Editorial

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Smart solution to environmental sustainability for a better world

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EDITORIAL

In 2024, *Science, Engineering and Health Studies* (SEHS) collaborated with the Thai Institute of Chemical Engineering and Applied Chemistry International Conference (TIChE) to provide a platform for researchers to publish their work in the field of chemical engineering. The conference focused on the theme "Smart Solutions to Environmental Sustainability for a Better World," emphasizing the development and implementation of intelligent and innovative technologies to address environmental challenges. The theme highlighted the integration of advanced scientific research and technical solutions into practical applications to tackle pressing issues such as environmental pollution, resource depletion, and climate change. The focus was on promoting sustainability across various sectors to improve global environmental health and ensure a sustainable future. As a result of this collaboration, seven selected research papers were published in 2024, showcasing groundbreaking contributions to environmental sustainability and innovative problem-solving in chemical engineering.

Akkawong et al. (2024) proposed a novel framework that combines deep learning with Latin Hypercube Sampling (LHS) to improve prediction models based on small datasets, addressing issues such as overfitting and underfitting due to limited experimental data. By applying this integrated framework to predict the size of silver nanoparticles, the study demonstrates improved prediction performance with R^2 values of 0.924 and 0.918 for the validation and test datasets, respectively. The LHS technique was employed to augment the dataset, enabling the development of a more accurate and robust prediction model. Models trained on the expanded dataset exhibited significantly higher accuracy in predicting silver nanoparticle sizes compared to those trained on limited data. These findings underscore the effectiveness of the proposed framework in delivering precise predictions even with small experimental datasets.

To improve energy efficiency in chemical processes, particularly in distillation columns, Puangto et al. (2024) explored the design of an internally heat-integrated distillation column (HIDiC) using an economic-based column energy profile approach. The study introduced the concept of maximum energy saving per additional investment (MESAI) profiles, demonstrating the economic and energy-saving advantages of HIDiC designs over conventional methods. Using Aspen Plus simulations and economic evaluations, the research highlighted the effectiveness of MESAI profiles in optimizing heat loads and balancing additional investments, resulting in more cost-effective HIDiC configurations. The findings showed that HIDiC designs incorporating multiple side exchangers achieved lower operational costs and significantly enhanced energy efficiency. This work provides valuable insights into HIDiC design methodologies, emphasizing the economic feasibility and sustainability advantages of advanced distillation technologies.

Another application model focused on developing a two-stage stochastic optimization model for a sustainable bioethanol supply chain under demand uncertainty and multi-season biomass. Fahrullazi and Siemanond (2024) considered multiple feedstocks such as rice residue, sugarcane residue, cassava residue, and palm residue, as well as varying biomass supply over the seasons. The model aimed to maximize profits by optimizing biomass type, plant location, and pathways. An extension model included environmental performance, specifically carbon credits, to enhance profit margins. The stochastic model outperformed the deterministic model by 16% in terms of profitability across various demand scenarios. In addition, the incorporation of carbon credits contributed around 5% to the total profit, showcasing the potential for sustainable bioethanol production with reduced CO_2 emissions.

The reduction of emitted CO_2 was also addressed by New et al. (2024). They compared the life cycle impacts of conventional hydrogen production methods (methane steam reforming) with two zero-carbon emission technologies: proton exchange membrane electrolysis and methane pyrolysis. The analysis focused on five impact categories, with methane pyrolysis proving to have the lowest overall environmental impact. Despite relying on hydrocarbon feedstock, methane pyrolysis demonstrated significantly lower global warming potential and reduced toxicity impacts compared to steam methane reforming and proton exchange membrane electrolysis. The study highlighted the potential of methane pyrolysis as a sustainable hydrogen production method, emphasizing its role in promoting a circular carbon economy and reducing the scarcity of fossil resources.

Two research were focused on the bio-circular-green economic model (BCG). Padettaku et al. (2024) investigated the effect of glycerol concentration on enhancing the fracture resistance of dried lotus leaves when used as a bio-coating agent. By incorporating glycerol, beeswax, and chitosan into the coating, the study aimed to improve the elastic properties of lotus leaves. The optimal ratio of glycerol in the bio-coating was determined based on the recovery percentage of lotus leaves post-coating, indicating improved elasticity. Results showed a 27% increase in recovery when using specific concentrations of chitosan, glycerol, and acetic solution. The coated lotus leaves exhibited increased moisture content and thickness, decreased contact angle, improved mechanical properties with reduced Young's modulus but increased elongation, and enhanced thermal stability compared to untreated leaves. Incorporating chitosan in the coating formulation reinforced the structure and improved water resistance. Sangjun et al. (2024) proposed the recovery of light cycle oil (LCO) discarded from the petroleum process. They focused on the hydrogenation reaction of polycyclic aromatic hydrocarbons (PAHs) in LCO using NiMo-based catalysts to produce higher value-added chemicals. Different catalyst supports such as γ-alumina, KIT-6, and β-zeolite were studied. The NiMo/KIT-6 catalyst had the highest efficiency in PAHs removal (77.4%) and selectivity towards alkylbenzenes, decalins, and tetralins. The acidity of the catalyst was found to be crucial for performance, with NiMo-zeolite exhibiting the highest total acidity. The study provided an alternative method for converting petroleum refinery by-products into valuable chemicals, contributing to sustainable development, and addressing environmental concerns related to PAHs in LCO.

Singhyakaew and Rueangjitt (2024) investigated the effects of alkali treatment time and the SiO_2/Al_2O_3 ratio on the structural modification of commercial and synthesized ZSM-5 zeolite catalysts. The study focused on introducing mesopores into the ZSM-5 structure to enhance catalytic performance in cracking and reforming processes. The results showed that increasing alkali treatment time promoted the formation of mesopores in both commercial and synthesized ZSM-5 catalysts, leading to an increase in mesopore surface area and pore volume. However, excessive treatment time reduced mesoporosity in synthesized ZSM-5 samples, particularly at higher SiO_2/Al_2O_3 ratios. The optimal conditions were achieved with synthesized ZSM-5 treated in a 0.2 M NaOH aqueous solution for 1 h at a SiO_2/Al_2O_3 ratio of 140, resulting in a high mesopore surface area and volume while maintaining the integrity of the MFI structure.

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