Characterization of oil palm trunk biocoal and its suitability for solid fuel applications

ABSTRACT

Mankind’s quest to reduce its dependency on fossil fuel involves biomass as a promising alternative. However, direct application of raw biomass faces problems such as high moisture content, low heating value, and poor grindability. Pyrolysis is one of the pre-treatment methods to improve biomass properties particularly its energy density. This study is aimed at investigating the pyrolysis of oil palm trunk (OPT) into biocoal and its suitability for solid fuel applications in terms of slagging and fouling tendencies, bulk density, proximate and ultimate analysis, higher heating value, energy densification ratio, and mass and energy yield. The biocoal was produced using a top-lit, updraft reactor with a peak temperature of 550 °C and fixed air flowrate of 4.63 L/min. The bulk density of OPT biocoal was 87.7 kg/m3 which is 4.63% lower than that of original OPT due to the increased porosity. The elemental composition of our biocoal resembles lignite. The volatile matter content decreased by a factor of 1.87 while the fixed carbon content and higher heating value (HHV) increased from 4.29 to 30.9% and from 14.5 to 19.6 MJ/kg, respectively. The HHV of biocoal increased by a factor of 1.36 relative to that of raw OPT; however, the resulting energy yield was low (37.6 ± 1.9%) due to a low biocoal yield of 27.8 ± 1.4%. The ash content increased by a factor of 1.5, resulting in an ash content of 27.8 wt% for biocoal. This increment may exacerbate the slagging and fouling propensity in furnaces and boilers as indicated by the slagging and bed agglomeration index which increased from 2.0 to 5.2 and from 0.4 to 0.7, respectively. Demineralization, a lower pyrolysis temperature and subsequent briquetting of OPT biocoal are suggested to improve its fuel properties for co-combustion in coal-firing power plants.

Keyword: Biomass; Biocoal; Pyrolysis; Energy densification; Oil palm trunk; Ash behavior; Fouling; Slagging; Solid fuel