Hydrothermal carbonization of biomass for production of densified solid fuel

A. Toptas Tag, G. Duman, J. Yanik

[1]Department of Chemistry, University of Ege, Izmir, 35100, Turkey
Keywords: wet carbonization, dry carbonization, hydrochar, biocoal.
Presenting author email: gozdeduman@gmail.com

In this study, wet carbonization of different types of biomasses, namely lignocellulosic, algal and animal waste, was studied at different temperatures (150-275 °C) with the range of 0.05-0.55 biomass:water ratio for varying reaction times (0-300 min.). For each biomass, the effect of process conditions on biocoal (or hydrochar) yield and fuel properties was investigated. The process conditions were optimized by using Design Expert Software programme based on mass yield and energy density. Fuel properties of hydrochar were determined according to standard fuel analysis methods. The temperature was the significant factor effecting the yield and energy densities of hydrochar for all types of biomass. Higher temperatures reduced mass yield but increased energy density. For comparison purpose, dry carbonization of biomasses was also carried out at the temperature of 300 °C. Due to the dissolution of inorganics under the hydrothermal conditions, hydrochars obtained had lower ash content than raw biomasses. On the contrary, dry carbonization produced a biocoal with higher ash content compared to raw biomass as a result of increasing fraction of inorganics in the biocoal. Although dry carbonization yielded biocoals with higher energy yield, their calorific values was lower than calorific value of hydrochar. High energy yield should be the result of highest mass yield obtained in dry carbonization process. The properties of both hydrochars and biocoals were comparable to lignite.

Combustion behaviors of selected hydrochars and biocoals were investigated by TGA. Because of high volatile matter content, the ignition and burnout temperatures of raw biomasses were lower than that of hydrochars/biocoals. For lignocellulosic biomass and animal waste, combustion reactivity of hydrochars was lower than that of biocoals, whereas it was higher than that of biocoal for algal biomass.

As conclusion, the results obtained in this study showed that wet carbonization of wastes appears to be promising process to provide benefits to energy sector as well as to protect environment.