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Preface

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1st Process Systems Engineering & Safety (ProSES) Symposium 2019 Preface

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The special issue of 1st ProSES Symposium is a collection of invited contributions from the presenters of the inaugural Process Systems Engineering & Safety (ProSES) Symposium, organized by Process Systems Engineering & Safety (ProSES) Research Group, Faculty of Chemical and Process Engineering Technology, formally known as the Faculty of Chemical and Natural Resources Engineering, Universiti Malaysia Pahang, on 4th September 2019 in Kuantan, Pahang, Malaysia. The theme for the 1st ProSES Symposium 2019 is The Role of Modelling and Simulation Towards IR 4.0, since the emergence of IR4.0 technology provides the opportunity for dramatically increasing the reliability and efficiency in production operations of many industrial sectors including chemical-based processing. Hence, it is the aim of this conference to provide the platform for intellectual discourse for the application of computer aided tools for modelling and simulation in the area of process systems engineering and safety particularly in the era of IR4.0, and related topics. 1st ProSES Symposium 2019 attracted more than 60 extended abstracts submissions. Two keynote speakers delivered their particularly interesting topics – Professor Ir Dr Haslenda Hashim from Universiti Teknologi Malaysia with a talk on "Process Modelling and Simulation Toward IR4.0"; and Professor Dr Azmi Mohd Shariff from Universiti Teknologi Petronas on "Process Safety in IR4.0".

This Special Issue has compiled 60 invited full-length contributions in the mentioned area with specific scopes of renewable energy; integration and optimization; control and monitoring; catalyst and reaction engineering; material science and engineering; separation and purification technology; safety and loss prevention and related topics. In the area of renewable energy, Ravendran et al. [1], developed a process model using Aspen Plus to simulate the biogas production through anaerobic digestion process, highlighting the economical potentials and environmental benefits of the process. Through their work, they determined the optimum feed rate of 0.36 l/day and operating pressure of 3 bar with hydrogen flow of 180 l/day, in which the maximum amount of methane was achieved. In another work by Abdul Rahman et al. [2], food waste was pre-treated through the conventional torrefaction process while Ismail et al., [3] studied the application of microwave to enhance the torrefaction of food waste to produce biochar, a source of renewable energy that can potentially replace the conventional fossil-based fuel such as coal. On the other hand, Jamin et al., [4] developed the kinetic model on the anhydrous weight loss of green waste, one of the main compositions of municipal solid waste. The model was developed based on the two-steps reaction in series from Di Blasi and Lanzetta, through thermogravimetric analysis (TGA). Bio-based fuels such as bioethanol [5] and biobutanol [6] from oil palm fruit juice have been

studied and proven to be useful in the production renewable energy, both of which applied the central composite design (CCD) through response surface methodology (RSM). In addition, levulinic acid was produced from matured coconut water and modeled successfully in Simulink, to evaluate and predicts its production [7]. A process simulation study on co-gasification of coal and empty fruit bunch [8] has been carried out to evaluate the performance of entrained flow gasifiers in the production of synthesis gas, mixture of carbon monoxide and hydrogen, which can be further utilized in power production or specialty chemicals. They developed the process model in Aspen Hysys and found that carbon conversion reached above 90% and the maximum value of cold gas efficiency (CGE) and higher heating value (HHV) were obtained. Another optimization study on biomass gasification [9] has also been done using CCD through RSM. Saleh and Samad [10] has successfully developed a thermodynamic equilibrium model in Excel to evaluate a wide range of biomass gasification process. The model has been validated and was found to be reliable with the root mean square errors (RMSEs) of lesser than 1 has been obtained.

