PROCEEDING

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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 aboard such as Japan, Taiwan, Korea, Malaysia, Thailand, and Australia, Philiphine, 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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B-10 Henry's Constant Of Polar Solutes In Polymer Solutions
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B-11 Optimisation Of Ls54/Dx Aqueous Two Phase System Conditionsfor Cutinase Recovery
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B-12 Principal Component Analysis of Optimum Linear Estimator in Chemical Processing System
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B-13 State and Parameter Estimation of Large Scale Chemical Processing System
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B-14 A decision modeling approach to evaluate the climate change mitigation options in the Philippines

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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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Dep.Chem.Eng., Syiah Kuala Uni., Banda Aceh, Indonesia

C-02 Effect of Coalescer Height to Oil Separation in Produced Water Using Gas Flotation Vessel Cell
Yazid Bindar, Ira Susanty and Dinar Citra Indar Hutami
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Departement of Chemical Engineering ,Faculty of Industrial Engineering
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C-03 Comparison of Cutinase Separation in Different Chromatographic Media
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Department of Chemical & Process Engineering, Faculty of Engineering & Built Environment, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor

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-Methylimidazoliumbis(Trifluoromethylsulfonyl)imide[C_4mim][NTf_2]with Anisole
Elisabeth Widowati, Ming-Jer Lee
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Renita Manurung, Rakhmat Akbar Sinaga and Rahmad Taufik Simatupang
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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
Putu D. Sutrisna, Julius Candrawan, and Wira W. Tangguh
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C-21 The Use of Ion-Exchange Resin in The Production of Clean Biodiesel
Manal Ismail, Naidatul Fariha, and Zahira Yaakob
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C-22 Co-solvent Selection for Supercritical Fluid Extraction of Essential Oil andBioactive Compounds from *Polygonum minus*
Norsyamimi Hassim, Masturah Markom, Nurina Anuar, and Syarul Nataqain Baharum
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C-23 Vegetable oil reforming for high-temperature PEMFCs
Parinya Intaracharoena, Worapon Kiatkittipong, Suwimol Wongsakulphasatch and Sutichai Assabumrungrat
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Department of Chemical Engineering, Faculty of Engineering, Chulalongkorn University, Bangkok 10330, Thailand

C-24 Novel heterogeneous monolithic catalyst in biodiesel production: A review
Manal Ismail, Siti Rahayu Azman, Abdul Amir Hassan Kadhum, and Zahira Yaakob
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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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Center for Material and Technical Product, Ministry of Industry, Bandung 40135, Indonesia

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
Department of Chemical Engineering, Kyoto University – Japan

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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Department of Civil Engineering, National Taiwan University, Taipei 106 Taiwan
Graduate Institute of Environmental Engineering, National Taiwan University, Taipei 106 Taiwan

C-29 Kinetic Evaluation of the Graft Copolymerization of Acrylic Acid onto Starch Based on Concentration Measurements and on Torque Observation
Judy R.Witono, Hero J. Heeres, Leon P.B.M.Janssen, Inge W. Noordergraaf
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Department of Chemical Engineering University of Groningen, Groningen 9700AB The Netherlands

C-30 Identification of Potential Dyesand 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
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C-32 Prediction of Solubilities of CO, H2 and Its Mixture in Various Solvents
Joko Waluyo and Herri Susanto
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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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Petroleum Engineering Program, Bandung Institute of Technology, Bandung 40132, Indonesia

C-35 Adsorption of copper(II), cadmium(II) and zinc(II) ions by SDS-functionalized mesoporous silica
Wanchai Kaewprachum, Suwimol Wongsakulphasatch,Worapon Kiatkittipong, and Suttichai Assabumrungrat
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Department of Chemical Engineering, Faculty of Engineering and Industrial Technology, Silpakorn University, Nakhon Pathom 73000, Thailand.

