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APPLICATIONS OF A GREEN CHEMISTRY DESIGN, A CLEAN ENVIRONMENT, AND BIOENERGY TO PROMOTE THE SUSTAINABILITY AND ADDED VALUE OF PRODUCTS

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The development and application of green chemistry and engineering principles in the academic, industrial, and government sectors should be explored to promote sustainability and the added value of products. Innovations in the chemical design and development of new material products, such as waste-to-energy (alternative energy), composting, anaerobic digestion, pyrolysis and gasification, material recycling, and modeling in processes that lead to sustainable practices, are essential to achieving a safe and clean environment.

The green synthesis of nanoparticles and the utilization of waste have gained significance in recent years because of their advanced uses in the biomedical, chemical, energy, and materials fields, to name a few. Many studies have focused on green chemistry for the development of new products, including biofuel as an alternative and renewable form of energy. Physical characteristics, the materials used, the technique involved, configuration, and position parameters play a crucial role in reaching the optimum process in the production of nanoparticles, composites, and bioenergy for tropical environment applications.

A clean environment and clean technologies can be achieved through the use of a chemical design process that minimizes waste and improves product performance. In addition, the utilization of raw materials from secondary resources or material recycling may have good environmental effects. Improving the design and process to create a new product in such a way that they meet sustainable and green requirements is also needed.

In this special edition, we are pleased to present 20 selected papers that discuss various strategies and developments in chemical and materials technology.

The first paper, written by W.W. Purwanto, D. Supramono, R. Muthia, and M.F. Firdaus, investigate the use of biomass, such as rice straw, rubber wood, and an empty fruit bunch of palm oil, to produce biofuel with the use of pyrolysis process. This study promotes the use of renewable and sustainable energy resources from biomass. The results showed that the catalyst enhanced de-oxygenation and aromatic production with the use of Ni/ZSM-5 catalyst at 550°C and at atmospheric pressure in the reaction.

The second paper, written by A.T. Yuliansyah, A. Prasetya, M.A.A. Ramadhan, and R. Laksono, focuses on the pyrolysis of plastic waste (low-density polyethylene) to produce fuel oil as an alternative fuel. A commercial zeolite was used as a catalyst to enhance the oil conversion in the pyrolysis process at 300°C to 450°C. The optimal temperature was obtained at 350°C, with oil producing a yield of 52.6% (v/wt) (with catalyst) and 51.7% (v/wt) (without catalyst). The physical properties (i.e., specific gravity, kinematic viscosity, gross heating value, flash point, and water content) of the oil produced were analyzed and compared with those of commercial fuel. Such properties of the oil produced were found to be similar to kerosene properties.

The third paper, written by D. Supramono, Y.M. Devina, and D. Tristantini, discusses the effect of the heating rate of the torrefaction process on the physical characteristics of sugarcane bagasse. In their work, sugarcane bagasse was torrefied at various heating rates and holding times. The findings showed that increasing the heating rate and holding time significantly reduced the cellulose content of sugarcane bagasse. As a result, the lignin content increased, and hardness and hydrophobicity improved. The torrefied

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bagasse was therefore appropriate for further biomass pelletisation, storage, and transportation.

The fourth paper, written by T.S. Utami, R. Arbianti, and B.N. Manaf, discusses the use of a microbial desalination cell as a modified desalination technology that can remove salt content in water with the help of *Debaryomyces hansenii* microorganism through organic matter degradation. This method can be considered as an alternative, simple, and cheap technique compared with previously developed ones, such as distillation, vapor compression, and reverse osmosis, which are energy intensive and costly. In this work, the authors examined the effect of the volume chamber ratio, culture–substrate ratio, and volume progression of the culture and substrate on salt removal and electricity generation. The authors found that the best salt removal rate of 55.03% was obtained at a 9:1:9 volume chamber ratio, 2:3 (v/v) culture–substrate ratio, and 1.5 times volume progression of the culture and substrate.

The fifth paper, written by W. Budhijanto, Deendarlianto, H. Kristiyani, and D. Satriawan, investigates the efficiency improvement of organic matter decomposition in aerobic wastewater treatment technology by application of attached growth microorganisms and micro bubble generator (MBG) for aeration. For an airflow rate (Qg) ranging from 0.1 L/min to 0.2 L/min, a tendency to have high soluble chemical oxygen demand removal efficiency was observed; this parameter indicates the value of the substrate degradation coefficient (kL). MBG potentially reduces the energy need for aeration, and the design of the MBG configuration and its position are also considered to avoid excessive micro bubble collisions.

