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A model for optimizing the enzymatic hydrolysis of ionic liquid-pretreated lignocellulose

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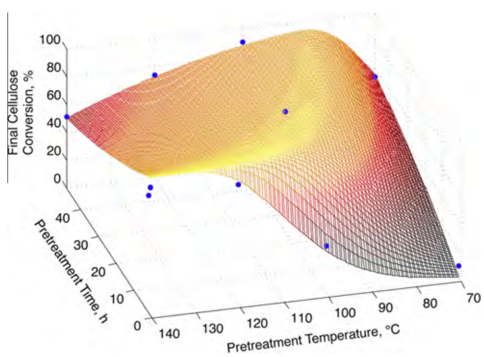
HIGHLIGHTS

- *Miscanthus x giganteus* was pretreated with the ionic liquid [C_2mim][OAc].
- The enzymatic hydrolysis of IL pretreated *Miscanthus* was measured over time.
- A kinetic model was developed for IL pretreatment time and temperature effects.
- The model was used to predict enzymatic conversion for different IL pretreatments.
- Pre-exponential constants and activation energies were obtained from the model.

GRAPHICAL ABSTRACT



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ABSTRACT

Miscanthus x giganteus was pretreated with the ionic liquid (IL) 1-ethyl-3-methylimidazolium acetate at ten different pretreatment temperatures and times. The enzymatic hydrolysis of the pretreated *Miscanthus* to glucose and xylose was measured as a function of time to provide rate and final conversion data. A series of two irreversible, first-order reactions with Arrhenius temperature dependencies was used to model both the cellulose and hemicellulose pretreatment. This kinetic model was used to predict the enzymatic hydrolysis conversion of IL pretreated *Miscanthus* over a range of pretreatment temperatures (70–140 °C) and times (1–48 h), and indicated a wide range of optimal pretreatment conditions, from high temperatures/short times to lower temperatures/long times. Pre-exponential constants and activation energies obtained from the kinetic model are within reported ranges of experimentally obtained values for other pretreatments, indicating that the model may be broadly applicable to a variety of lignocellulosic pretreatment processes.

1. Introduction

Lignocellulose is primarily composed of cellulose, hemicellulose, and lignin. Cellulose is a highly stable polysaccharide composed of cellobiose repeating units. The individual cellulose strands interact through strong hydrogen bonds to form a crystalline cellulose network that provides structural integrity, but is also difficult to degrade. The cellulose is further wrapped in lignin, a complex polyaromatic material, and hemicellulose, a non-crystalline polysaccharide that can contain a variety of sugars and their derivatives. A key step in the conversion of lignocellulosic biomass to biofuels is the pretreatment of biomass to facilitate the hydrolysis of the polysaccharides into monomeric sugars, which can then be converted into fuel (Himmel et al., 2007).

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