In the research area related to integration and optimization, Changresegaran et al. [11] performed a simulation and optimization study of industrial spent caustic wastewater treatment by wet oxidation method. The process was successfully simulated, and the optimization results shows that 1:9.2 is the minimum spent caustic feed flow rate to air flow rate ratio and optimum operating temperature of flash separator unit is 140 ^{o}C for maximum flow rate of CH_3SSCH_3 in off gas stream. Sidek and Othman [12] assessed the performance of distillation column heat pumping technology for oleochemical fatty acid fractionation. Two heat pumping system configurations were simulated using Aspen Plus. Simulation results indicates that both configurations of heat pump can be feasibly integrated with the distillation column. However, to satisfy the heating and cooling requirement, supply of make-up utility is necessary. Mansor et al. [13] integrate ionic liquid to dissolve palm fruit cellulose to improve the extraction of palm oil. By integrating the ionic liquid, it was found that highest average percentage dissolving of cellulose was 10.67 wt% with condition concentration of sulfate-based ILs is 9000 ppm and the mixing time was two hours. In a nutshell, the higher concentration of ILs and more mixing time will achieve higher percentage of cellulose dissolved. Misrol et al. [14] and Saád et al. [15] studied optimal production of biogas and water integration system of an Eco-Industrial Park (EIP). Both studies show that generating biogas and treating wastewater could be potentially feasible to reduce unnecessary pollutant while reduce the water treatment burden. A superstructure optimization of bioethanol production from corn stover was proposed by Azizan et al. [16] to design an optimal processing route. Generic Algebraic Modelling System (GAMS) was used and the optimization results indicate that the optimal processing route include steam explosion, dilute acid followed by fermentation, beer and dehydration of ethanol on zeolite for each process interval with maximum yield of 2238.4 kg/h. Nafees and Abdul Rasid [17] modelled and simulated natural gas powered solid oxide fuel cell using Aspen HYSYS as well as user defined unit operation in MATLAB. In addition, Mansur and co-workers [18] developed a process model to evaluate the performance of the co-gasification of sub-bituminous coal with densified sawdust pellet using Aspen Plus. The result shows that 50% of the sawdust pellet blending ratio in the co-gasification is the best as it produced maximum syngas subsequently the best performance.

In the research area related to control and monitoring, Sulaiman and Ahmad [19] proposed a partial decoupler approach to minimize loop interation in multi input multi output (MIMO) system. Using case study found in literature, they found that the partial decoupler provides better performance as compared to conventional full decoupler. Hasnen et al. [20] developed an adaptive soft sensor based on dynamic PLS method. The method was applied to an industrial water-tube boiler for continuous online prediction of nitric oxides emission. It was found that the approach can significantly improve the prediction accuracy and reliability by 72.7%. Alias and Othman [21] and Othman [22] performed control study on dividing wall distillation column for fatty acid fractionation. The former focuses on temperature control while the latter on controllability analysis. Adnan and Samad [23] extended the method of classes (MOC) approach for solving population balance equations and optimization problem for to achieve desired CSD with minimum fine crystals. Based on the simulations, the MOC have shown comparable

results with published literature, which indicates MOC has been successfully extended to solve the PBE and representing CSD for size dependent growth rate system.

In the research related to recent trends in the area of catalyst and reaction engineering, Razak et al. [24] reported on the effect of Ni loading on SBA-15 synthesized from oil palm ash (OPA) catalysts for methane dry reforming process to produce syngas. The increase of Ni loading from 1 to 3wt.% results in lower surface area and pore volume of catalyst as more Ni particles tend to agglomerate and positioning on the SBA-15 pores. Ahmad et al. [25] synthesized Pt/MCNTs and P-dopedPt/MCNTs catalysts via hydrothermal method for glycerol oxidation reaction (GOR). P-dopedPt/MCNTs catalyst is more stable with high activity compared to Pt/MCNTs alone. In addition, P-dopedPt/MCNTs result high product yield and selectivity of tartronic acid and glyceric acid through selective GOR. Abdullah et al. [26] develop the kinetic model using Langmuir-Hinshelwood approach for the photocatalytic reduction of CO_2 to methanol in liquid phase reaction using cerium oxide-titanium dioxide (CeO_2-TiO_2) catalyst.

