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High Titer Cellulosic Ethanol Production Achieved by Fed-Batch Prehydrolysis Simultaneous Enzymatic Saccharification and Fermentation of Sulfite Pretreated Softwood

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Abstract : Cellulosic ethanol production from lignocellulosic biomass can reduce our reliance on fossil fuel, mitigate climate change, and stimulate rural economic development. The relative low ethanol production (60 g/L) limits the economic viable of lignocellulose-based biorefinery. The ethanol production can be increased up to 80 g/L by removing nearly all the non-cellulosic materials, while the capital of the pretreatment process increased significantly. In this study, a fed-batch prehydrolysis simultaneously saccharification and fermentation process (PSSF) was designed to converse the sulfite pretreated softwood (~30% residual lignin) to high concentrations of ethanol (80 g/L). The liquefaction time of hydrolysis process was shortened down to 24 h by employing the fed-batch strategy. Washing out the spent liquor with water could eliminate the inhibition of the pretreatment spent liquor. However, the ethanol yield of lignocellulose was reduced as the fermentable sugars were also lost during the process. Fed-batch prehydrolyzing the while slurry (i.e. liquid plus solid fraction) pretreated softwood for 24 h followed by simultaneously saccharification and fermentation process at 28 °C can generate 80 g/L ethanol production. Fed-batch strategy is very effectively to eliminate the “solid effect” of the high gravity saccharification, so concentrating the cellulose to nearly 90% by the pretreatment process is not a necessary step to get high ethanol production. Detoxification of the pretreatment spent liquor caused the loss of sugar and reduced the ethanol yield consequently. The tolerance of yeast to inhibitors was better at 28 °C, therefore, reducing the temperature of the following fermentation process is a simple and valid method to produce high ethanol production.

Keywords : cellulosic ethanol, sulfite pretreatment, Fed batch PSSF, temperature
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