SESSION 3
Bioprocessing Research

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Bioprocessing research is crucial to the production of chemicals and fuels from biomass, because it assesses not only the scientific merits of the biochemical process, but also its engineering soundness and technoeconomic feasibility. Hence, the session on bioprocessing research covered a variety of interesting topics from metabolic and thermodynamic studies and material balances to mass transfer and fermentation investigations for the production of both chemicals and enzymes.

In the area of cell metabolism, the fermentation of xylose to ethanol was used as a model system. A metabolic competition model was developed for *Saccharomyces cerevisiae* to depict the spontaneous oscillations observed in the concentration of various fermentation parameters during the organism's diauxic utilization of glucose and xylose. This simple cybernetic model can serve as a tool in efforts to enhance the uptake of 5-carbon sugars by several yeast species. Besides modeling, the availability of thermodynamic data is also important to the success of bioprocess engineering. Using experimental measurements and theoretical calculations, the equilibria of a variety of biochemical reactions over a wide range of temperature, pH, and ionic strength were determined. This information can then be used to predict the feasibility of biochemical reactions and their product yields. With respect to product yield calculations, another presentation emphasized the need for detailed material balances in order to achieve process optimization. Based on developed material balance templates, the true yield of ethanol from pretreated cellulosic biomass was determined.

In the area of fermentation studies, the production of cellulase enzyme and succinic acid were investigated. Using NaOH-pretreated wheat straw, the effect of environmental conditions on the solid-state cultivation of *Trichoderma reesei* was measured for the synthesis of cellulase and β-glucosidase. On the same subject, the rheological, mass transfer, and biological kinetics of cellulase production were outlined in another presentation, based on shear measurements of the suspension of *T. reesei* and the development of a biological kinetic model. Finally, the bacterial production of succinic acid by an *Anaerobiospirillum* species was presented. Using sodium carbonate for pH control and bubbling carbon dioxide through the fermentation broth, high yields of succinic acid were achieved.