Microwave-assisted pyrolysis of EFB-derived biochar as potential renewable solid fuel for power generation: biochar versus subbituminous coal

ABSTRACT

The present study was conducted to study the physico-chemical characteristics (proximate and ultimate analyses, particle size distribution, energy content and ash analyses) and investigate the combustion behaviour of empty fruit bunch (EFB)-derived biochar (EFBC) as potential solid fuel for power generation. The EFBC was produced using a 10 L microwave-assisted pyrolysis system. Proximate analysis was conducted on the EFBC by using a thermogravimetric analyser (TGA) (TGA/SDTA851, Mettler Toledo, USA) to determine the fixed carbon, volatile matter, moisture and ash contents. The ultimate analysis was conducted to determine elemental composition of mature EFBC by using CHNS/O analyser (model LECO CHN628 and 628S, USA) according to ASTM D-5291 standard method. The particle size distribution was determined using particle size distribution analyser (Malvern mastersizer) and the higher heating value (HHV) of EFBC was measured by using Parr 6100 oxygen bomb calorimeter according to BS EN 14918. The ash compositional analysis was measured using energy dispersive X-ray fluorescence spectrometer (EDX, SHIMADZU EDX-720). The combustion tests on both EFBC and sub-bituminous coal (SBC) were conducted using a fluidised bed reactor (370 mm high and 54 mm wide dimension) and the gaseous emissions were analysed using gas chromatography (GC). EFBC exhibited a comparable HHV (6,317.99 kcaL/kg) with almost similar H/C ratio, higher O/C and (N + O)/C ratios compared to SBC signifying a stable burning. Furthermore, EFBC combustion resulted in lower CO and NOx emissions than the SBC combustion by 51.60% and 60.50%, respectively, suggesting that EFBC is a potential solid fuel in power generation.

Keyword: Biochar; Biomass; Microwave; Pyrolysis; Solid fuel