineering, SepuluhNopember Institute of Technology, Surabaya 60111, Indonesia

[D-57](#) The Analysis of Particle Formation Mechanism in the Diffusion Flame Reactor using Liquid Precursor

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[D-58](#) Effect Sonication in Cellulose Degradation Using Hydrothermal Method

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E. Environmental Science and Technology

[E-01](#) Hydrothermally Prepared Iron Oxide Nanoparticles Pillared Montmorillonite as an Effective Adsorbent for Pb and As Removal

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Department of Chemical Engineering, Faculty of Engineering, University of Lambung Mangkurat, Banjarbaru 70711 Indonesia

[E-02](#) Photo-Oxidation of VOCs with Hydrogen Peroxide

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Department of Materials Engineering, Akita National College of Technology, Akita 010-8511 Japan

[E-03](#) Precipitation of struvite: a feasible approach for scale prevention and nutrient recovery from wastewater

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Chemical Engineering Vocational-D3 Program, Diponegoro University, Tembalang Campus, Semarang 50275, Indonesia

- [E-04](#) Removal of Acid Blue 158 from Solution by Sunflower Seed Hull
Siriwan Srisorrachatr
Department of Chemical Engineering, Faculty of Engineering, Srinakharinwirot University, Nakhon Nayok 26120, Thailand.
Graduate School, Srinakharinwirot University, Bangkok 10110, Thailand.
- [E-05](#) Synthesis of Ferrate (Fe(VI)) from Sludge and its Performance in Arsenite Removal from Water evaluated by Response Surface Methodology (RSM)
Vincent Paul G. Monterosoa, Meng-Wei Wan, Chi-Chuan Kan, Ma. Lourdes P. Dalida
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Department of Environmental Engineering and Science, Chia Nan University of Pharmacy and Science, Jen-Te, Tainan, 71710, Taiwan
- [E-06](#) Removal of Lead(II) and Copper (II) Heavy Metals From Binary Mixture Using Rice Straw Wastes As Biosorbent
F.E. Soetaredjo, A. Kurniawan, L.K. Ong, S. Ismadji
Department of Chemical Engineering, Widya Mandala Surabaya Catholic University, Kalijudan 37, Surabaya 60114, Indonesia
- [E-07](#) Improving the performance of cellulose acetate pervaporation membrane by the addition of bentonite and natural zeolite Malang
Dianika Lestari and Irwan Noezar
Department of Chemical Engineering , Faculty of Industrial Technology, Institute Technology Bandung, Jalan Ganesha 10 Bandung 40132 Indonesia
- [E-08](#) The Use of Natural Coagulants in Wastewater Treatment
Pretty Mori Budiman, Ta Yeong Wu, and Chee Yang The
Chemical Engineering Discipline, School of Engineering, Monash University, Jalan Lagoon Selatan, Bandar Sunway, 46150, Selangor Darul Ehsan, Malaysia.
- [E-09](#) Recent Development In Solid Waste Management Through Composting and Vermicomposting
Katrina Pui Yee Shak, Ta Yeong Wu, Pei Nie Lim and Su Lin Lim
Chemical Engineering Discipline, School of Engineering, Monash University, Jalan Lagoon Selatan, Bandar Sunway, 46150, Selangor Darul Ehsan, Malaysia
- [E-10](#) Treatments of Pulp and Paper Mill Effluent
Wennie Subramonian, Ta Yeong Wua, and Jaqueline Xiao Wen Hay
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- [E-11](#) Variation of Size Distribution and Iron Loading in Iron Oxide-Coated Sand Sorption Systems
Jay R T. Adolaciona and Maria Lourdes P. Dalida