C-36 Dye Adsorption on Silica-filled ENR/PVC Beads
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C-37 Phase Behaviour Of CH_4-CO_2 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
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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 PreparationofAmine-GraftedMesoporousMaterialMCM-48UsingGeothermalSolidWasteSilica
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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-12 Synthesis and Characterization of ZeoliteMonolith by Ice-Templating and Steam-Assisted Crystallization
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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
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D-15 Production and Characterization of Polyethylene-Clay Nanocomposites through in situ Polymerization using Montmorillonite Supported Metallocene Catalyst
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D-16 Thermomechanical Properties of Kevlar^{TM} Reinforced Benzoxazine-Urethane Alloys
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D-17 Effectiveness of Tannin as Corrosion Inhibitor for Carbon Steel in Chloride Solutions
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D-18 Polymer Flooding for Improving Oil Recovery
Suryo Purwono, Bardi Murachman, Rochmadi, Wahyu Hasokowati, Dodi Irawan and Yudha Endriadi
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D-19 Evaluation of micro-catalytic reactor with *in situ* UV microscopy
Tomohiko TAGAWA, Lee Yi Fuan and Hiroshi YAMADA
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D-20 Innovation process and equipment in the traditional tempe industries without pollution
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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
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D-22 Bimodality Criterion for Sequence Length Distribution of Ethylene/1-olefin Copolymers
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D-23 Simulation of Morphological Development during Crystallization of Syndiotactic Polypropylene in a Temperature Field
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D-24 Effect of Ethylene-Vinyl Acetate Copolymer on Properties of Acrylonitrile-Butadiene-Styrene/Zinc Oxide Nanocomposites
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D-25 Developing Anti-Fogging Visor Using Titania Nanoparticle Coating
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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
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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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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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Department of Chemical Engineering, Faculty of Engineering, Srinakharinwirot University, Nakhonnayok 26120, THAILAND

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
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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
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D-35 Effect of Temperature and Type of Inorganic Acid in Acidolysis of Epoxy and Polyurethane Thermosetting Resins
Jonas Karl Christopher N. Agutaya, Zarlon M. Bernardo, Lorenz Anthony T. Fernando, Timothy David T. Salmo, Terence P. Tumolva
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D-36 SynthesisofProton Exchange Membrane from SO_3H-Grafted Silica Membrane in Production of Electrolized Oxidized Water (EOW)
Zarra Miantina Putrie, Rizki Pratama, Vania Mitha Pratiwi, Minta Yuwana and Heru Setyawan
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D-37 Coating Steel With Nanosilica By Electrophoresis For Corrosion Protection
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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
Renung Reningtyas, Indra Perdana, I Made Bendiyasa
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D-40 Validation of a Base-Extraction □-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
Masao Gena, Hideo Kakutac, Yoshihito Kamimotod and Wuled Lenggoroa
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Kanagawa Industrial Technology Center, Ebina, Kanagawa 243-0435, Japan

Department of Chemical Engineering, Osaka Prefecture University, 1-1 Gakuen-cho Naka-ku, Sakai, Osaka, Osaka 599-8531, Japan

D-57 The Analysis of Particle Formation Mechanism in the Diffusion Flame Reactor using Liquid Precursor
Agung Nugroho, Widiyastuti, and Sugeng Winardi
Department of Health and Safety Engineering, Surabaya Shipbuilding State Polytechnic, 60111, Indonesia
Department of Chemical Engineering, Sepuluh Nopember Institute of Technology, Surabaya 60111, Indonesia

D-58 Effect Sonication in Cellulose Degradation Using Hydrothermal Method
Sumarno, P.N. Trisanti, Sumari, and Mulyanto
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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
Katsuyasu Sugawara, Takahiro Kato, Kenji Murakami, Takuo Sugawara and Hitoshi Funayama
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E-03 Precipitation of struvite: a feasible approach for scale prevention and nutrient recovery from wastewater
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E-04 Removal of Acid Blue 158 from Solution by Sunflower Seed Hull

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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

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E-07 Improving the performance of cellulose acetate pervaporation membrane by the addition of bentonite and natural zeolite Malang

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E-08 The Use of Natural Coagulants in Wastewater Treatment

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E-09 Recent Development In Solid Waste Management Through Composting and Vermicomposting

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E-10 Treatments of Pulp and Paper Mill Effluent

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E-11 Variation of Size Distribution and Iron Loading in Iron Oxide-Coated Sand Sorption Systems

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E-12 Photocatalytic Degradation of Azo Dyes (Reactive Red 198) using Platinum-loaded AgBr-TiO_2 Coupled Catalysts
Argenia B. Co, Daryll Anne T. de Joya,Eunice H. Mabutas, and Rolly G. Santos
School of Chemical Engineering and Chemistry
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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
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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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Additional Paper

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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).

