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Thermo-kinetic assessment of glucose decomposition to 5-hydroxymethyl furfural and levulinic acid over acidic functionalized ionic liquid

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Abstract

Decomposition of biomass feedstock is a promising technique for producing versatile chemicals such as 5-hydroxymethyl furfural (5-HMF) and levulinic acid (LA). Glucose, the model compound of cellulose, is one of the most important starting components for bio-based chemical synthesis. Herein, the kinetics of glucose decomposition catalyzed by an acidic functionalized ionic liquid, 1-sulfonic acid-3-methyl imidazolium tetrachloroferrate ([SMIM][$FeCl_4$]) was studied in the temperature range of 110 to 170 °C. A simplified kinetic model was developed based on pseudo-homogeneous first-order reactions. The kinetic model consists of four main key steps: (1) dehydration of glucose to 5-HMF; (2) degradation of glucose to humins; (3) rehydration of 5-HMF to LA; and (4) degradation of 5-HMF to humins. The proposed model was in a good agreement with the experimental results. The evaluated activation energies for glucose decomposition to 5-HMF and 5-HMF decomposition to LA were 37 and 30 $kJ.mol^{-1}$, respectively. The first-order rate constants were also used to calculate the thermodynamic activation parameters. The kinetic and thermodynamic parameters obtained can be applied to provide insights on the biomass decomposition to 5-HMF and LA using acidic ionic liquid.