In the research area related to material science and engineering, Elganidi et al. [27] synthesize novel terpolymers via polymerization of stearyl methacrylate (SMA), benhely acrylate (BA), and maleic anhydride (MA) monomers to inhibit the wax precipitation in pipelines and reservoir formation. The terpolymer applied in pour point depressants (PPD) as wax control strategy shows high yield (87%) at the concentration (1:1:1) of BA-*co*-SMA-*co*-MA. In another work by Elarbe et al. [28], Stearyl Acrylate-Behenyl Acrylate (SABA) copolymer is synthesize using free-radical solution polymerization method. The highest yield of SABA copolymer was obtained at the mass ratio of monomers of 1:1 (w/w), the reaction temperature of 90 ºC, the reaction time of 7 h, and concentration of initiator at 1 wt%. Hybat et al. [29] propose membrane anaerobic system (MAS) to treat Palm Oil Mill Effluent (POME). High COD removal efficiency (94%-97%) in a short period of time and methane recovery around 67.8-70.3% was achieved. A MAS is also successfully applied for sugarcane mill effluent (SCME) with the removal efficiency of COD from 94.2% to 93.9% and produced methane gas (CH_4) 75.4%. [30]. Jusoh et al. [31] investigates intermolecular interaction between monomers m-phenylenediamine (MPD) and trimesoyl chloride (TMC) with polymer Nylon 6 6 (N66) in thin film membrane application. High intermolecular interaction at 3:1 of amount of MPD to TMC shows strong deposition of MPD and TMC on N66. Alashwal et al. [32] extract keratin from chicken feather and characterize it using Fourier transform infrared spectroscopy (FTIR), Scanning electron microscopy (SEM) and X-Ray Diffraction. The extracted keratin shows aspheric shaped, small microspheres with smooth surface. Husain et al. [33] used keratin protein extracted from a chicken feather to synthesize hydrogel using physical crosslinking by the freeze-thawing method for potential biomedical applications. A paper authored by Mohd Sofi et al. [34] highlighted preparation of non-soap based grease from waste transformer oil (WTO) by two types of non-soap based thickeners, i.e. fumed silica and bentonite. The best formulation is bentonite grease formulation with ratio of 80:20 (WTO: bentonite) due to it consistency of NLGI grade 2 which is comparable to most commercial greases. Sukaimi et al. [35] investigated low acid concentration (1.5, 2.5 and 3.5 M) and hydrolysis temperature (40, 60 and 80 °C) for the Microcrystalline cellulose (MCC) isolation from oil palm empty fruit bunch (EFB). The optimum condition for the acid hydrolysis process is 1.5M H_2SO_4 at 60 °C with the middle range of crystallinity (74.7 %) and yields (82.4 %). Ismail et al. [36] investigate three types of tea which are green tea (GT), black tea (BT) and oolong tea (OT) as surfactant in liquid phase exfoliation (LPE) of graphite to get high yield of graphene. Green tea is preferable which result high yield of graphene due to small components of polyphenols that present in a green tea. Alhadadi et al. [37] propose a melt blend of poly (lactic acid) (PLA), polyamide (Nylon 66) and graphene nanoplatelets (GnP) to produce nanocomposites with improved thermal stability. On the other hand, Mokaizh and co-workers [38] recovered alumina from aluminum can waste for biodiesel production as alumina is one of the most important ceramic oxides which have vast technological and industrial applications.

In the research related to recent trends in the area of separation and purification technology, several research works were focused on the screening of influencing factors in membrane development using

Design Expert software for better separation efficiency of membrane. Raj and Sunarti [39] developed the mixed matrix membranes (MMMs) comprised of polyvinyl chloride (PVC) and graphene oxide (GO). Screening test was carried out using Design Expert software by employing 2 Level full factorial design where five factors such as weight ratio PVC, weight ratio GO, pressure, type of solvent and time membrane in water was used to determine the performance of the MMMs in gas separation of CO_2 and CH_4. Study revealed that weight ratio of PVC, weight ratio of GO and type of solvents show the most contribution to the selectivity and highest response during interaction among factors. Study on the factors influencing CO_2 and CH_4 gas separation performance of PVC/Pebax thin film composite (TFC) was also conducted by Ghazali et al. [40] using Design Expert software. The effects of factors such as immersion time, concentration of Pebax and number of coating layer on CO_2 permeability and gas selectivity were explored by using a 2^3 fractional factorial design. The results show that the immersion time and Pebax concentration are the most influential factors that affect permeability while Pebax concentration and number of coating layer are the most influencing factors determine the selectivity. The best conditions to maximize permeability and selectivity were identified; immersion time for 15 min, Pebax concentration at 5wt% and 4 layers of coating resulted in CO_2 permeability and gas selectivity of 19612 Barrer and 7.15, respectively. Furthermore, 2^4 fractional factorial design was employed in the factors screening and interaction between factors in PVDF/Pebax film development on CO_2 gas selectivity in Abdul Wahab et al. [41]. Four factors such as Pebax concentration, bath temperature, evaporation times and quenching times was selected and run simultaneously and the effect on the ideal selectivity was evaluated. Pebax concentration shows the most contribution followed by quenching times, bath temperature, and evaporation times. Among the factors, Pebax concentration, quenching time and bath temperature showed positive effect towards gas selectivity. The interaction of evaporation times and Pebax concentration was the only interaction that contribute to the good gas selectivity. The PVDF/Pebax film composite produced in this study obtained higher barrer of CO_2 permeability of 393 and selectivity of 64.75 compared to the previous study. In addition, Malid et al. [42] applied 2^3 full factorial design for factors screening involved during vapour induced phase separation (VIPS) process for the preparation of polyethersulfone-graphene (PES) graphene membrane supported liquid membrane (SLM) system. The influence of three factors such as temperature of water coagulation bath, exposure time and air humidity on extraction percentage of acetic acid was investigated. The air humidity factor gave the highest contribution of 28.96% among the main factor. The interaction effects of the water bath temperature with exposure time show the most significant contribution of 45.01%. The highest extraction percentage of acetic acid using SLM system was 75.95% which was using the membrane prepare at water bath temperature of 30°C, 10 s exposure time and 70 % air humidity.

