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PRETREATMENT AS THE CRUCIAL STEP FOR A CELLULOSIC ETHANOL BIOREFINERY: TESTING THE EFFICIENCY OF WET EXPLOSION ON DIFFERENT TYPES OF BIOMASS

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Abstract

In this study, the efficiency of wet explosion (WEx) pretreatment as the primary step in a biorefinery concept for the production of ethanol, biogas and a solid lignin fraction was investigated on several lignocellulosic biomasses: Lucerne, ryegrass, grass, fescue grass, cocksfoot grass, rye fescue, and wheat straw. All biomasses were crop residues or supplementary crops harvested on the island of Bornholm, Denmark, and investigated as potential biomass resources for a 2nd generation bioethanol production plant to be built in demo-scale on Bornholm (BornBioFuel concept).

Wet explosion is a pretreatment method for breaking the lignocellulosic structure, operating at around 150-200°C and the addition of dilute acid**.** The output from the pretreatment is a solid fraction mainly composed of cellulose and lignin, and a liquid fraction with solubilized hemicellulose sugars and other low molecular compounds. The efficiency of the pretreatment was assessed in terms of cellulose and hemicellulose recovery and their conversion into sugar monomers after enzymatic hydrolysis. The highest cellulose recovery of 97% was found in grass harvested in July, while the highest recovery of solubilized hemicelluloses of 89% was found in wheat straw with minor losses of valuable materials. The WEx conditions applied showed generally high enzymatic convertibility of cellulose from the solid fraction. The highest glucose yield of approximately 86% was achieved in wheat straw, followed by cocksfoot harvested in August, with a glucose yield of 78%. The formation of degradation products (furfural, hydroxymethylfurfural (HMF), and carboxylic acids) was generally low for all biomasses. From the different sugar yields after WEx pretreatment and enzymatic hydrolysis the theoretical ethanol production potentials were calculated. The highest theoretical ethanol yield was obtained in wheat straw and cocksfoot ranging from 300 to 330 mL/kg-DM, both harvested in August. Mass balance calculations revealed a loss of dry matter after WEx pretreatment between 11.5-96.9 g per kg of dry matter input to the WEx process. The study shows that the implementation of the WEx pretreatment in the BornBioFuel biorefinery concept opens up the possibility of utilizing a wide range of biomass resources with high conversion efficiencies into bioethanol.