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Wei Weiqi, Wu Shubin

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Experimental and kinetic study of glucose conversion to levulinic acid catalyzed by synergy of Lewis and Brønsted acids

WEI Weiqi¹, WU Shubin^{1*}

1) State Key Laboratory of Pulp and Paper Engineering, South China University of Technology,
Guangzhou 510640, China.

Abstract: Conversion the glucose to levulinic acid (LA) using various homogeneous Brønsted acids or Lewis acids in a batch reactor has been investigated in this study. The results show that coupling of CrCl₃ and H₃PO₄ as a mixed catalyst has a positive synergistic catalytic effect on glucose conversion to LA compared with single CrCl₃ or H₃PO₄ catalyst. Both the reaction time and temperature have strong effect on glucose conversion and LA formation, the highest LA yield of 54.24% was obtained from 100% glucose conversion at 170 °C for 240 min. Furthermore, a simplified kinetic model was developed to describe the behavior of glucose conversion and LA formation based on the pseudo homogeneous first-order model, and the results show that this model is in good agreement with the experiment data. The reaction rate constants for glucose decomposition, hydroxymethylfurfural (HMF) conversion, and LA formation are all increased with elevated temperature, the activation energies for glucose dehydration into HMF and HMF rehydration to LA were 65.4 and 60.6 kJ/mol, respectively, significantly lower than previous reports in the measure of single homogeneous Brønsted acid or Lewis acids.

Keywords: Glucose conversion; Levulinic acid; Kinetic study; Synergistic catalysis

1. Introduction

In order to reduce our dependence towards fossil carbons and to limit CO₂ emissions,

* Corresponding author Tel: 020-22236808, E-mail address: shubinwu@scut.edu.cn.

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