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Design of process parameters for the production of xylose from wood sawdust

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ABSTRACT

Meranti wood sawdust (MWS) is a cheap and widely available lignocellulosic biomass, which can be a potential source of xylose. This xylose can be an economic raw material for the production of a wide variety of specialty chemicals, mainly xylitol. It is particularly important to establish rapid hydrolysis conditions, which can yield xylose-rich hydrolysate that do not require further treatment. The aim of this research was to study the effect of residence time, temperature, acid concentration, and liquid to solid ratio (LSR) on the formation of xylose and byproducts. Batch hydrolysis was performed using different levels of residence time (10–120 min), temperature (105–130 °C), H_2SO_4 concentration (2–12%), and LSR (8–20 g/g). One-factor-at-a-time (OFAT) method was followed to select the optimum level of parameters. The residence time, temperature, and acid concentration were found to be the major factors affecting xylose production with the effective level of 60 min, 125 °C, and 4%, respectively. In these conditions, the xylose concentration was 17.9 g/l, corresponding to a yield of above 86% of the potential concentration.

Keywords: Lignocellulose; *Meranti* wood sawdust (MWS); Xylose; Hydrolysis; Parameter design; One-factor-at-a-time (OFAT)

1. Introduction

Lignocellulosic biomass is renewable, widespread, and a cheap source of sugar polymers that can be used as raw material for bioconversion into fuels, chemicals or food ingredients (Kuhad and Singh, 1993; Parajó et al., 1996; Rahman et al., 2007). Sawdust is a sawmill waste, a lignocellulosic material. It is produced in large quantities by sawmills throughout the year and the economical disposal of them is a serious problem to the wood industries. Sawdust is commonly used as fuel in manufacturing plants and local utilities (Arends and Donkersloot-Shouq, 1985; Harkin, 1969). Sawdust from red *Meranti* species was chosen as raw material in this study because it is one of the most common and popular hardwood species in Malaysia, the hydrolysis of which to produce xylose solution could be a good alternative to manage this abundant waste. The *Meranti* wood sawdust (MWS) biomass contains cellulose, hemicellulose and lignin as the major biopolymers. It is estimated that this biomass is comprised of more than 29% xylan, a sugar polymer made of pentose sugar xylose. Xylose can be used as a substrate for the production of a wide variety of specialty chemicals or fuels by chemical and biochemical processes. One of these specialty chemicals is xylitol that is extensively utilized in the food, pharmaceutical, and odontological industries (Roberto et al., 1995).

The hemicellulosic fraction of lignocellulosic material (LCM) is generally hydrolyzed by either acid, autohydrolysis, or enzyme to produce xylose and/or xylooligosaccharides. Dilute acid hydrolysis is one of the most studied and widely used methods because it is effective and inexpensive (Sun and Cheng, 2005; Balat and Balat, 2008). Autohydrolysis is an alternative technology for the solubilization of hemicellulose, with various advantages over the dilute acid hydrolysis, namely a more limited delignification and small quantities of sugar degradation products (Garrote et al., 2002; Carvalheiro et al., 2005) and no chemicals other than water are used (Brosse et al., 2009; El Hage et al., 2010). Normally, autohydrolysis is used as a pretreatment to yield mainly oligosaccharides without modifying the cellulose and lignin structure substantially (Garrote et al., 2004; El Hage et al., 2010). However, the liquor of autohydrolysis is partially fermentable by microorganisms since the sugars are mainly in the oligomeric form

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