Recent Progress in Studies of Pyrolysis Chemistry and Kinetics

Pyrolysis, a thermochemical process in which organic substances are decomposed into a variety of products with external heat supply, has moved to the forefront of renewable energy researches. Compared with traditional biological ways, pyrolysis is able to produce a large amount of energy and chemicals in quite short period. In the last decade, a rapid increase of efforts has been paid to the pyrolysis chemistry and kinetics of biomass, coal, solid municipal waste, and polymers, etc. However, because of the inherent complexities associated with the organic components and structures of the pyrolyzed reactants, so far the understanding of pyrolysis chemistry and kinetics is still far from satisfactory. This thematic issue aims to provide a platform for researchers to discuss the recent state-of-the-art progress in all aspects of pyrolysis chemistry and kinetics, from both experiments and modeling. This thematic issue consists of five invited review papers from world famous researchers in the field of pyrolysis. Although the invited review papers cannot cover all topics and issues on pyrolysis chemistry and kinetics, they give comprehensive and professional views on the up-to-date progresses in the specific research areas of all invited experts and we are pleased to share these valuable papers with readers.

In the paper entitled “Review of Reactions and Molecular Mechanisms in Cellulose Pyrolysis”, Kawamoto reviewed the state-of-the-art progress in reaction mechanisms associated with cellulose pyrolysis. Cellulose is the most common component in biomass, whose pyrolysis mechanisms are of great value to the further studies on biomass pyrolysis. In this paper, the reactions and molecular mechanisms that determine the reactivity and product selectivity of cellulose pyrolysis are discussed. Both low- and high-temperature regimes of cellulose pyrolysis are included and the molecular-level pyrolysis mechanisms for primary and secondary reactions are summarized.

In the paper entitled “Fast Pyrolysis of Lignocellulosic Biomass for the Production of Energy and Chemicals: A Critical Review”, Attia et al. provide a comprehensive review on the processing of biomass for the production of valuable-products. Several chemical reactors and their related fast pyrolysis processes for lignocellulosic biomass are summarized. The organic chemistry issues for the three main components, i.e., cellulose, hemicellulose, and lignin when pyrolyzed are discussed. In addition, the effect of the heating mechanism, process parameters, loading of catalyst and other aspects are discussed.

In the paper entitled “Densification and Pyrolysis of Lignocellulosic Biomass for Renewable Energy”, Wang et al. discuss the aspects of the basic principles, processes and influencing factors, and the recent developments in both densification and fast pyrolysis of biomass. The combination of pelleting and fast pyrolysis is emphasized. The paper gives a perspective for the future directions on development of efficient, cost-effective and scalable fast pyrolysis technologies for generating fuels or chemicals.

In the paper entitled “Kinetic study on pyrolysis of biomass components: a critical review”, Wang et al. review the popular kinetic models developed in past decades for biomass pyrolysis. The computation processes for each kinetic models are introduced, and their advantages and disadvantages are discussed and compared. Experimental procedures to determine reaction mechanisms and constants are discussed in detail. The recently popular so-called distributed activation energy model is emphasized in this paper.

In the paper entitled “Pyrolysis of Energetic Ionic Salts Based on Nitrogen-rich Heterocycles”, Kumbhakarna and Chowdhury review the decomposition pathways and the associated chemical kinetic parameters in the pyrolysis of energetic ionic salts. Focuses are given to the reaction mechanisms of four major families of energetic ionic salts.

ACKNOWLEDGEMENTS

All contributors are gratefully appreciated for their excellent research work and graceful writing. Reviewers are also greatly acknowledged for their invaluable time and effort in reviewing each manuscript carefully, which is indispensable to the success of this thematic issue.

Qingang Xiong (Guest Editor)
Computer Science and Mathematics Division, Oak Ridge National Laboratory, USA, E-mail: qgxiong@126.com

Haruo Kawamoto (Guest Editor)
Department of Socio-environmental Energy Science, Kyoto University, Japan, E-mail: kawamoto@energy.kyoto-u.ac.jp

Shurong Wang (Guest Editor)
State Key Laboratory of Clean Energy Utilization, Zhejiang University, China, E-mail: srwang@zju.edu.cn