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Characterisation of porous biochar using X-ray micro-CT and FTIR techniques

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Biochar is a carbonaceous porous material with wide range of applications. Biochar is produced via pyrolysis of organic material such as agricultural or forestry waste. Some examples of possible applications are fertiliser production, carbon storage, and water/soil decontamination (Cao et al., 2009). Biochar can be produced from waste material, such as manure, sawdust, or wastewater sludge (Chen et al., 2021). This makes biochar especially valuable, as it allows to recycle waste along with production of useful material. This also proves useful when we speak of net zero economy. Decomposing biomass emits carbon dioxide in the atmosphere while pyrolyzing it into the biochar allows to capture carbon in the solid form for centuries.

This work studied the possibilities to use brown algae as a feedstock for biochar production, as it can be grown year-round, at a rapid rate due to natural plant properties (Singh et al., 2021). With the ongoing climate change and resulting eutrophication, the total amount of brown algae in the sea has increased. This excess algae growth offers an excellent opportunity if it can be converted into some useful and valuable material (Zhao et al., 2022). An added benefit of using brown algae as a feedstock for biochar production is that algae do not compete with traditional terrestrial sources of biomass. Important factors to consider here are competition with food crops, land use, and fresh water use. For this study, two species of brown algae were selected - Laminaria Digitata and Pelagic Sargassum. The algae were pyrolyzed at temperatures of 300 ℃, 600 ℃, and 800 ℃. Samples pyrolyzed at 600 ℃ were additionally chemically activated with potassium hydroxide (KOH).

The X-ray micro-CT study was performed on the biochar samples to measure the porosity and, using pore-network modelling, to calculate the permeability of the samples. In addition to that, similar study was performed on commercial biochar (SoilFixer) to compare their properties. To better understand the chemical composition of the biochar, and if there are differences between the activated and non-activated biochar samples, a study with Fourier-Transform Infrared Spectroscopy (FTIR) was performed.

As a result of the X-ray micro-CT study, it was concluded that algal biochar is heterogeneous, with large mineral deposits in the structure. Additionally, it was shown that despite being of the same species, porosities measured for different (mm scale) samples were not necessarily similar. This stands true for algal and wooden biochar. Distribution of porosity along the sample, however, was more homogeneous for wooden biochar.

The FTIR study showed that spectra produced for the biochar samples were similar, which may signify that there is a common compound in the algae, which influences the spectra, such as cellulose.

Participation

In-Person

References

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