

Bio-coal Production via Torrefaction of Pelletized Food Waste: Effect of Pellet Size

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Abstract

This study produced bio-coals of different sizes via torrefaction of pelletized food waste and evaluated the effect of pellet sizes on the bio-coal quality. The torrefaction was conducted in a fixed bed reactor by changing the torrefaction conditions of temperature and residence time. The temperature was varied from 230 °C to 290 °C temperature and residence time was varied from 15 minutes to 60 minutes. Thereafter, the characterization of bio-coals produced from torrefaction was done using proximate analysis, elemental analysis, lingo-cellulosic analysis, quality parameter analysis, SEM analysis, TGA analysis, and FTIR analysis. Through these analysis, it was shown that bio-coal produced at severe torrefaction conditions i.e. 290 °C temperature and 60-minute residence time was also dependent on size of pellets as opposed to the conclusion of the previous study (Riaz et al., 2021) where it showed that pellet size mattered only at milder conditions. The pellet sizes used in this study were 16, 20, and 28 mm and the smallest size pellets i.e. 16 mm pellets were found to be producing bio-coal of the best quality in terms of mass yield, energy yield, energy density, surface to volume ratio, fuel ratio, H/C ratio, and O/C ratio. Additionally, SEM analysis showed the large pores got developed in 16 mm bio-coal, a desirable property as it would facilitate the movement of oxygen inside the coal and increase the burning rate. Furthermore, the FTIR showed that complete absence of OH, CO, and COOH groups in 16 mm bio-coal that imparted hydrophobicity in that bio-coal, another desirable property in a coal. Finally, the bio-coals developed in this study were compared with the natural coals using Ven Krevelen diagram and it was shown that quality of the bio-coal produced from torrefaction of 16 mm pellets was much closer to the quality of the peat coal.

Keywords: Bio-coal, torrefaction, food waste, pellet

References

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