Editorial Corner

Trends in Lignocellulosic Biorefinery for Production of Value-added Biochemicals

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Biorefinery is a facility that combines a network of technologies in different areas to form an integrated process for conversion of biomass to various classes of products. The beginning of biorefinery concept was originally developed based on petro-refinery that uses crude oil or fossil fuel as raw material. Lignocellulosic biomass has been proposed as a high potential raw material for biorefining process due to its abundance worldwide and its sustainability. Lignocellulosic biorefinery has gained more interest since last two decades from researchers and industries as a response to awareness to global warming problems. The examples of current representative lignocellulosic derivatives that have been continuously developed for productions in industrial scale are bioethanol, biobutanol, biomethane and furfural derivatives [1]. Other value-added biochemicals that their productions become closer to the commercialization in Europe, USA and China, are lactic acid, levulinic acid derivatives, muconic acid, itaconic acid [2], butanediol, polyols, hydroxylpropionaldehyde derivatives etc.

In general, conversion process of lignocellulosic biomass is composed of pretreatment, hydrolysis, conversion and upgrading [3]. A major impedance preventing commercialization of lignocellulosic biorefinery is a competitive performance in terms of economical aspects, especially the cost of pretreatment and hydrolysis processes. Many pretreatment methods ranging from conventional processes, i.e. acid/alkaline pretreatment [4] and biological treatment [5], to newly ones, i.e. ionic liquid [6] and deep eutectic solvent pretreatment, have been continuously developed since last two decades alongside the early era of biorefinery. Yet, most of pretreatment processes were successfully demonstrated only in lab scale, but the breakdown of economical feasibility was still not able to overcome the financial impedance.

Additionally, the current trend to use petro-chemical is still a mainstream provider for customers and industries because its price is still relatively lower compared to biorefining-derived biochemicals. Also, biorefinery is considered to be a relatively young business compared to well-established petro-chemical business, therefore the capital investment and current production scale of biorefinery is mostly smaller than petro-chemical. This concern is consequently related to the difficulty to find the downstream users or customers to be their business partners for the newly developed processes, and to become the challenge to get a market sharing from petro-chemical business.

In a bright side, lignocellulosic biorefinery has characteristics to gain advantage over petro-refinery in terms of environmental impacts based on LCA analysis and it is considered as a milestone of bioeconomy and circular economy. Furthermore, many lignocellulosic derivatives, for example, levulinic acid, sorbitol, squalene, 2,3-butanediol etc., have been demonstrated to be used in high value, social-sensitive business, or even engaging in religion restriction, such as cosmetic, pharmaceutical, food, feed and human health. These scenarios, therefore, shine a light to pave the path of lignocellulosic biorefinery, especially for platform chemical and intermediate chemical productions, which have the expected sales worldwide at 441 billion USD in 2020.

Currently, biorefining processes have been stepped up to commercial scale of productions, which developed and engaged with International Energy Agency (IEA). The existing commercial facilities have been mostly located in Europe and North America, including Austria,

Please cite this article as: M. Sriariyanun and K. Kitsubthawee, "Trends in lignocellulosic biorefinery for production of value-added biochemicals," *Applied Science and Engineering Progress*, vol. 13, no. 4, pp. 283–284, Oct.–Dec. 2020.

Canada, USA, Denmark, France, Germany, and Netherlands. Although major commercial sectors of biorefining products are biofuels, other biochemical have gained bigger market sharing, such as resin, furfural, bioplastic, electricity, food additives, feed supplements. After all, the commercial biorefining factory are mainly operated by large companies due to the advantages in scale of production. Several concepts have been applied for small and medium sized enterprises (SME) to promote the bargaining power in the markets, for example, high-valued products co-production, government supportive policy, and cooperative networking among SME owners and communities.

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