Initial Data and Models for Enzymatic Hydrolysis of Cellulose Prepared by Leading Pretreatment Technologies

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Biological conversion of cellulosic biomass such as agricultural residues (e.g., corn stover), herbaceous plants (e.g., switchgrass), and wood (e. g., poplar) to fuels and chemicals can provide powerful and unique economic, environmental, and strategic benefits and offers the possibility to achieve costs competitive with conventional products. However, cellulosic biomass must be pretreated to achieve cost effective conversion of cellulosic biomass materials such as by biological routes. Several researchers have devised promising technologies to address this need and are teamed in a cooperative project to compare and understand their relative attributes. The chemical consequences of these approaches vary significantly with some removing hemicellulose (dilute acid and neutral pH), others removing lignin (liquid ammonia and lime), still others removing neither (ammonia fiber explosion), and some removing both (flowthrough). Nonetheless, all result in highly digestible cellulose, and we seek to better understand the relationship between enzymatic hydrolysis performance and key features of the substrates prepared by these pretreatment approaches to help enhance these methods. Results from digestion of corn stover pretreated by these methods will be reported over a range of cellulase loadings to characterize the relative effects of pretreatments on performance. In addition, we will present initial data on the influence of β-glucosidase supplementation on the rate and yield of sugar release versus time for the different pretreatments to determine the relationship between pretreatment type and optimal enzyme activity balances. Data will also be provided on adsorption of cellulase enzyme and β-glucosidase on washed lignin recovered after enzymatic digestion with each technology to determine whether pretreatment affects non-productive cellulase binding. As part of this research, kinetic models reported in the literature will be compared to determine how well they can account for enhancement in enzymatic hydrolysis and explain cellulase adsorption for cellulose prepared by these different pretreatment technologies.

Keywords: Cellulase, β-glucosidase, Enzymatic Hydrolysis, Kinetic models, Pretreatment