

Process development, process simulation and energy calculation of integrated utilization of woody biomass

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ABSTRACT: Completing full utilization of the biomass feedstock is what the current biorefinery needs to solve. Compared with cellulose and lignin, hemicellulose exhibits a higher susceptibility to depolymerization. In this paper, a biorefinery process is developed for the fractionation of oil-tea camellia fruit shell wastes into three main products. A scale-up experiment was first carried out in this paper. Oil-tea camellia fruit shell wastes were first hydrolyzed in a $C_6H_8O_7/H_2O$ system to remove the hemicellulose. The aqueous fraction comprises monosaccharides and oligosaccharides, achieving a hemicellulose removal efficiency of 79.7%. Lignin was extracted from the residual solids using an ethanol/isopropanol solvent system with a purity of 87.81%. The three products obtained have potential applications in feed, cultivation substrates and sterilizers. Then given the energy-intensive nature of pretreatment, energy consumption of the process was assessed via process simulation software. The water evaporation utilities account for approximately 62% of the overall energy consumption. When the pretreatment reaction is conducted at 130°C with a raw material to water mass ratio of 1:3, energy consumption can be optimized to 0.2140 t/t. With the adoption of reaction liquid recycling, energy consumption can be further reduced to 0.1763 t/t. The pretreatment reaction temperature and the mass ratio of raw material to water have an effect on energy consumption, with the latter exerting a slightly greater influence. Specifically, at a reaction temperature of 130°C and a mass ratio of raw material to water of 1:3, energy consumption can be further reduced by approximately 0.05t/t. Under these conditions, when the reaction liquid is recycled once and twice, the energy consumption is reduced by 0.034t/t and 0.037t/t, respectively. This paper outlined a pathway for the integrated utilization of lignocellulose, facilitating the feasibility of engineering calculations for biorefinery processes.