Editorial

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Editorial: Special Issue of 29th Symposium of Malaysian Chemical Engineers (SOMChE) 2016 – Process System Engineering

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Abstract:
This special issue presents a set of twelve selected papers from 29th Symposium of Malaysian Chemical Engineers (SOMChE) 2016 on the area of process system engineering. SOMChE 2016 itself was held in Miri Marriott Resort & Spa, Miri, Sarawak, Malaysia from 1st to 3rd December 2016. This symposium was co-organised by Department of Chemical Engineering, Curtin University Malaysia and Institution of Chemical Engineers (IChemE), Malaysia. Since the theme of the symposium is "Engineering Solutions for Sustainable Development", its papers are related to the latest advances and best practices of engineering solutions in industry and academic for sustainable food, water, energy and environment. Consequently, the selected papers in this special issues focus on how process system engineering is employed to address energy, environmental and economic issues faced by process industries. Each paper in this special issue had undergone double peer review to ensure its quality. We believe that this issue will serve as a book of knowledge and an essential literature, which will lead to not only scientific and engineering progress but also other novel processes and new products. We express our gratitude to the authors, reviewers and editors of this journal who make the publications of these papers possible.

Keywords: SOMChE 2016, process system engineering, modeling & simulation, process control
DOI: 10.1515/cppm-2017-0062
Received: September 14, 2017; **Accepted:** September 15, 2017

Summary of Papers

Paper 1 – Effect of Inventory Change in a Liquid – Solid Circulating Fluidized Bed (LSCFB)

In this paper, Gnanasundaram et al. presents hydrodynamic studies of liquid-solid circulating fluididized bed. Specifically, investigations were directed toward the effect of inventory changes on axial and average solid hold-up, rate of solid circulation and slip velocity. On increasing the inventory, uniformity of axial solid holdup was confirmed to be consistent with holdup patterns. As hypothesized, solid flux was observed to be in an inverse relationship to holdup. The change in slip velocity with varying inventory was also monitored, and was found to decrease with inventory. The distribution parameter, C_o of the drift flux model was used to determine the extent of non-uniformity in solid distribution. C_o was calculated to be less than unity in the range of 0.983–0.994, suggesting non-uniformity in solid distribution, with higher solid concentration near to the walls compared to the core.

Paper 2 – Simulation and Optimization of Triethylene Glycol Utilization of a Natural Gas Dehydration System

This paper reports findings on the optimization of dehydration unit in natural gas processing plant. The main objectives of this optimization are to satisfy the requirement of allowable water concentration in natural gas and minimize the energy consumption and triethylene glycol (TEG) loss. Data from Farashband natural gas processing plant in Iran were adopted, analysed using Design Expert software and fed into ASPEN HYSIS to simulate the process. The input variables are lean glycol circulation rate, the temperature of the reboiler, and the number of trays in the contactor column. Meanwhile, the output variables consist of amount of glycol that was lost, the reboiler duty, water concentration in the dry gas, and the temperature at which the hydrate

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formed. The simulated data were then optimized using response surface methodology and it was evident that optimum operation conditions for the lean glycol circulation rate, the reboiler temperature, and the number of trays in the glycol contactor column were 3944 kg/hr, 180 °C, and three trays, respectively.

Paper 3 – Development of Adaptive Soft Sensor using Locally Weighted Kernel Partial Least Square Model

This paper proposed and discussed locally weighted Kernel partial least square (LW-KPLS) as a better adaptive soft sensor model compared to locally weighted partial least square (LW-PLS). From the simulation results, it is apparent that LW-KPLS based soft sensor outperformed its LW-PLS counterpart in terms of predictive performances. Nevertheless, LW-KPLS based soft sensors require longer computational times than of LW-PLS. An ensemble method was then incorporated to LW-KPLS algorithm and simulated data indicated that while maintaining its predictive capability, this modified LW-KPLS showed comparable computational load to LW-PLS one.

Paper 4 – Comparison of Turbulence Models for Single Sphere Simulation Study under Supercritical Fluid Condition

A comparative study of turbulence models for flow around single sphere under supercritical conditions was carryout out and presented in the current paper. The simulation was first conducted for non-supercritical conditions and validated against Dixon et al.'s data (2011) [1]. The simulations were then extended to model and capture super critical fluid flow behaviour around single sphere in which different turbulence models were compared and evaluated and their parameters were fine-tuned. The results from this study reveal that SST k-ω turbulence model is the best model suitable to investigate and simulate flow characteristics near-wake of the sphere.

Paper 5 – Integrated Palm Biomass Supply Chain toward Sustainable Management

This paper put forward an idea of having a systematic approach which integrates both economic and environmental concerns in the sustainable biomass supply chain management using the concept of analytic hierarchy process (AHP). Instead of merely focusing on carbon emission, the proposed approach incorporates other environmental indicator as well, i. e. global warming potential (GWP), ozone depletion potential (ODP), acidification potential (AP), photochemical ozone creation potential (POCP), nutrification potential (NP), aquatic toxicity potential (ATP), terrestrial toxicity potential (TTP), abiotic depletion potential (ADP), water footprint and land footprint. Both economic and environmental sustainability are expressed in a vector form. With the aid of the graphical representation, the tendency of the process towards each sustainability dimension can be clearly seen. A case study in Johor state was used to demonstrate the proposed method and a palm biomass supply chain with high sustainability performance (λ^{SCM}= 0.8437) was synthesised in this paper.

