Concentrated acid hydrolysis of biomass for biofuel and biorefineries

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Introduction

Unlike dilute acid hydrolysis, hydrolysis of lignocelluloses using concentrated acids achieves near-theoretical sugar yields with fewer degradation products. Several different mineral acids may be employed, however the most widely investigated are sulfuric acid, phosphoric acid and hydrochloric acid. The gelatinous nature of lignocellulose after concentrated acid treatment gives a dramatically improved accessibility for the process chemicals during hydrolysis and reduces the risk for degradation of sugar monomers before complete hydrolysis is obtained, thus reducing the formation of fermentation inhibitors like furfurals and hydroxyacids.

The concentrated acid hydrolysis process has had some major drawbacks, namely consumption of large quantities of concentrated acids, high costs of neutralization and gypsum disposal problems. Quite recently, new acid recovery technologies like Arkenol’s chromatography-based process or Weyland’s solvent extraction-based process have been invented, and the high flexibility of this process towards different feedstocks including solid wastes has revived interest on this process which was once left behind in research. Currently, both technologies are being implemented in pilot scale; Arkenol's process by Bluefire Ethanol in Japan and the Weyland process by Weyland in Norway.

Process parameters

The kinetics of the concentrated acid hydrolysis process depends mainly on the type of acid, acid concentration, temperature and time. We have investigated the interdependence of time, temperature and acid concentration in multivariate experimental design using an empirical polynomial model.

Fermentability

We have investigated the fermentability of hydrolyzates from aspen and pine at different degrees of decrystallization severity. Even with quite high yield losses in the severely treated hydrolyzates, we were not able to detect any inhibitory effect on anaerobic fermentation of the hydrolyzates with Saccharomyces cerevisiae ATCC 96581.

The effect of temperature, acid concentration and their interaction on the total sugar yield from pine

Glucose utilization (open symbols) and ethanol production (filled symbols) in pine hydrolyzates. ○: Moderate pretreatment, △: Mild pretreatment, □: Severe pretreatment.