



Feedback control of temperature in the pyrolysis process by using microwave heating system

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Abstract

Heating with microwaves (MW) has gained popularity because it can provide rapid and more uniform heating than conventional methods relying on the diffusion of heat from outside the sample. As the pyrolysis mechanisms and products strongly depend on temperature, aside from uniformity of temperature also control of its level will strongly affect experimental results. A temperature control system was therefore developed for use in an experimental MW cavity, modified from a domestic multimode MW oven with maximum 800 Watt power output and 2.45 GHz MW frequency. To homogenize the heating effect, a metallic propeller-driven at 50 rpm is used to scatter the MW radiation. The sensor in the temperature control system is a type-K thermocouple probe, connected to the ground to reduce noise in the measured signal. The electric signal from the probe is amplified and then goes to a microcontroller board that controls a solid-state relay (SSR). The relay serves as a switch providing ON-OFF control of MW power. The results show good performance of the developed feedback control system. It was experimentally tested with water at temperature set-point 80 °C; and with a pyrolysis substance (oil palm shell biomass or OPS, mixed with activated carbon or AC) at set-points 400, 500, and 600 °C. The most average bio-oil yield obtained from experimental conditions: ratio 70:30 at 500°C and the top seven chemical components were found as phenol, acetic acid, and etc., which analyzed by GC-MS.

Keywords: Temperature control system, Microwave heating, Microwave interaction, pyrolysis and bio-oil