

## **Microwave-assisted pre-carbonisation of palm kernel shell produced charcoal with high heating value and low gaseous emission**

### **ABSTRACT**

Production of charcoal with a high higher heating value (HHV) while maintaining low gaseous emission requires high energy input and complicated methods. This paper presents a study of the production of charcoal with high HHV and low gaseous emission from palm kernel shell (PKS) within a microwave-assisted pre-carbonisation system. The maximum temperature was 300 °C, and three magnetrons were employed to assist with the pre-carbonisation process. The magnetrons were programmed to automatically shut down when the temperature reached 250 °C. Carbonisation took place when the PKS was combusted and the resulting heat was used to sustain the carbonisation. The gaseous emission was passed through a condensation unit and a scrubber system connected to the microwave reactor. Untreated PKS biomass with particle size of 6–15 mm was used in this study. A high HHV of 27.63 MJ/kg was obtained. The concentrations for the particulate matter with a size of 10 µm and below (PM10), CO, NO<sub>2</sub>, SO<sub>2</sub> and HCl were below the standard limits set by the Malaysian Ambient Air Quality Standards (2014). Therefore, the microwave-assisted pre-carbonisation technology proposed in this study produced charcoal with high HHV and low gaseous emission which can be used as co-combustion for renewable energy generation.

**Keyword:** Microwave-assisted carbonisation; Higher heating value; Palm kernel shell; Charcoal; Waste utilisation