

ABSTRACT

Biomass material is a renewable source of energy which are readily available and being produced in large quantities as most of it goes to waste. These materials can be recovered through pyrolysis process in order to produce usable products like biochar and pyroligneous acid. These products can be used as bio-fertilizer and bio-pesticides. The aim of this research was to optimize the selected pyrolysis parameters in pyroligneous acid production rate and quality from acacia twigs. The parameters varied were feedstock moisture content (10%, 15% and 20%), Pyrolysis residence time (90 minutes, 135 minutes and 180 minutes) and chimney inclination angle (30°, 45° and 60°). Smoke condensation system also known as heat exchanger was used for condensing the pyrolysis smoke in to pyroligneous acid. Response Surface Methodology technique by using *Box-Behnken Design* was used to develop a mathematical equation to predict the production rate and quality of the pyroligneous acid with respect to varied parameters which was later optimized to determine the optimal conditions for pyroligneous acid production rate and quality. The pyroligneous acid quality was based on its pH and density. The combined optimal conditions were 20% feedstock moisture content, 137.27 min pyrolysis residence time and 60° chimney inclination angle resulting to a density of 1.03 gcm⁻³, pH of 3.01 and production rate of 0.19 kg/min (26.08%). The mathematical equation developed had a composite desirability of 0.9663 for pyroligneous acid production rate at *p*-value ≤0.05 which made it viable. These research findings are of importance since pyrolysis of the biomass material will maintain a balance in the environment and also serve as a source of livelihood when the products are sold as bio-fertilizer or bio-pesticides.