Fundamental characteristics that affect enzymatic digestibility of autohydrolysis pretreated biomass

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Abstract

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Autohydrolysis has been widely studied as a pretreatment technology for bioethanol production on a wide range of feedstock. Among all the pretreatment methods, autohydrolysis, pretreats lignocellulosic biomass in chemical-free, water only media. It has several advantages compared to other pretreatment processes because it is a simple, low-cost and environmental friendly process. In addition, lower amounts of undesirable degradation inhibitors are produced during autohydrolysis compared to other pretreatment methods. Autohydrolysis pretreatment predominantly depolymerizes the hemicellulose in biomass and also removes some of the lignin. Mechanical refining has been widely applied in pulp and paper industry in order to improve the bonding ability of the fiber and increase paper strength. It has also been used to generate microfibrils, shorten long fibers, and develop the porosity and internal surface area (up to 10%) of fiber. It has been reported that refining significantly improved enzymatic conversion, while enzyme loading was reduced up to 50%. Before enzymatic hydrolysis, the pretreated residue was mechanically refined to improve enzyme accessibility and increase the sugar recovery at a low enzyme dosage.

Six types of lignocellulosic biomass including sugarcane bagasse, wheat straw, switchgrass, maple, sweet gum, and nitens were subjected to autohydrolysis pretreatment, followed by enzymatic hydrolysis to evaluate the impact of biomass characteristics on autohydrolysis pretreatment and the subsequent enzymatic hydrolysis. It has been found that the lignin of non-woody biomass is easier to depolymerize during autohydrolysis compared to woody biomass because of the existence of significant amount of p-coumaric acid and ferulic acid. More than 30% of lignin in non-woody biomass can be solubilized during the pretreatment whereas only around 18% of lignin in woody biomass depolymerized into the autohydrolysis filtrate. The pretreatment yield for non-woody biomass was between 55-60% as compared to 65%+ for the woody biomass. However, the total amount of sugar recovered was higher for the non woody biomass. The overall sugar recovery was the highest from Eucalyptus (85%) and the lowest was from Maple at 70%. The sugar recovery for all the non-woody biomass was about 72%. The lignin structure such as S/G ratio in the woody biomass played a significant role in the total sugar recovery from autohydrolysis process where the higher the S/G ratio, the higher amount of sugar can be extracted from the woody biomass. Now correlations were observed with lignin structure for the non-woody biomass.