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- [E-12](#) Photocatalytic Degradation of Azo Dyes (Reactive Red 198) using Platinum-loaded AgBr-TiO₂ Coupled Catalysts
Argenia B. Co, Daryll Anne T. de Joya, Eunice H. Mabutas, and Rolly G. Santos
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- [E-13](#) Treatment of Quick-Service Restaurant Wastewater by Electrocoagulation: Effect of Charge Loading on Pollutant Removal and Energy Consumption
Jem Valerie D. PEREZ and Wilfredo I. JOSE
Department of Chemical Engineering, University of the Philippines, 1011 Diliman, Quezon City, Philippines
- [E-14](#) Photocatalytic Degradation of Acetaminophen in TiO₂/Visible Light Reactor System
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- [E-15](#) Decomposition of gas-phase benzene using Ag/TiO₂ packed nonthermal plasma catalysis reactor
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- [E-16](#) Treatment of Quick Service Restaurant Wastewater through Compact Electrocoagulation Technology
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- [E-17](#) Two Stages Phytoremediations Of Palm Oil Mill Effluent (POME) By Using Apu-Apu (*Pistia Stratiotes*) Plant And Algae Spirulina Sp For Protein Production
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[E-18](#) Ultrasound-Assisted Oxidative Desulfurization of Organosulfur Compounds using Ferrate (VI) from Sludge
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Additional Paper

[Ad-1](#) Comparison between Multi-culture Fermentation Method and Series in Bioethanol Production using *Saccharomyces cerevisiae* and *P.pastoris* GS115 mut+
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Department of Chemical Engineering – Faculty of Industrial Technology, Institut Teknologi Bandung

[Ad-2](#) Numerical Study on A Bead Mill by Lagrangian-Lagrangian Coupling Method
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[Ad-3](#) Effect H₂O and SO₂ Concentration on Selective Catalytic Reduction of Nitrogen Oxide by Ammonia over V₂O₅-WO₃/TiO₂ Catalyst
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Center of Excellence on Catalytic Reaction Engineering, Department of Chemical Engineering, Faculty of Engineering, Chulalongkorn University, Bangkok, 10330, Thailand

[Ad-4](#) Synthesis of Gold Nanostructures Using Paper for Active SERS Substrate
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Dynamic Simulation and Control in A Non-Interacting-Tank System

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Abstract

Relative Gain Array (RGA) analysis has been previously implemented on design of control configuration of Non-Interacting-Tank (NIT) system [Hermawan et al, 2010]. The previous work produced the process control configuration of NIT system. The aim of this research is to examine the resulted process control configuration of NIT system through closed loop dynamic simulation. The developed mathematical model is solved numerically. Trial and error method has been used for tuning of the feedback control parameters. According to my dynamic simulation, the resulted process control configuration of NIT system produces stable responses to a change in the input mass disturbance load.

Keywords: Closed Loop; Control Configuration; Dynamic Simulation; Non-Interacting-Tank.

1. Introduction

The multi-capacity processes such as Non-Interacting-Tank (NIT) and Interacting-Tank (IT) are frequently used in chemical process industries. However, the propagations of mass and thermal disturbances are possibly occurred in those multi-capacity processes. Therefore, implementation of automatic process control on the multi-capacity processes is very important to overcome the disturbances.

There are some contributions to the study of process dynamic and control. Composition dynamic in a mixing tank has been studied experimentally [Hermawan et al, 2012]. Dynamic simulation and composition control in a mixing tank has also been presented recently [Hermawan, 2012]. Process Reaction Curve was implemented for tuning of temperature control parameters in a stirred tank heater [Hermawan, 2011]. The use of Relative Gain Array (RGA) for design of process control configuration of NIT system has been studied experimentally [Hermawan et al, 2010]. This study produced the control configuration of NIT system, with 4 couples of CV-MV (Controlled Variable – Manipulated Variable).

