Simulation and optimisation of the pyrolysis of rice husk: Preliminary assessment for gasification applications

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Abstract

Thermochemical conversion of biomass into useful products is a promising route to harness biofuels. This process is clean, renewable and can reduce the use of fossil fuel. In this study, SuperPro Designer (SPD) software and response surface methodology (RSM) is used to simulate and optimize rice husk pyrolysis process. The SPD simulator was built to handle kinetics and stoichiometric reaction of lignocellulosic composition of rice husk into final products. The SPD simulation and RSM optimization were performed at a temperature ranging from 350 to 800 °C and residence time of 0.25−60 s. The simulated results were in agreement with product yield published in the literature at an average relative error of 6.8 %. The combined effect of temperature and residence time were analysed by using RSM and analysis of variance (ANOVA). A cubic model for bio-oil and quartic model for char and gas yield were proposed. The desirability function in Design-Expert showed that the optimum bio-oil yield (36.72 %) could be attained at a temperature 588 °C and a residence time 0.25 s while the optimum gas yield (73.25 %) could be achieved at a temperature 798.8 °C and a residence time 15.47 s. These findings therefore revealed that the energy content of the rice husk could be harnessed by pyrolysis/gasification to obtain substantial fuel products.

Keywords

Pyrolysis; Gasification; Rice husk; Super Pro designer; Response surface methodology