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Editorial

Catalyst Special Issue on Catalytic Reactors Design for Industrial Applications

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Due its better reaction performance, catalytic reaction has been a major choice in various chemical industries. It has been widely adopted in various processes, including a wide range of oxidation reactions, the emerging semi-hydrogenation, various chemical syntheses, and a variety of pollutant mitigation strategies. Most chemicals have been subjected to catalytic reactions at some point during their production. Aside from industry interest, catalytic reactions have been a major topic in the chemical engineering field and has attracted considerable attention from researchers worldwide due to the complex transport phenomena and reactions involved. In typical catalytic reactions, three components are present, i.e., reactant, product, and catalyst. The last component is added to enable faster reaction rates by reducing the activation energy without being consumed in the reaction. As such, this component can be reused numerous times. A vast number of reports on catalytic reactions can be found in the literature. Depending upon the energy involved, various catalytic reactions have been identified ranging from electro catalytic, photo catalytic, to plasma catalytic reactions. All this while, major focus is given to elaborate the mechanism of the reaction and to improve the effectiveness of the reaction. Successful enhancement of catalytic reaction performance implies that the operating temperature and/or pressure required for the reaction can be reduced, which means significant amounts of energy can be conserved and thus huge operational cost savings for large scale industrial processes.

Even though catalytic reactions have been extensively studied and numerous investigations on catalytic reactions have been reported, further studies which aim to disclose the fundamental physicochemical mechanisms of the reaction and to accelerate the development of an optimum catalytic reactor for industrial applications are still required. Hence, this special issue was proposed with the aim at compiling the best papers on the development and investigation of catalytic reactors for industrial applications.

Authors were encouraged to contribute by submitting their experimental and computational studies. Several manuscripts were submitted and after the peer-review process, four articles were published in this special issue. Two manuscripts were focused on the technical aspect, one manuscript deals with technoeconomic analysis in addition to process design, and one manuscript provides a comprehensive review on electrochemical reactors for CO_2 conversion. Han et al. [1] evaluated the electrocatalytic performance of a nanoflower-like MnO_2 catalyst for oxygen reduction in alkaline media. The catalyst, which was prepared by using a hydrothermal method, was found to improve oxygen reduction reaction (ORR) and oxygen evolution reaction (OER) in a zinc–air battery. Chaedir et al. [2] reported their numerical study on catalytic combustion of ventilation air methane. They proposed a novel helical reactor equipped with twisted tape insert to enhance the catalytic combustion of ventilation air methane collected from gassy underground coal mines during the active mining process. This novel geometry was found to offer higher reaction performance as compared to the traditional straight reactor without a twisted tape insert. In addition, they reported higher reactor performance in terms of net power and FoM (Figure of Merit) for reactors with higher twisting ratios (lesser number of twists) as compared to those with higher twisting ratios.

Bagnato and Sanna [3] reported their thermodynamic analysis of the production of bio oil from lignocelluloses through catalytic hydrogenation. The technoeconomic analysis for this process was reported as well. In their study, simulation of the catalytic hydrogenation reactions were carried out by using ASPEN Plus software. The results suggested separation of bio oil into two parts, i.e., water-soluble and insoluble fractions, prior to hydrogenation due to significantly different requirements of process conditions for each portion. By assuming the plant can be effectively used for 30 years, it was found that 69.18% return of investment, 2.48 years pay-out time, and 19.11% discounted cash flow rate of return can be achieved by the proposed biorefinery.

Lastly, driven by the alarming situation of global greenhouse impact on the environment and necessity for developing sustainable technologies to reduce CO_2 emissions in the atmosphere through carbon capture, sequestration, and utilization, Lin et al. [4] prepared a comprehensive review which provided a detailed explanation on different components in the CO_2 reduction reaction (CO_2RR) reactors and related industrial processing. The manuscript provides a brief introduction on CO_2RR, with viewpoints from technoeconomic analysis followed by detailed discussion on various reactor types, critical features in flow cell systems, electrolyte, catalyst, and flow channel and anode design. Afterwards, elaboration on CO_2 feed and downstream purification are presented and concluded with foreseen challenges and opportunities for achieving viable carbon capture and utilization technology.

In conclusion, for practitioners, researchers, and technology developers, this Special Issue could help illuminate the way forward in the crucial area of catalytic reactor design for industrial applications.

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