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Enhanced Production of Levulinic Acid from Oil Palm Empty Fruit Bunch

Abstract

Levulinic acid (LA) was produced from oil palm empty fruit bunch (OPEFB) pretreated in two different ways: (1) a two-step treatment with peracetic acid (PA) and alkaline peroxide (AP); and (2) an ammonia soak pretreatment. The pretreated material was subjected to acid hydrolysis (5% w/v sulfuric acid, 125 °C to 175 °C, 120 min) to produce LA. Compared to the ammonia treatment, the two-step PA–AP pretreatment was better in removing lignin from OPEFB, and resulted in a higher LA yield based on the mass of the pretreated OPEFB. On a mass basis, the LA yield was 31.1% on pretreated OPEFB, that had been pretreated using the PA–AP process, but only 16.7% from the biomass treated using the ammonia process. The kinetics of acid-catalyzed production of LA from the pretreated OPEFB were investigated to develop a mathematical model for predicting the conversion of cellulose to the intermediates (glucose, 5-hydroxymethylfurfural), and the final product, LA. The hydrolysis of cellulose to glucose was found to be the rate-controlling step in acid-catalyzed production of LA, confirming the importance of the delignification pretreatment in making cellulose more amenable to hydrolysis. During the two-stage acid hydrolysis, the reaction at 175 °C for 15 min in the first stage, followed by 125 °C for 105 min in the second stage, resulted in LA molar yield (based on cellulose) of ~40%. This was comparable to the yield obtained if both steps were performed at 150 °C for a total of 120 min.

Keywords

Cellulose Conversion; Levulinic acid; Lignocellulose; Oil palm Empty Fruit Bunch