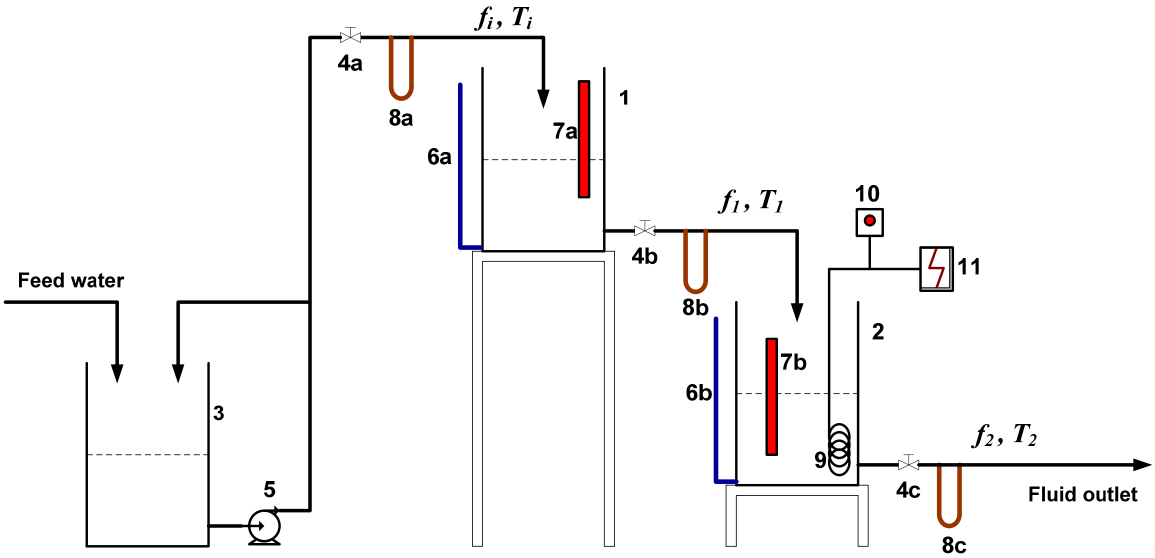
The goal of this research is to examine the control configuration of NIT system which is resulted by our previous work [Hermawan et al, 2010]. The mass disturbance load is made to examine the performance of control configuration of NIT. PI (Proportional Integral) Control is implemented in all control 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 trough 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 (cm^3/sec) and temperature of T_1 (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 temperatur 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_1 [cm^3/sec]	15.2	Output flowrate, f_1 [cm^3/sec]	15.2
Liquid level, h_1 [cm]	15.5	Liquid level, h_1 [cm]	15.1
Temperature, T_1 [^{o}C]	28	Temperature, T_1 [^{o}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
2 : **Tank-2** for NIT system
3 : Storage Tank
4 : Valve
5 : Pump
6 : Level Indicator
7 : Thermometer
8 : U-Tube Manometer
9 : Electric Heater
10 : Watt-meter
11 : Electricity

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

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

$$\frac{dh_1(t)}{dt} = [f_i(t) - f_1(t)]/A_1 \quad (1)$$

Mass and energy balance of Tank-2 are:

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

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

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:

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

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

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

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

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

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

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

Where: $e_4(t) = T_2^{SP} - T_2(t)$ (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/^{o}C]	10 [sec]

