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Designing biochar properties through pre-pyrolysis feedstock metal blending

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Metal enhanced biochars have been produced by pyrolysis of wood chips previously blended with different metal-containing compounds: Cu(OH)2, Mg(OH)2, MgCl2, FeSO4, KCl and AlCl3; under an inert gas at 400 and 700°C. The obtained metal-enriched biochars have an organic and inorganic fraction, each accounting approximately to 50% of the mass, and they have been characterized in detail and compared to control samples produced without previous metal blending. The characterization at different European laboratories includes elemental analysis, surface area, pore size distribution, thermo-gravimetric analysis (TGA), sorption isotherms with P and As, pH, Eh, nuclear magnetic resonance (NMR), and zeta potential.

It is shown that the presence of metals during pyrolysis affects to a great extent the structure and functionality of the obtained chars. The biochars have a high concentration (>15% in mass for almost all cases) of elemental metals introduced before pyrolysis. These metals strongly affect the development of char internal surface area and pore structure. The total surface area and pore volume increase while porosity decreases, and the pore size distribution and pore network are significantly modified. At high temperatures (700°C), some metals enhance char graphitization and its thermal stability. Mg(OH)2 produces the highest impact on physical structure. Furthermore, the blending with Mg, Al and Fe increased the sorption capacities for anionic forms of As and P by more than 800% compared to control biochar. Depending on the blended metal species and pyrolysis temperature, the pH of the biochar blends varied between 2.7 (Fe) and 10.8 (Cu) while Eh varied between 228 mV (Mg(OH)2 at 400°C) and 504 mV (MgCl2 at 700°C).

The promising results obtained with pre-pyrolysis feedstock metal blending open the possibility towards designing biochars for special functions and purposes.