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Influence of Torrefied Biomass on Co-Combustion Behaviors of Biomass/Lignite Blends

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Abstract : Co-firing of coal and biomass blends is an effective method to reduce carbon dioxide emissions released by burning coals, thanks to the carbon-neutral nature of biomass. Besides, usage of biomass that is renewable and sustainable energy resource mitigates the dependency on fossil fuels for power generation. However, most of the biomass species has negative aspects such as low calorific value, high moisture and volatile matter contents compared to coal. Torrefaction is a promising technique in order to upgrade the fuel properties of biomass through thermal treatment. That is, this technique improves the calorific value of biomass along with serious reductions in the moisture and volatile matter contents. In this context, several woody biomass materials including Rhododendron, hybrid poplar, and ash-tree were subjected to torrefaction process in a horizontal tube furnace at 200°C under nitrogen flow. In this way, the solid residue obtained from torrefaction that is also called as 'biochar' was obtained and analyzed to monitor the variations taking place in biomass properties. On the other hand, some Turkish lignites from Elbistan, Adıyaman-Gölbaşı and Çorum-Dodurga deposits were chosen as coal samples since these lignites are of great importance in lignite-fired power stations in Turkey. These lignites were blended with the obtained biochars for which the blending ratio of biochars was kept at 10 wt% and the lignites were the dominant constituents in the fuel blends. Burning tests of the lignites, biomasses, biochars, and blends were performed using a thermogravimetric analyzer up to 900°C with a heating rate of 40°C/min under dry air atmosphere. Based on these burning tests, properties relevant to burning characteristics such as the burning reactivity and burnout yields etc. could be compared to justify the effects of torrefaction and blending. Besides, some characterization techniques including X-Ray Diffraction (XRD), Fourier Transform Infrared (FTIR) spectroscopy and Scanning Electron Microscopy (SEM) were also conducted for the untreated biomass and torrefied biomass (biochar) samples, lignites and their blends to examine the co-combustion characteristics elaborately. Results of this study revealed the fact that blending of lignite with 10 wt% biochar created synergistic behaviors during co-combustion in comparison to the individual burning of the ingredient fuels in the blends. Burnout and ignition performances of each blend were compared by taking into account the lignite and biomass structures and characteristics. The blend that has the best co-combustion profile and ignition properties was selected. Even though final burnouts of the lignites were decreased due to the addition of biomass, co-combustion process acts as a reasonable and sustainable solution due to its environmentally friendly benefits such as reductions in net carbon dioxide (CO2), SOx and hazardous organic chemicals derived from volatiles.

Keywords : burnout performance, co-combustion, thermal analysis, torrefaction pretreatment
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