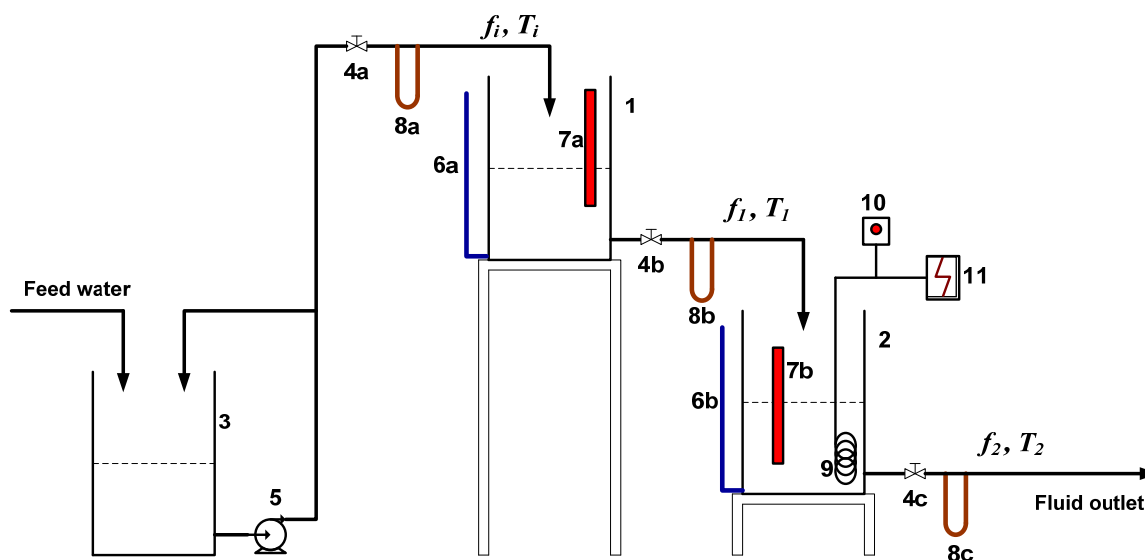
The goal of this research is to examine the control configuration of NIT system which is resulted by our previous work [Hermawan et al, 2010]. The mass disturbance load is made to examine the performance of control configuration of NIT. PI (Proportional Integral) Control is implemented in all control loops of NIT system. PI Control parameters are tuned based on trial and error method. Dynamic behaviors of NIT's control system will be explored through rigorous dynamic simulation. The Scilab software is utilized to carry out dynamic simulation.

2. Experimental

Experimental apparatus setup is shown in **Figure 1**. As can be seen from **Figure 1**, tanks No. 1 and No. 2 are considered as a NIT system. In this research, water was used as a fluid with both of its density and its heat capacity are assumed constant. Tank-1 has an input stream with volumetric rate of f_i (cm³/sec) and temperature of T_i (oC). The output stream of Tank-1 is then flowed to Tank-2. Electric heater was employed in Tank-2 to heat liquid in the tank. The liquid levels of both Tank-1 and Tank-2 are indicated by means of glass level indicator. The liquid temperature and flowrate are measured by means of thermometer and U-tube manometer respectively. The steady state parameters of NIT system are shown in **Table 1**. This steady state parameters results are then used as the initial conditions for closed loop dynamic simulation.

Table 1. Steady state parameters of NIT System [Hermawan et al, 2010].

Tank-1		Tank-2	
Parameters	Value	Parameters	Value
Input flowrate, f_i [cm ³ /sec]	15.2	Input flowrate, f_i [cm ³ /sec]	15.2
Output flowrate, f_o [cm ³ /sec]	15.2	Output flowrate, f_o [cm ³ /sec]	15.2
Liquid level, h_l [cm]	15.5	Liquid level, h_l [cm]	15.1
Temperature, T_l [°C]	28	Temperature, T_l [°C]	39.5
Input valve open (%)	40	Electric heat, q_e [watt]	800
Output valve open (%)	50	Input valve open (%)	50
Tank surface area, A_1 [cm ²]	491	Output valve open (%)	50
		Tank surface area, A_2 [cm ²]	491



Notes:

- | | | |
|---------------------------|----------------------|---------------------|
| 1 : Tank-1 for NIT system | 5 : Pump | 9 : Electric Heater |
| 2 : Tank-2 for NIT system | 6 : Level Indicator | 10 : Watt-meter |
| 3 : Storage Tank | 7 : Thermometer | 11 : Electricity |
| 4 : Valve | 8 : U-Tube Manometer | |

Figure 1. Experimental apparatus setup [Hermawan et al, 2010].

