

Accepted Manuscript

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Nur Aainaa Syahirah Ramli, Nor Aishah Saidina Amin

PII: S1385-8947(17)31827-2
DOI: <https://doi.org/10.1016/j.cej.2017.10.112>
Reference: CEJ 17896

To appear in: *Chemical Engineering Journal*

Received Date: 10 March 2017
Revised Date: 17 October 2017
Accepted Date: 18 October 2017

Please cite this article as: N.A.S. Ramli, N.A.S. Amin, Thermo-kinetic assessment of glucose decomposition to 5-hydroxymethyl furfural and levulinic acid over acidic functionalized ionic liquid, *Chemical Engineering Journal* (2017), doi: <https://doi.org/10.1016/j.cej.2017.10.112>

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

Nur Aainaa Syahirah Ramli^a, *Nor Aishah Saidina Amin^b

^aAdvanced Oleochemical Technology Division, Malaysian Palm Oil Board, 6, Persiaran Institusi, Bandar Baru Bangi, 43000 Kajang, Selangor, Malaysia

^bChemical Reaction Engineering Group, Faculty of Chemical and Energy Engineering, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, Malaysia.

*Corresponding author Tel: +6075535579; Fax: +6075588166. Email: noraishah@cheme.utm.my

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][FeCl₄]) 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.

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