INVESTIGATION OF INNOVATIVE AND CONVENTIONAL PYROLYSIS OF LIGNEOUS AND HERBACEOUS BIOMASSES FOR BIOCHAR PRODUCTION

Marina Morando, Politecnico di Torino, Italy
Silvia Fiore, Politecnico di Torino, Italy
Silvia.Fiore@polito.it
Cedric Briens, ICFAR, Western University, Canada
Franco Berruti, ICFAR, Western University, Canada

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Pyrolysis is a thermochemical process involving the thermolysis of carbon-based materials in absence of an oxidizing agent. Adjusting the operating conditions, in order to maximize the gaseous, liquid or solid products, may optimize pyrolysis process. This work investigates the performances of three laboratory-scale reactors on the grounds of the quantity and quality of the biochar obtained from different biomasses. Three types of biomass were fed to each reactor: two ligneous (rubberwood and eucalyptus) and one herbaceous (Phragmites australis). A novel reactor developed at ICFAR, the Jiggled Bed Reactor (JBR) was employed in slow pyrolysis mode. A Mechanically Fluidized Reactor (MFR) and a more conventional Bubbling Bed Reactor (BBR), which respectively run slow pyrolysis and fast pyrolysis, were also used. The 9 sets of samples of bio-chars obtained were then physically activated in the JBR.

The first objective of this project was to investigate bio-char production utilizing two different pyrolysis processes (slow vs fast) and three different reactor designs (MFR vs BBR vs JBR). Secondly, the efficiency of physical bio-char activation processes (performed via the JBR) of the samples derived from the three reactors was studied. In summary, an evaluation of the JBR was carried out to determine whether it could offer a valid alternative to more conventional MFR and BBR, combined with the ability of activating the carbon. Finally, a comparison among bio-chars originated from distinct biomasses has been performed with the purpose of determining whether an herbaceous feedstock may be effective as ligneous biomasses for the production of pyrolytic bio-char.

The results obtained in this work show a good validation of the performances of the JBR, meaning that it can be seen as a valid experimental alternative capable of simulating the performance of conventional reactors for the production and study of chars derived from ligneous and herbaceous feedstock. In detail, the two-step JBR process (bio-char production + activation) resulted in the highest yields (88-98%). Secondly, it returned analogous results about surface area (385 m²/g) and micro-pores area (283 m²/g), respectively compared to BBR and MFR. Thirdly, micro-pore volume (0.13 cm³/g) and pore size (21 Å) were similar to the values obtained with both the MFR and the BBR. Finally, the overall results obtained demonstrate that Phragmites australis can be employed for the production of bio-char and activated carbon, showing a behavior similar to ligneous biomasses.