Mass balance of Tank-1 can be written as follow:

$$\frac{dh_1(t)}{dt} = [f_i(t) - f_o(t)] / A_1 \quad (1)$$

Mass and energy balance of Tank-2 are:

$$\frac{dh_2(t)}{dt} = [f_1(t) - f_2(t)] / A_2 \quad (2)$$

$$\frac{dT_2(t)}{dt} = [f_1(t)\bar{T}_1 - f_2(t)\bar{T}_2 + q_e(t) / (\rho c_p) - \bar{T}_2(f_1(t) - f_2(t))] / V_2 \quad (3)$$

Control configuration of NIT system resulted by our previous work is illustrated in **Figure 2**. There are 4 couples of CV-MV in NIT's control configuration as shown in **Table 2**; They are flow controller in the input stream of Tank-1, liquid level controller in Tank-1, liquid level controller in Tank-2, and liquid temperature controller in Tank-2. Tuning control parameters for all controllers are also listed in **Table 2**. In this work, feedback PI controls are implemented to maintain the controlled variables as its set point. Manipulated variables for all controllers are as follow:

$$\text{Manipulated variable of FC-01: } f_i(t) = f_i^{SP} + K_c e_1(t) + \frac{K_c}{\tau_I} \int e_1(t) dt \quad (4)$$

$$\text{Where: } e_1(t) = f_i^{SP} - f_i(t) \quad (5)$$

$$\text{Manipulated variable of LC-01: } f_1(t) = \bar{f}_1 + K_c e_2(t) + \frac{K_c}{\tau_I} \int e_2(t) dt \quad (6)$$

$$\text{Where: } e_2(t) = h_1^{SP} - h_1(t) \quad (7)$$

$$\text{Manipulated variable of LC-02: } f_2(t) = \bar{f}_2 + K_c e_3(t) + \frac{K_c}{\tau_I} \int e_3(t) dt \quad (8)$$

$$\text{Where: } e_3(t) = h_3^{SP} - h_3(t) \quad (9)$$

$$\text{Manipulated variable of TC-01: } q_e(t) = \bar{q}_e + K_c e_4(t) + \frac{K_c}{\tau_I} \int e_4(t) dt \quad (10)$$

$$\text{Where: } e_4(t) = T_2^{SP} - T_2(t) \quad (11)$$

The developed mathematical model of NIT control configuration system is solved numerically with the easiest way of explicit Euler. The free software Scilab is chosen to carry out the closed loop dynamic simulation. The input mass disturbance load is made in order to examine the performance of NIT control configuration. The closed loop responses of control system to a change in the mass disturbance load will then be explored in this work.

Table 2. Couples of CV-MV and tuning control parameters of NIT System

Controller	CV	MV	Control Type	Tuning Control Parameters	
				K_c	τ_I
FC-01	f_i	f_i	PI	0.01	10 [sec]
LC-01	h_1	f_1	PI	-5 [cm ² /sec]	60 [sec]
LC-02	h_2	f_2	PI	-5 [cm ² /sec]	60 sec]
TC-01	T_2	q_e	PI	15[watt/°C]	10 [sec]