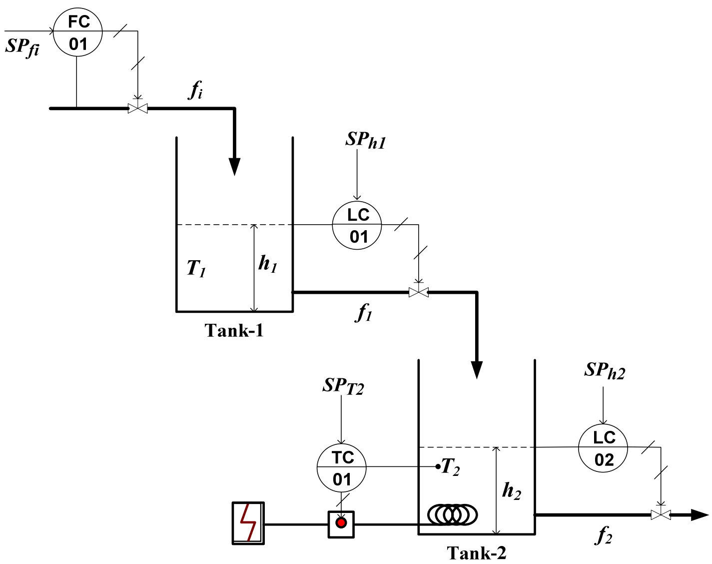


Figure 2. Control configuration of NIT System

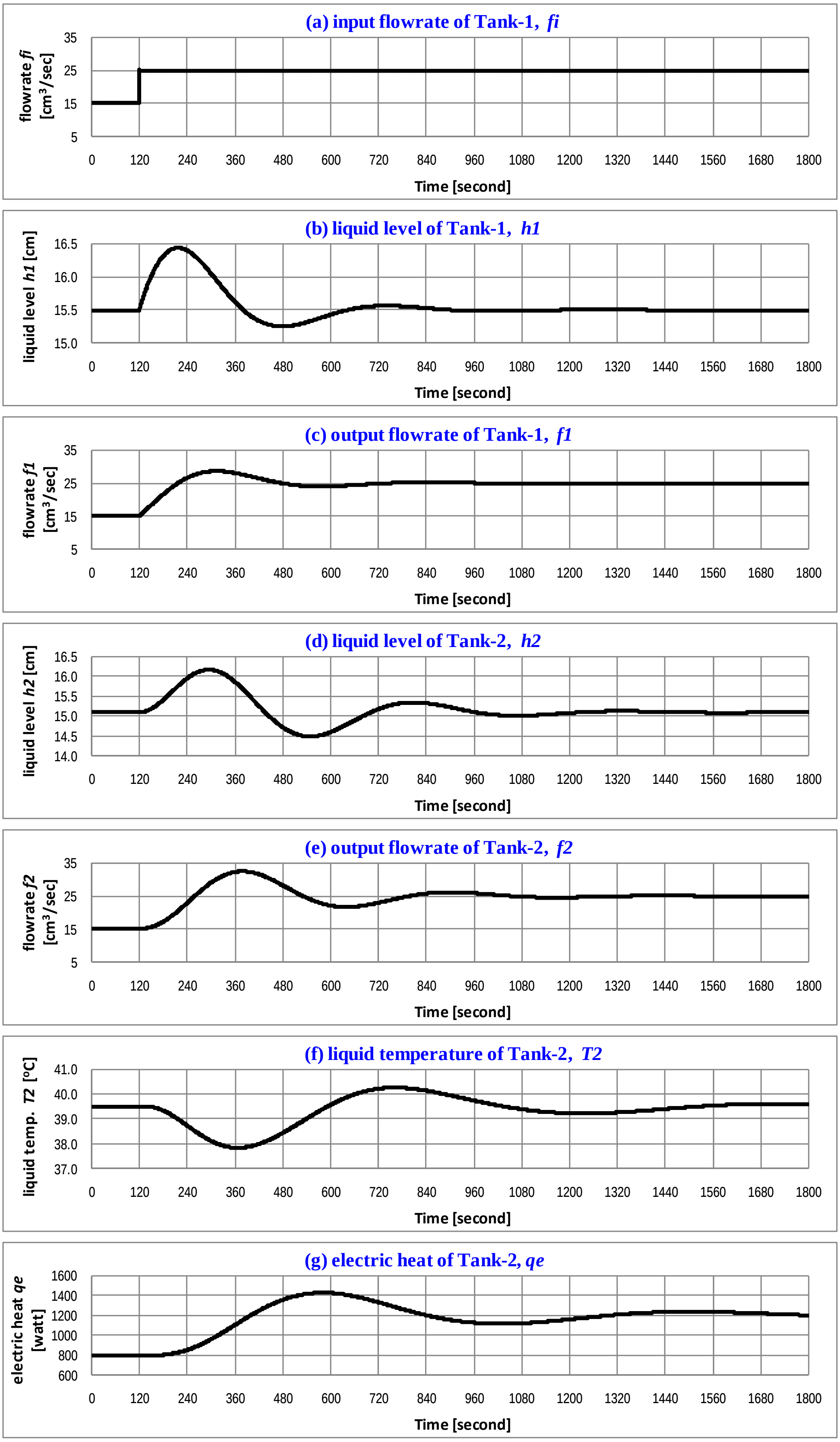


Figure 3. Dynamic responses of NIT control system to a change in set point of f_i.

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 cm^3/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 cm^3/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 inTank-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 cm^3/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.^{o}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 (^{o}C)
T_2^{SP}	set point of liquid temperature of Tank-2 (^{o}C)
t	time (second)
$V_{1,2}$	liquid volume in Tank 1,2 (cm^3)
Greek letters	
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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