PERSPECTIVES IN THE USE OF BIOCHARS AS LOW-COST CO_2 ADSORBENTS

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The recognized versatility of biochar in environmental remediation issues opened up an increasing interest in its applications in multidisciplinary areas of science and engineering. Possible biochar applications include carbon sequestration, soil fertility improvement, pollution remediation and agricultural by-product/waste recycling. A proper application in specific environmental areas requires a fulfilled biochar chemico-physical characterization and overall properties.

In this work, biochars produced by steam assisted slow pyrolysis experiments on cellulose fibers and Populus nigra wood at different temperatures have been used for gas to solid adsorption tests with different probe molecules. The goal of these tests was the identification of the optimal shape, size, geometry and chemistry of the pores as ought to be for the monitoring of pollutants emission. Structural biochar features are relevant in view of the adsorbent selection and optimization since the main parameters governing both the CO_2 uptake capacity and selectivity are micropore volume and size and chemical functionalization of the pores. As a general rule, high CO_2 uptakes correspond to samples with high micropore volumes.

In this work, the gas storage ability of the different biochars was evaluated with volumetric analyzers at various temperatures (from cryogenic to near ambient conditions) from vacuum up to ambient pressures, under equilibrium conditions by using N_2, CO_2, CH_4 as probe molecules. The adsorption data were analyzed and modeled to have a complete characterization of the textural properties of all the materials.

Increasing values of surface area were detected as the pyrolysis temperature is raised for all the investigated biochars. The shape of the N_2 isotherms allowed the classification of most of the biochars under study as microporous materials. In all the samples the total pore volume roughly corresponded to the micropores total volume, which indicated a low contribution of mesoporosity to the overall porous structure. The analysis of CO_2 isotherms at 273 K revealed that the volume of adsorbed CO_2 increased with pyrolysis temperature, indicating that a higher pyrolysis temperature allowed the development of a narrower microporosity. CO_2/N_2 and CO_2/CH_4 selectivities were also predicted and a good affinity toward the adsorption of CH_4 and N_2 were found in all the cases.

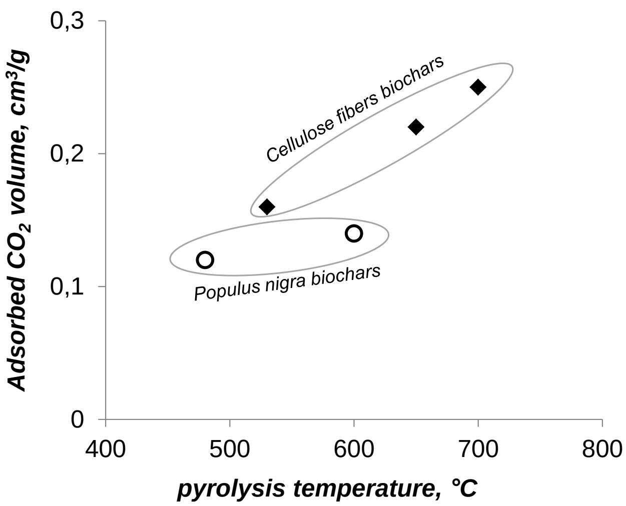

Figure 1 – Adsorbed CO_2 volume as function of pyrolysis temperature