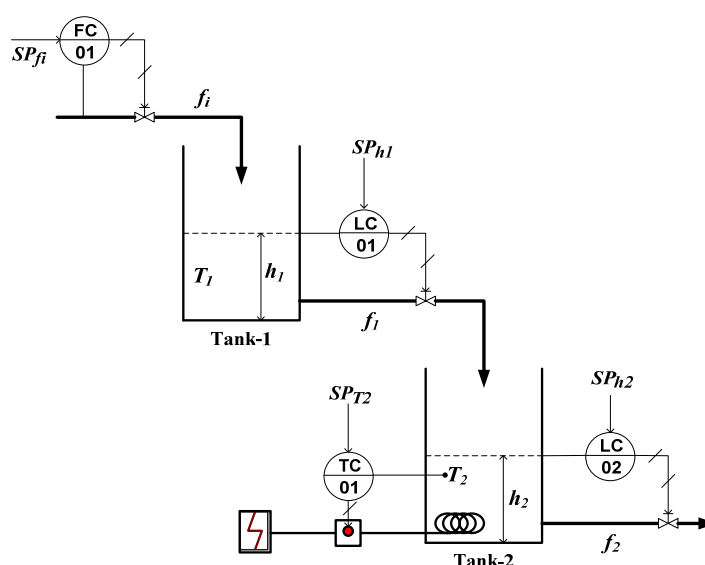


Figure 2. Control configuration of NIT System

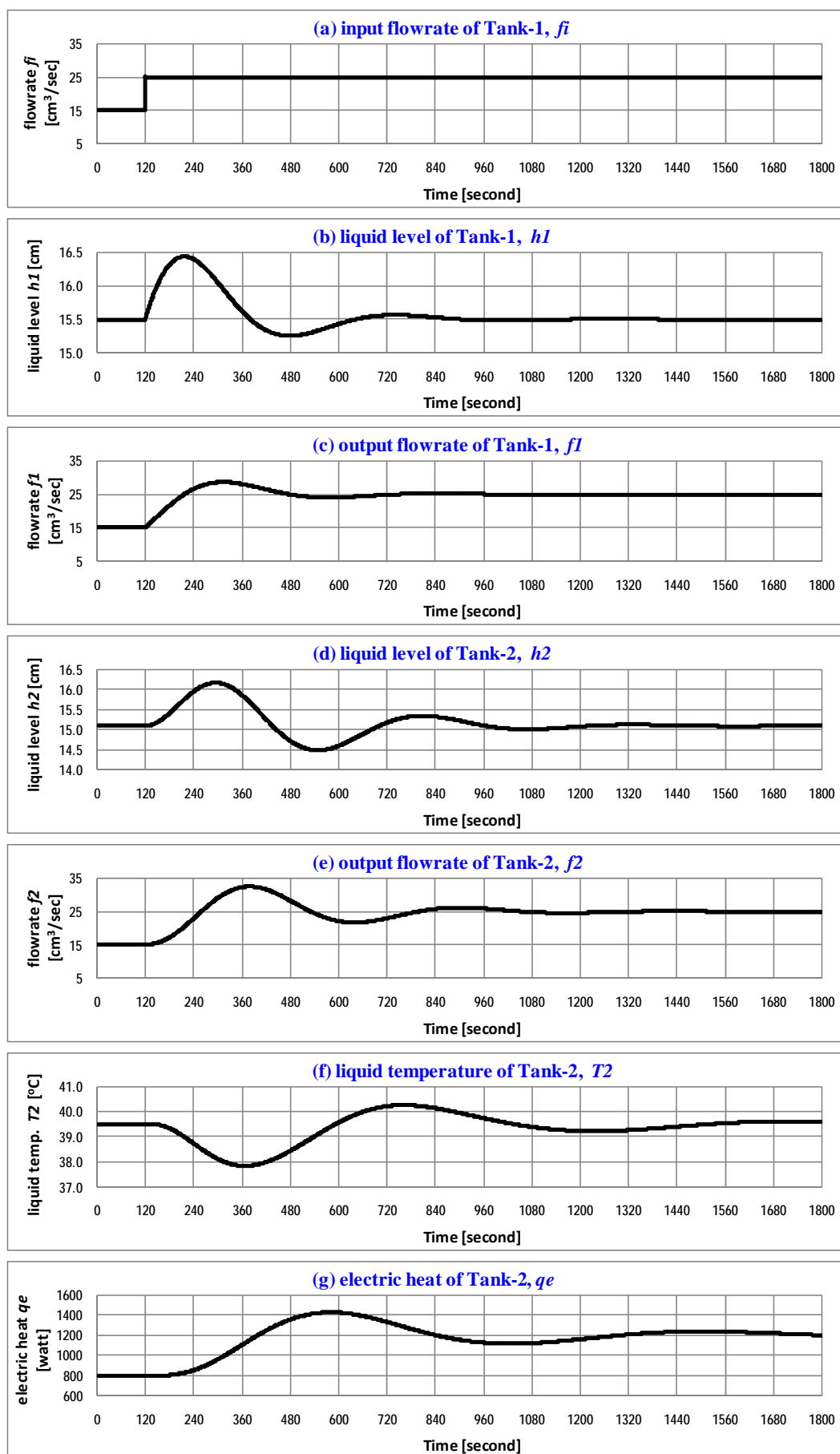


Figure 3. Dynamic responses of NIT control system to a change in set point of f_i .

3. Results and Discussion

Figure 3 shows the closed loop responses to a change in the input flowrate of Tank-1 (f_i). The set point of input flowrate f_i is increased by an amount of 10 cm³/sec at time equals 120 seconds (**Figure 3.a**). Since the input flowrate of Tank-1 increases, it is understandable that the liquid level in Tank-1 (h_1) rises first, and then it can be returned to its set point of 15.5 cm at time about 960 seconds (**Figure 3.b**). The output flowrate of Tank-1 (f_1) is manipulated to maintain the liquid level in Tank-1 at its set point (**Figure 3.c**). Finally, the flowrate f_1 achieves new steady state value of 25 cm³/sec at time equals 960 seconds (**Figure 3.c**).

The characteristic change of Tank-1 propagates to the next tank, i.e. Tank-2. The dynamic behavior of liquid level in Tank-2 is similar with that in Tank-1. However, the liquid level of Tank-2 can be returned to its set point of 15.1 cm at time equals 1560 seconds (**Figure 3.d**). The output flowrate of Tank-2 (f_2) is manipulated to keep the liquid level in Tank-2 constant. The flowrate f_2 rises a new steady state value of 25 cm³/sec at time equals 1560 sec (**Figure 3.e**).

As can be seen from **Figure 3.f**, the liquid temperature of Tank-2 (T_2) decreases first as the input flowrate increases. The liquid temperature T_2 is controlled by manipulating the electric heat q_e . The electric heat must be increased to rise the liquid temperature T_2 . Finally, the electric heat q_e achieves a new steady state value of 1200 watt at time equals 1560 sec (**Figure 3.g**).

