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Editorial

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Sustainable Chemical Product and Process Engineering

Of the major challenges to today's global society, some of the most pressing include the depletion of nonrenewable resources; air, water, and soil pollution; global warming; depletion of stratospheric ozone and forests; scarcity of water for drinking and agriculture; and excessive population growth. Consequently, engineering sustainability has become a focal point for long-term industrial development. In the past decade, significant progress has been made in recognizing and understanding the issues with sustainability in industries. Today, manufacturing sustainability, process and product sustainability, nanotechnology sustainability, energy sustainability, environmental sustainability, water sustainability, etc. are studied and practiced extensively. However, much remains to be done, as sustainability science is still far from exact, and sustainable engineering practice continues to show its potential to be applied more broadly, deeply, and systematically.

On May 27−31, 2013, the Third International Conference on Sustainable Chemical Product and Process Engineering (third SCPPE) was held in Dalian, China, with the sponsorship of the U.S. National Science Foundation and China National Science Foundation. The conference provided a unique forum for researchers, scientists, and practitioners to assess and critique the current status and future directions of research and development in sustainable chemical manufacturing and energy supply. An important aim of the conference was to bring together leading experts from around the world to share their knowledge, research, and educational experience in the most challenging areas of chemical engineering sustainability. The primary objectives were (1) to assess state-of-the-art sustainable chemical product and process engineering, (2) to bridge the gap between research and development, strengthening ties between academia and industries, (3) to discuss research directions for chemical engineering sustainability and educational approaches for the integration of sustainability science into chemical engineering curriculum, and (4) to explore opportunities for international collaboration. The conference covered an important diverse set of topics in sustainable product and process systems engineering. These included (1) green chemistry and engineering applications, (2) fine chemical innovation and manufacturing sustainability, (3) innovation in process design for sustainability, (4) nano/bio materials and system sustainability, (5) alternative and renewable energy systems and supply chains, (6) energy and sustainability in production, (7) green reaction engineering and separation, (8) biological conversion and process sustainability, (9) waste management and reuse, and (10) LCA, sustainability assessment, and tools. The conference attracted about 300 attendees from 15 countries.

This special issue includes 12 papers presented at the third SCPPE, which are representative in covering all 10 conference topics listed above. In particular, four papers (Liu et al., Mo and Savage, Souza et al., and Wu et al.) address applications of green chemistry and engineering principles in, respectively, using electrons as a green reducing agent to prepare highly dispersed metal catalyst, using HZSM-5 zeolite under hydrothermal conditions to produce valuable chemicals from renewable fatty acid feedstocks, producing DMC from CO_2, and using a nonfluorinated proton exchange membrane in an electrochemical hydrogen pump to separate H_2/CO_2.

Sustainable process design and sustainability assessment are particularly important in ensuring manufacturing sustainability. The paper contributed by Cheali et al. introduces a generic modeling approach for computer-aided design of biorefinery networks. Ehlinger et al. announce a process synthesis approach for the production of methanol from shale gas, where energy and material efficiency and economic performance are analyzed. Souza et al. provide a technical−economical−environmental assessment approach in chemical manufacturing. Tong et al. describe a stochastic programming approach to optimal design and operations of integrated hydrocarbon biofuel and petroleum supply chains. In Uttarwar and Huang's paper, a sophisticated modeling and simulation technique is introduced for characterizing nanoparticle emission and estimating environmental impact in nanocoating material applications while minimizing energy consumption. Yang et al. report a comprehensive sustainability assessment method in coal/biomass conversion to Fischer−Tropsch fuels.

Five papers address a variety of sustainability issues in nanotechnology and biotechnology applications. Hu et al. describe their approach to the preparation of single-walled carbon nanotubes from fullerene waste soot. Jiang et al. explore the advantages of nanostructured ternary nanocomposites of rGO/CNTs/MnO_2 in the development of high-rate supercapacitors. In nanomaterial applications, there is always an issue of how to predict and manage nanoparticle emission; these are discussed through case studies in Uttarwar and Huang. In their study of the conversion of pentose to ethanol, Liang et al. develop a constraint-based metabolic network model for the central carbon metabolism of *Scheffersomyces stipites*. Cheali et al., on the other hand, propose a data collection and management method that should be valuable for benchmarking new biorefinery technologies and concepts as well as in superstructure-based optimization studies.

Energy sustainability has been a key area of research in the process and energy industries. In the study of integrated use of hydrocarbon biofuel and petroleum, Tong et al. introduce a stochastic programming approach to the design and operation of supply chains. Ehlinger et al. and Yang et al. studied, respectively, the conversion of shale gas to methanol and coal/biomass to fuel processes. Uttarwar and Huang discuss how to minimize energy consumption in managing nanoparticle emissions in material applications.

Taken collectively, the papers in this special issue are filled with closely knitted, carefully chosen, and mutually interacting research of significant state-of-the-art work. They add considerable value to readers in the domain of sustainable

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chemical product and process engineering. Researchers in both academic and industrial organizations will benefit from this collection of papers, which is aimed at advancing current research to the next level for greater societal benefits.

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