Paper 6 – Process Optimization and Multi-Scale Control of Bunsen Section in Iodine-Sulphur Thermochemical Cycle Process for Hydrogen Production

A strategy of plant-wide modelling and advanced process control with optimization for the Hydrogen production via the Iodine-Sulphur thermochemical cycle process is presented in this paper. Multi-scale model was developed and then employed in the control system where sets of manipulated and controlled variables were selected via a sensitivity study method by incorporating the multivariate Response Surface Analysis method. From the simulation studies, the proposed control strategy was proven to be able to produce good closed-loop and robustness performances even in the worst case uncertainty scenario

Paper 7 – Optimisation of Design and Operation Parameters for Multicomponent Separation via Improved Lewis-Matheson Method

This paper describes simulation and optimization procedures of multicomponent distillation assisted with modified Lewis-Matheson method. The objective function of the optimization is to minimize total annualized cost, which includes both capital and operating costs. The effectiveness of the proposed design and optimization procedures was demonstrated and tested using data from an industrial-scale natural gas liquids (NGLs) depropanizer fractionation unit.

Paper 8 – The Effect of Various Components of Triglycerides and Conversion Factor on Energy Consumption in Biodiesel Production

Simulation studies on biodiesel production from palm oil were simulated using ASPEN HYSIS to study the effect of various components of triglycerides on the conversion factor and energy consumption. Results showed that triolein with 0.12 wt% of oleic acid and tripalmitin with 0.5wt% of palmitic acid are able to produce 99.75 % of biodiesel and 99.67 % of biodiesel, respectively. Energy usage of each process was also estimated and evaluated.

Paper 9 – CFD Simulation of Hydrodynamics in Gas-Liquid Airlift Reactor

This paper presents a transient simulation using computational fluid dynamics to predict the hydrodynamics in a three dimensional internal airlift reactor by implementing standard *k-ε* dispersed turbulence model. The simulation results were compared with local gas holdup and liquid velocity obtained from Couvert (2000) [2] experimental work. A comparison between four different drag models, two turbulent dispersion models and

two types of bubble induced models were carried out. In addition, the evaluation on the effect of the lift force on local gas holdup prediction in the riser and downcomer was also performed.

Paper 10 – Analysis of the steady-state multiplicity behaviour for polystyrene production in CSTR

The paper presents and discusses two different approaches, system theory and heat balance based methods, employed to analyze the abnormal phenomena of the continuous polystyrene reactors, e. g. multiplicity behavior in the wide range of operating conditions. Multiplicity behavior of polystyrene production in a continuous stirred tank reactor was carried out via numerical simulations through the Van Heerden diagram and phase plane. Bifurcation diagrams in terms of two different inputs including jacket temperature and volumetric flow rate of initiator were also adopted to predict the appearance of multiplicity behavior as well as the saddle-node bifurcation points. Results showed that multiplicity behavior of the system appears under considered operating conditions and bifurcation behavior was able to assist the theoretical prediction of multiplicity behavior.

Paper 11 – Numerical studies on the laminar thermal-hydraulic efficiency of water-based Al_2O_3 nanofluid in circular and non-circular ducts

Numerical results of laminar forced convective heat transfer performance and the flow behaviour for Al_2O_3-water nanofluid in circular and non-circular ducts are reported and discussed in this paper. The ducts considered for this study were circular pipe, 2:1 rectangular, 4:1 rectangular and square ducts. The concentrations of Al_2O_3 nanoparticles taken into account were 0.01 %, 0.09 %, 0.13 %, 0.25 %, 0.51 % (low volume fractions) and 1.00 %, 4.00 % (high volume fractions). Two different single phase approaches were employed: (a) temperature-independent properties (b) temperature-dependent properties. The simulation results indicate that Al_2O_3-water nanofluid is able to enhance the heat transfer performance of water for all the ducts used. However, this heat transfer enhancement is achieved at the penalty of higher pressure drop. Therefore, overall the thermal-hydraulic efficiency of nanofluids is found to be smaller than that of water system.

Paper 12 – Simultaneous carbon capture and reuse using catalytic membrane reactor in water-gas shift reaction

This paper describes the possibilities of capturing CO_2 and reusing it in the dry methanation in a water-gas shift reaction used to produce H_2. In the proposed reuse strategy, the WGSR uses carbon monoxide (CO) and water as the reactants while the dry methanation reaction uses CO_2 and methane (CH_4) to produce CO and H_2. Based on two case studies of industrial plants, rigorous evaluation on the technical and economic feasibility of the implementation of this reuse strategy in a H_2 selective membrane reactor (MR) was carried out. Upon extensive analysis of different strategies with and without carbon capture technology, it is found that with the proposed carbon capture strategy, the industrial plants show positive improvement in terms of both technical and economic performances.

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