4. Conclusion

This paper has discussed dynamic simulation and control in a NIT system. The resulted control configuration of NIT system has been examined through rigorous dynamic simulation. As can be seen from our closed loop dynamic simulation, the NIT control configuration gives stable responses to a change in the input mass disturbance load. This study also reveals that by developing the appropriate control configuration, i.e. proper couples of CV-MV, stable and fast responses can be achieved.

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Nomenclature

$A_{1,2}$	surface area of Tank 1,2 (cm ²)
c_p	heat capacity of fluid (J/(gr.°C))
$e_{1,2,3,4}$	error for FC-01, LC-01, LC-02, and TC-01
$f_{i,1,2}$	volumetric flowrate of stream i, 1, 2 (cm ³ /second)
$h_{1,2}$	liquid level of Tank 1, 2 (cm)
h_1^{SP}	set point of liquid level of Tank-1 (cm)
h_2^{SP}	set point of liquid level of Tank-2 (cm)
K_c	proportional gain controller
q_e	electric heat/energy (Watt or J/second)
$T_{1,2}$	liquid temperature of Tank 1, 2 (°C)
T_2^{SP}	set point of liquid temperature of Tank-2 (°C)
t	time (second)
$V_{1,2}$	liquid volume in Tank 1,2 (cm ³)
<i>Greek letters</i>	
ρ	liquid density (gr/cm ³)
τ_i	integral time constant (second)

Abbreviations

CV	Controlled Variable
FC	Flow Controller
LC	Level Controller
MV	Manipulated Variable
NIT	Non-Interacting-Tank
TC	Temperature Controller

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