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Pretreatment: A key process for development of second-generation biorefineries

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Lignocellulose can be used for sustainable production of different biofuels (e.g., bioethanol, biogas, and biobutanol), biochemicals (e.g., citric and lactic acids, fungal chitosan, carotene, and xanthan gum), animal feed (e.g., fish feed and cattle feed), and a number of other valuable products. However, lignocellulose is made in nature to resist against microbial and physical attacks. Thus, any biorefinery development based on the application of lignocellulose should deal with these recalcitrant properties of lignocellulose using a pretreatment prior to biological processing. Lignocellulose are non-food wastes, including industrial wastes (e.g., sawdust, food industry wastes, and paper mill discards), forestry wastes (i.e., hardwoods and softwoods), agricultural residues (e.g., straws, stovers, and non-food seeds), domestic wastes (e.g., kitchen wastes, sewage, garden wastes, and waste papers), and municipal solid wastes. Cellulose, hemicellulose, and lignin are the major constituents of lignocellulosic biomass. Different pretreatment processes, including physical, chemical, and biological treatments, have been presented. Among them, pretreatment with cellulose solvents, e.g., NaOH/urea, concentrated phosphoric acid, N-methylmorpholine-N-oxide, and different ionic liquids, are highly effective. After dissolution and regeneration, without major derivatization, the pretreated biomass can be subjected to microbial or enzymatic hydrolysis and converted. However, there are several challenges in these processes for industrial applications. The pretreatments efficiency is studied using a variety of analytical methods, including different imaging techniques, compositional analyses, measurement of crystallinity, degree of polymerization, enzyme adsorption/desorption, and enzyme accessibility. An introduction to lignocellulose properties, recent advances in different solvent pretreatments, and the related analysis will be presented.

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