In the work by Rahman et al. [43], Classical Scaling (CMDS) method was used to develop a set of membrane profile performance for various types of UV-grafted polyethersulfone (PES) membrane using MATLAB software. Euclidean distance was employed to measure the dissimilarity between all samples. Three parameters were considered in creating the profile namely water permeability, solute permeability, and structural parameter. Based on the finding, the modified membranes were easily clustered based on its grafting mechanism. The study concluded that CMDS profiling tends to favor the pore size as the dominant impact factor in characterizing the membrane performance based on the three specified parameters. Isa et al. [44] investigated the potential of promoted potassium carbonate with glycine for CO_2 removal at elevated pressure of 10 bar for different temperature and solvent concentration. The results show that absorption of CO_2 is less favor at higher temperature and lower concentration of solvent. Meanwhile, Chan et al. [45] report on the vanillin adsorption onto resin H103. The adsorption process was modelled using artificial neural network (ANN) approach. Comparison between simulation and experimental data show that ANN has an excellent performance in predicting the experimental data and suitable to be used in the modeling of vanillin adsorption resin H103. Modeling and simulation of pressurized water scrubbing process for biogas purification to produce bioCH_4 was carried out by Abu Seman and Harun [46] using Aspen Plus software. The simulated results show that both absorber column pressure and liquid to gas (L/G) ratio have significant effect on bioCH_4

purity and percentage of carbon dioxide removal. The simulation of purification process produce 97.6 mole % bioCH_4 purity and 99.9 mole % CO_2 removal and show good agreement with the previous work.

In the study by Abdurahman and Sundarajan [47], separation of the essential oil from dry patchouli leaves have been studied by using Microwave-assisted hydrodistillation (MAHD) and traditional hydrodistillation (HD) techniques. MAHD showed a greater potential for separation of the essential oil from patchouli leaves as compared to HD method. At solid to solvent ratio of 1:12 g/ml and 45 minutes of extraction time, the results show that MAHD method extracted higher percentage of essential oil from patchouli leaves (5 %) compared to 4 % obtained using HD method. In addition, MAHD method can retain 16 compounds compare to 11 chemical compounds using HD. Meanwhile, study by Ismail et al. [48] focuses on the model development of the counter current extraction process for two rare earth (RE) elements, europium (Eu) and gadolinium (Gd) by using 2-ethylhexyl phosphoric acid mono 2-ethylhexyl ester P204 and ionic liquid-based system of [A336][P204]. The modelling was based on the Counter-current theory and the least number of extraction and scrubbing stages were preferred. The results demonstrated that P204 required a total of thirteen stages (eight stages for extraction and five stages for scrubbing) to extract Eu from Gd with 99.99% purity and 90% recovery, while [A336][P204] required only six stages (four for extraction and two for scrubbing). Therefore, the [A336][P204] offered better separation capacities and more favorable compared to P204. Liyananadirah et al. [49] report the effectiveness of acid/alkali reagents in rare earth (RE) leaching in terms of self-diffusion coefficient (Di) and overall diffusion coefficient (DAB) by using Nernst-Haskell equation. The results of Di have good agreement with experimental data from the previous study where most of calculation and experiment data are less than 5% error. Different alkali and acid reagents such as H_2SO_4, HCl, HNO_3, NaOH and Na_2CO_3 were compared in terms of DAB value. The high quantity of DAB shows the high potential acid/alkaline reagent extract RE elements. NaOH has the highest DAB, hence determined as the best reagent among the others.