The sixth paper, written by H. Hermansyah, A.P. Wisman, D. Firdaus, R. Arbianti, T.S. Utami, and A. Kurnia, investigates the effect of aeration and the nutrients from *Saccharomyces cerevisiae* cultivation using lignocellulose hydrolysate from an empty fruit bunch. The optimal condition for cultivation is 1 (v/v) per minute of aeration and glucose 5 g/L, which is produced by 24% ethanol yield from 0.04 g dried yeast.

The seventh paper, written by P.P.D.K. Wulan, W.W. Purwanto, and M. Sudibandriyo, presents the synthesis of an aligned carbon nanotube (CNT) through catalytic decomposition of methane by water-assisted chemical vapor deposition method; in this method, a bench-scale plate-structured catalyst reactor and a fixed-bed reactor were used. Fe-Ni/Al_2O_3 and Ni-Cu-Al catalysts were utilized to synthesize the CNT. The presence of water in methane decomposition facilitated the formation and prevented the sintering of the catalyst. Water vapor significantly improved the quality of the CNT.

The eighth paper, written by M. Sudibandriyo, P.P.D.K.Wulan, and P. Prasodjo, focuses on the hydrogen storage of a CNT synthesized in the authors' laboratory. The adsorption capacity and dynamic behavior of the CNT were examined and compared with those of a commercial CNT. The results showed that adsorption and desorption on both the synthesized and commercial CNTs occurred quickly. However, at a high pressure (960 psia), the adsorption and desorption equilibrium on the local CNT was reached at approximately 30 seconds, whereas in the commercial CNT, it was achieved within 2 seconds only. In desorption, while the equilibrium time was reached slightly faster at a higher pressure for the commercial CNT, the time was almost similar at all pressures for the synthesized CNT.

The ninth paper, written by D. Heltina, P.P.D.K. Wulan, and Slamet, presents the synthesis and characterization of a titania nanotube (TNT)–CNT composite via mixing under acidic conditions and ultrasonic method for the degradation of phenol. The TNT–CNT composite with 3 wt% of CNT exhibited a higher phenol degradation activity (up to 37%) than the TNT or CNT itself.

The tenth paper, written by S. Kartohardjono, M.I. Fermi, Yuliusman, K. Elkardiana, A.P. Sangaji, and A.M. Ramadhan, evaluates the effectiveness of a polypropylene hollow fiber membrane contactor in removing dissolved ammonia in wastewater with the use of sulfuric acid solution as absorbent. In their experiments, wastewater and absorbent solutions flowed through the shell and the lumen sides of the contactor, respectively, where the pH of wastewater, rate of circulation, and initial ammonia concentration were the operating variables, to study the efficiency of the removal process. The results showed that the efficiency of ammonia removal and the overall mass transfer coefficient increased with the pH and the wastewater flowrate. By contrast, it decreased with the increase in the initial ammonia concentration in wastewater.

The eleventh paper, written by N. Saksono, R.T. Seratri, R. Muthia, and S. Bismo, discusses about phenol degradation in wastewater with a contact glow discharge electrolysis (CGDE) system by using sodium sulfate solution. Several parameters, including the effect of voltage, electrolyte concentration, anode depth, and the presence of Fe^{2+} ions, were examined. Phenol degradation was high with a large voltage, electrolyte concentration, and depth of anode. The addition of Fe^{2+} ions was proven effective in enhancing the degradation.

The twelfth paper, written by T.I. Sari, A.H. Saputra, S. Bismo, D.R. Maspanger, and A. Cifriadi, evaluates the effect of styrene monomer on the graft copolymerization of acrylonitrile onto deproteinized natural rubber. These modifications of natural rubber are important steps to increase its oil resistance. The presence of styrene monomer prevents coagulation in the early stage of graft copolymerization. Stabilization of the emulsion was achieved up to 1.5 wt% concentration of styrene monomer at a deproteinized natural rubber–styrene ratio of 70:30 (wt%).

The next two papers, written by Andriayani, S.L. Raja, H. Sihotang, and N. Sofyan; and by I.N. Jujur, J. Sah, A. Bakri, and A.H.S. Wargadiputra, respectively, discuss about increasing the added value of local resources in Indonesia. Natural silica sand in Tanjung Tiram, Asahan North Sumatera was attempted to be extracted by means of a magnesiothermic process at the temperature range of 750°C–950°C for 2–3 h. The optimal condition for silicon extraction was 800°C for 3 h, with a sample and magnesium ratio of 1:1.75. This study presents an alternative method and added value of natural sand utilization to produce silicon. The added value of local raw metallic materials, such as scraps and ferronickel from Pomala, Indonesia, was also studied. The raw materials were melted and refined to produce a medical grade of 316L stainless steel. This study focused on the analysis of oxide inclusion in metals as an indicator of metal quality. The results showed that various kinds of oxide inclusions were observed in the microstructures of the metals, and these inclusions may affect the mechanical properties of the metals, especially tensile stress.

