INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: Non-Catalytic and Catalytic Co-Pyrolysis of Delonix Regia and Butyl Rubber Tube Wastes: Kinetic and Thermodynamic Investigations

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SHORT ABSTRACT

The outline of this dissertation was to investigate the kinetics and thermodynamic insights for the catalytic and non-catalytic pyrolysis of *Delonix Regia* (DR) and butyl rubber tube (BRT) wastes. The specific objectives proposed in this dissertation were: 1. non-catalytic pyrolysis of DR biomass, 2. non-catalytic pyrolysis of BRT, 3. non-catalytic co-pyrolysis of DR and BRT (1:1 wt. %) wastes, 4. In – situ catalytic pyrolysis of DR biomass, and 5. In – situ catalytic co-pyrolysis of DR and BRT (1:1 wt.%) wastes. For all the stated objectives, the experimental runs were performed with a sample mass of about 6 mg at a temperature range from 25 – 1000 °C between 5 – 55 °C min^{-1} in an inert (nitrogen gas 40 mL min^{-1}) atmosphere using a thermogravimetric analyzer (TGA). Three different types of catalysts, namely zeolite (Na – Y), noble metal on activated carbon (10 wt. % Pt/C), and two–metal oxide (1:1 wt. % TiO_2 – ZnO) with loadings from 30 to 10 wt. % were utilized for the catalytic studies. For investigating the kinetic and thermodynamic, several iso-conversional techniques such as Differential Friedman (DFM), Ozawa–Flynn–Wall (OFW), Kissinger–Akahira–Sunose (KAS), Starink (STK), and Distributed Activation Energy (DAE) were applied. The reaction mechanisms were affirmed by Criado's master plot for all the objectives. Additionally, the pyrolysis performance indices (PPI) were also discussed for all the objectives.

From kinetic investigation, the average apparent activation energy (E_α, kJ mol^{-1}) and pre-exponential factor (k_o, s^{-1}) were: 202 – 206 and 4.98 × 10^{17} – 2.04 × 10^{20}, 223 – 245 and 6.82 × 10^{21} – 2.73 × 10^{24}, 230 – 208 and 2.55 × 10^{30} – 5.15 × 10^{26}, 182 – 181 and 1.33 × 10^{16} – 2.10 × 10^{16} at DR:Na – Y (1:10 wt. %), and 200 – 179 and 3.03 × 10^{24} – 1.39 × 10^{19} at DR:BRT:Na – Y (1:1:10 wt. %) ascertained from all iso-conversional techniques for objectives 1, 2, 3, 4, and 5 respectively. From thermodynamic investigation, the average change in enthalpy (ΔH, kJ mol^{-1}) and change in Gibbs free energy (ΔG, kJ mol^{-1}) were: 197 – 201 and 183 – 206, 217 – 239 and 185 – 218, 226 – 225, and 180 – 182, 178 – 177 and 176 – 177 at DR:Na – Y (1:10 wt. %), and 175 – 174 and 179 – 184 at DR:BRT:Na – Y (1:1:10 wt. %), determined from DFM technique between 5 – 55 °C min^{-1} for objectives 1, 2, 3, 4, and 5 respectively. Criado's master plot confirmed the multi–step reaction mechanism for all the objectives during the pyrolysis (catalytic and non-catalytic) of DR and BRT wastes.