Processing of Lignocellulosic Biomass to Chemicals

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Abstract

Lignocellulose is the most abundant biomass material. Beyond its established use as construction material, pulp and paper production, and in many other applications it still provides a significant mass potential for additional use. Lignocellulosic material is contained in a wide variety of purpose grown plants, by-products from agriculture and forestry as well as residues and waste. These materials differ greatly in composition, homogeneity, and availability. For chemical production in lignocellulose biorefineries two main options exist, either by separation of cellulose, hemicellulose and lignin, converting each fraction by secondary refining into chemicals and energy, or by thermochemical conversion into intermediates like bio-oil and synthesis gas, from which products and fuels can be obtained by chemical-catalytical and microbial processes. Unlike to fossil feedstock, the lignocellulose raw material costs are significantly influenced by the raw material logistics, raising the question on a possible structure and size of processing sites.

In the presentation, pre-competitive examples on the different pathways for chemical lignocellulose utilization are presented, referring to recent projects on fractionating and thermo-chemical biorefineries. Products, available by these approaches will be discussed together with the cost structure considering conversion capacity and logistics. A first case study addresses the hydrolysis of carbohydrates for furfural and 5-hydroxymethyl furfural production, while the lignin is further decomposed to aromatic products. For this example, an “on-farm” and a “regional” biorefinery concept were investigated, in which intermediate products are obtained intended for further use at other locations. the large-scale production of chemicals is investigated at the example of KIT´s bioliq process via the conversion of biomass to synthesis gas. Here it will be discussed to what extent “world scale” conversion capacities may be achieved. If large conversion capacities are demanded, biomass may be pre-treated to increase its energy density and thus reduce transportation costs. This can be conducted by mechanical or chemical processes. By fast pyrolysis lignocellulose is converted mainly into bio-oil, which can be used for gasification or may directly be upgraded to useful products.

From the comparison of these different technology pathways and product options conclusion will be drawn in view to the design for lignocellulose utilization for the production of chemicals. Perspectives for further development and R&D&I demand will be concluded for these still pre-commercial technologies.