The fifteenth paper, written by V. Rizkia, B. Munir, J.W. Soedarsono, and B. Suharno, focuses on the protection of materials during reaction with the environment in an effort to improve the added value of these materials. Anodized Al7075/SiC metal matrix composites, which have an anodic film defect, were improved by means of cerium sealing. Anodization of the Al7075/SiC surface was undertaken in H_2SO_4 solution at varied current densities of 15–25 mA/cm^2 at temperatures of −25°C to 25°C for 30 minutes. Further treatment of the cerium sealing was conducted in $CeCl_3.6H_2O + H_2O$ solution at room temperature and pH 9 for 30 minutes. The results showed that anodization at 0°C produced the best protection of the Al 7075/SiC surface. Furthermore, post treatment by cerium sealing was also established as a simple and cheap method to improve the corrosion resistance of Al7075/SiC metal matrix composites.

The sixteenth paper, written by A.H. Saputra and H.N. Anindita, evaluates a potential nata de coco fiber composite with conductive filler as an eco-friendly semiconductor material. For this purpose, the researchers impregnated a nata de coco fiber composite with ZnO and silica filler, and they then measured conductivity. The highest conductivity result was observed on the composite impregnated in 0.3–0.4 μm particle diameter of filler with 3% w/v suspension concentration for 3 days; the conductivity result was 6.95×10^{-6} S/cm for ZnO filler and 10.1×10^{-6} S/cm for silica filler or about 16 times higher than the conductivity of pristine nata de coco fiber.

The seventeenth paper, written by I. Akbar, A.H. Yuwono, N. Sofyan, G. Ramahdita, and A. Sholehah, presents the efficiency of dye-sensitized solar cell materials in a novel and simple precipitation technique of zinc oxide nanoparticles synthesized with citric acid addition as the capping agent. The morphology and crystallinity of the zinc oxide nanostructure were examined with various ratios of citric acid and zinc oxide mixture, followed by calcination at temperatures of 150°C and 400°C. The results showed that at a calcination temperature of 400°C, spherical and rod ZnO nano structures with a size of 19.8–30.8 nm were formed at the lowest band gap energy of 3.15 eV. The study showed that the technique can be used to produce a semiconductor oxide layer in a dye-sensitized solar cell.

The next two papers, written by K. Mulia, E. Krisanti, F. Terahadi, and S. Putri; and by K. Mulia, E. Krisanti, T. Maulana, and Dianursanti, respectively, discuss the methods to extract bioactive compounds in mangosteen pericarp and soursop leaves. Natural deep eutectic solvents (NADES) were

used to extract α-Mangostin from the pericarp of mangosteen (*Garciniamangostana L.*). It consists of choline chloride, quaternary ammonium salt, and four hydrogen donors, namely, 1,2-propanediol, citric acid, glycerol, and glucose. The findings suggest that NADES are effective in extracting bioactive compounds in the pericarp of mangosteen, with the highest yield at4.1 wt% α-Mangostin. This result was achieved with the use of choline chloride and 1,2propanediolmixture in 1:3 mole ratio. Another study attempted to extract an acetogenin-rich fraction, which contains annonacin from soursop leaves. Selective polar-guided extraction and column chromatography separation were used in such a study. Solvents, such as ethyl acetate, hexane, chloroform, ethanol, water, and their mixtures, with various polarities were used in the extraction. The results showed that 242 mg/g acetogenins were isolated from the soursop leaves on the basis of total lactone determination. This finding suggests that the isolated bioactive compounds may be used for anti-cancer treatment.

The twentieth paper, written by Y. Muharam, W.W. Purwanto, K. Mulia, P.P.D.K. Wulan, I. Marzuki, and M.N. Dewi, investigates mathematical model-controlled potassium chloride release systems from chitosan microspheres. The data of this model were compared with the experimental data, and the model was found to reproduce and agree well with the loading of potassium chloride (10.01 and 20.57%) in the experimental data. These controlled drug release systems are useful in maintaining drug concentrations in the blood or in diseased tissues at the desired value.

We hope that this edition of IJTech conveys some new insights in the way we conduct our research and we invite you to join us in this venture by sending your work for consideration.

With warmest regards from editorial board members,

Dr. EnyKusrini

Dr. Sri Harjanto

Prof. Dr. Akhmad Herman Yuwono