Non-catalytic Upgrading of Fast Pyrolysis Bio-oil in Supercritical Ethanol: Operating Conditions Study

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Fast-pyrolysis bio-oil is one of the potential renewable energy resources. The technology has been commercialized mainly due to its short residence time and simplicity. However, the bio-oil possesses inferior properties like high moisture, oxygen, acid, and reactive compounds contents which resulting in viscous, highly corrosive, thermally unstable oil with low calorific value. Ethanol at supercritical state exhibits superior properties including faster rates of mass and heat transfer, good dissolving power, and also can generate hydrogen to enhance cracking and hydrodeoxygenation reaction to convert unfavorable compounds to favorable ones. In this study, the effects of operating condition towards the upgraded oil yield and properties were examined. The upgrading was conducted under various reaction temperatures (300, 350, 400°C) and times (0, 30, 60, 120 min) with adjusted pressure and stirring speed of 500 rpm. The liquid, gas, and solid products were separated, quantified, and analyzed. The upgrading held at 400 °C for 30 min in supercritical ethanol gave the considered to be best results in terms of high oil yield of 82.5 wt% and low TAN (total acid number) of 4.84 mg KOH/g oil, H2O content of 1.6 wt%, oxygen content of 12.6 wt%, and HHV (high heating value) of 34.1 MJ/kg.