

Technical Assessment and Policy Analysis of Bio-Oil Production From Rice Straw

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Pyrolysis of rice straw using a fixed bed-batch reactor was investigated to determine the effects of varying pyrolysis temperature (300°C, 400°C, and 500°C) and heating rate (low (0.2-2.0°C min⁻¹), high (2.6-7.2 °C min⁻¹)) on pyrolysis products yield and composition. Bio-oil is a liquid fuel that may be refined or upgraded for advanced biofuels production. The gas product can be further utilized for energy production while biochar is used for combustion, for food and beverage industry as activated carbon and for waste treatment facility. A D-optimal coordinate exchange design of experiment was implemented and based on the results, the highest bio-oil yield obtained was 19.77% ww⁻¹ at 400°C and low heating rate. The highest biochar yield (71.77% ww⁻¹) was achieved at 300°C and high heating rate while the highest yield for gaseous product is equivalent to 19.65% under the conditions: 500°C and high heating rate. Compositional analysis of bio-oil via GC-MS was done to identify the compounds present which include N-containing compounds (amines and amides), oxygenates (carboxylic acids and ethers), aliphatics and aromatics. The physico-chemical characteristics of biochar were also determined. The H-C ratio of biochar ranges from 0.60 to 0.85 while the O-C ratio is between 0.16 to 0.22 which falls within the coal region suggesting that biochar has the potential use as solid fuels. The components of the gaseous product were also identified through GC and found to be mainly composed of H₂, O₂, N₂, CO, CH₄, CO₂, C₂H₄, C₂H₆, C₃H₆ and C₃H₈. Based on the policy analysis, it is recommended that rice straw conversion to bio-oil via pyrolysis should be adopted and implemented since the social benefit-cost analysis (SBCA) resulted to a benefit-to-cost ratio of 2.90 where the benefits are higher than the costs.

Keywords: bio-oil, policy analysis, pyrolysis, rice straw, SBCA