Modeling and Simulation of Simultaneous Saccharification and Fermentation of Paper Mill Sludge to Lactic Acid

JIAN-QIANG LIN[1], SANG-MOK LEE[2], AND YOON-MO KOO[2*]

[1]State Key Lab of Microbial Technology, Shandong University, Jinan 250100, China

[2]Dept. of Biological Engineering, ERC for Advanced Bioseparation Technology, Inha University, Incheon 402-751, Korea

TEL (032) 860-7513, Fax (032) 872-4046

Abstract

Bioconversion of paper mill sludge for production of lactic acid using simultaneous saccharification and fermentation (SSF) process was employed. Enzyme cost is a main reason that hinders the commercial application of this process. Thermal deactivation is generally considered the cause for large consumption of enzymes, but it was not supported by experiments. Therefore, new mechanism is proposed in this research.

Cellulase needs to adsorb to the surface of cellulose in order to react with the solid substrate. After one reaction, cellulase needs to desorb and then re-adsorb to a new place on the surface of cellulose molecule. Irreversible adsorption will make the cellulase unable to react continuously and become "apparently" deactivated, which should be the main reason for the large consumption of cellulase in cellulose hydrolysis.

With microbial and several enzymatic reactions going on simultaneously, SSF is relatively sophisticated. Modeling and simulation is a powerful tool in mechanism investigation, feasibility evaluation, design and optimization of SSF process. In this research, the mathematical models of simple cellulose hydrolysis based on the mechanism of cellulase adsorption deactivation, simple lactic acid fermentation, and SSF system for bioconversion of paper mill sludge to lactic acid are developed, and the characteristics of SSF is investigated using model simulation.

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