Finally, the 1st ProSES Symposium 2019 also has received contributions in the area of safety and loss prevention of which comprises of eleven (11) articles. Firstly, Badli and co-workers [50] investigated the explosion severity of polyethylene/ethylene hybrid mixture in a 20-L spherical vessel. The study concluded that the explosion severity of polyethylene/ethylene hybrid mixture steeply increases as the gas concentration and particle size increase to 15 g/m^3 and 125 μm, beyond which the Pmax and dP/dT steadily decrease. Meanwhile, Al Amshawee and Yunus [51] reviewed anaerobic biotreatment as cost-effective alternatives to deliver low sludge accumulation, efficient biodegradation and mineralisation, microbes' reduction, and solids-free effluents. The paper also comprehensively discusses the impact of various factors on both biological and filtration performances and identifying strengths and limitations. A study that was conducted by Shahid et al., [52] on the other hand, focuses on safety culture maturity progression, whereby a specific roadmap that integrates the present general and workplace models has been proposed. Later, this conceptual model, perhaps, can be the basis for further research in order to provide a comprehensive picture of the standard safety culture improvement. Anuar and co-workers [53] argued that there is lacking in terms of systematic approach to implement the Process Knowledge Management (PKM). Hence, this situation has motivated the group to develop a systematic PKMS database which utilizes Risk Based Process Safety (RBPS) guideline and Plan-Do-Check-Act (PDCA) concept as its general framework. The system was validated by applying real plant data from industries as well as received valuable feedbacks for improvement. The developed PKMS allows the end user to store, review, modify and update the data regarding hazardous chemicals, technology and equipment information that involved with the operation.

Daud et al., [54] on the other hand, investigated the effect of impurities in CO_2 compression systems which typically neglected during operation. The study depicts that decrement of the impurities content from 15 to 0.7%v/v in the CO_2 streams reduced the total compression power in the compression system. The study also concludes that the three-stage compressor combined with subcritical liquefaction and pumping can potentially offer higher efficiency than four-stage compressor with 4 intercoolers for almost pure CO_2 streams. The work of Amri et al., [55] produced two risk assessments that conducted

to predict and measure the causes of offshore pipeline failure due to the third party damages. Based on the qualitative analysis, the major threats identified in third party damage were categorized into "anchor impact" and "impact" meanwhile the consequences were human safety, marine life ecosystem and economical loss. In addition, Annuar et al., [56] proposed Behavior-Based Safety (BBS) approach to develop a compliance checklist based on the Building Operations and Works of Engineering Construction (BOWEC) requirements. The finding reveals that more than half of the construction activities that investigated were complying with the specified legal requirements. Meanwhile, Abed and co-workers [57] presented an overview of the emulsions, formation, classification, stability, properties. practical demulsification techniques in the petroleum sector, including chemical, microwave irradiation, biological, thermal, membrane, electrical, and ultrasonic techniques for both oilfield and synthetic emulsions. Their finding suggests that chemical demulsification has been the most widely applied and reported in the literature in this regard. In another instance, Kee et al., [58] explored on the psychological impact by means of noise exposure level among the machinery and non-machinery operators within the construction industry of Malaysia. The results discovered that highly level of personal noise exposure was significantly suffered by the machinery operators in contrast to the non-machinery operators based on the sixty one (61) respondents whom participated. Nurud et al., [59] conducted a numerical simulation to study the efficacy of natural smoke vent to confine fire-induced smoke transportation in the stairways of multi-storeys buildings. The study has demonstrated that when the value of heat release rate (HRR) were kept constant, the different vent's size opening had a different influence on the efficacy of smoke vent and an appropriate opening size was obtained and proposed for further action. Last but not least, Rose and colleagues [60] reported on productivity improvement through the integration of basic lean manufacturing and ergonomics in the food company. The questionnaire result has shown that the most of wasted motion is in weighing and measuring activity, in which, all workers in this process were affected by the musculoskeletal disorder at their neck and shoulder.

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