Introduction to Session 1

Thermal and Chemical Processing

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INTRODUCTION

The thermal and chemical processes to pretreat or convert biomass to useful commodities complement the purely biological processes with which this conference deals. The pretreatment of lignocellulosic materials was a major theme of this session. The objective of the pretreatment is the production of cellulosic substrates that are easily digestible by enzymes, prior to the fermentation of the resulting glucose to fuels or other chemicals. Several types of pretreatments were discussed in depth, such as steam explosion, rapid steam hydrolysis, dilute acid hydrolysis, and organosolv processes. A variety of feedstocks were included from easy to delignify, such as, *Populus species* and wheat straw to sweet gum, white oak, birch, and aspen bark. Several types of catalysts were employed, with special emphasis placed on sulfur dioxide. Ester group removal was shown to decrease the resistance of the plant cell wall polysaccharides of wheat straw (but not as much of aspen) to enzyme hydrolysis. Substantial progress has been made in the development of the kinetics of thermochemical pretreatment of lignocellulosic materials linked to enzyme hydrolysis kinetics for the prediction of temperature, time, and acid concentration needed to pretreat substrates effectively prior to enzyme hydrolysis. Data on the surface area based on pore volume measurements of pretreated lignocellulosic materials were presented as a function of the extent of enzyme hydrolysis. A large fraction of available surface area appears to come from pores that are too small for enzymes to penetrate. The effects of pore sizes as a function of pretreatment conditions and course of enzyme hydrolysis were presented.

The alternative to enzyme hydrolysis of cellulose is acid hydrolysis. Two types of hydrolysis are clearly distinguishable. The low temperature concentrated acid hydrolysis and the high temperature dilute acid hydrolysis. In the low temperature concentrated acid hydrolysis process substantial progress has been achieved in uncovering strategies to lower the cost of the acid recovery through electrodialysis. A few membranes have been identified that can lead to the desired concentration of the acid. The preliminary economic evaluation of the electrodialysis appears promising. In the case of the low-temperature dilute acid hydrolysis, developments have been presented on effects of nonuniform temperature profile and acid concentration on the acid hydrolysis of hardwood cellulose. Progress on the dilute sulfuric acid hydrolysis of biomass in two-stage continuous flow design processing high solids slurries was presented.

A few papers addressed chemicals from biomass, such as, vanillin from rice straw and combined products oxalic acid and high density carbon pellets. Slow pyrolysis empirical models were presented for oak chips.