183b Enzymatic Digestion of Corn Stover and Poplar Wood after Pretreatment by Leading Technologies

Charles E. Wyman, Rajeev Kumar, Mohammed Moniruzzaman, Bruce Dale, Richard T. Elander, Mark T. Holtzapple, Michael Ladisch, Y. Y. Lee, and John N. Saddler

Pretreatment operations are essential to high yields for biological processing of cellulosic biomass to fuels and chemicals that would open up major new agricultural markets with powerful societal benefits and have a major impact on costs. A team of researchers experienced with cellulosic biomass hydrolysis formed a Biomass Refining Consortium for Applied Fundamentals and Innovation (CAFI) to develop comparative data on the more promising pretreatment options for the first time. Pretreatment by ammonia explosion, aqueous ammonia recycle, controlled pH, dilute acid, flowthrough, lime, and sulfur dioxide steam explosion are applied to single sources of corn stover and poplar wood, and comparative data are developed on the digestibility of cellulose in the pretreated solids using a controlled source of enzyme. Most of the glucan in corn stover was solubilized in the enzymatic digestion step at cellulase enzyme loadings of 60 and 15 FPU/g glucan for each pretreatment, demonstrating that all are effective in making corn stover cellulose accessible to enzymes. The data showed slightly higher yields for lime, ARP, and flowthrough technologies that remove substantial amounts of lignin. However, because AFEX achieved such yields even though no lignin was removed, lignin removal does not appear to be essential to enhance the digestibility of corn stover cellulose. Although most of the xylose was released during pretreatment for dilute acid, flowthrough, partial flow, and controlled pH pretreatments, the cellulase formulation used was effective in releasing residual xylose for the solids from all pretreatments. The high-pH pretreatments of AFEX, ARP, and lime particularly benefited from this xylanase activity in that about half was solubilized by enzymes for ARP, two thirds for lime, and essentially all for AFEX. A more detailed study is exploring how addition of hemicellulase enzymes could improve recovery of hemicellulose sugars from the pretreated solids and tradeoffs in glucose yields over a wider range of cellulase loadings. Initial data for pretreatment of poplar wood show that more severe conditions are needed to achieve reasonable glucose yields from cellulose at higher pH.