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PO₄ recovery using mixtures of biochar and carbonate materials

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The recovery of PO₄ from wastewaters by using biochar proves not to be completely satisfactory. The surface of the biochar is typically negatively charged, which prevents the adsorption of PO₄. For this reason, mixtures of biochar and natural carbonate materials have been tested as a novel sorbent material for PO₄ recovery from both synthetic and waste-water. The goal of the research is to obtain a PO₄ based complex starting from natural second-generation materials such as food industry byproducts, plants and other residues to prepare fertilisers compliant to the component material category CMC 6 defined in the Regulation (EU) 2019/1009/EU. It has to be noted that natural carbonate materials are not pure CaCO₃, but present small impurities that contribute to modify their properties. Therefore, the use of carbonate materials obtained from different sources can lead to different performances when it comes to PO₄ removal from wastewaters.

In this work we present results of PO₄ removal obtained from a mixture of biomass and different carbonate materials. The mixture has been treated through a specific thermal protocol to obtain two different calcium-oxide rich charcoals here named composites C1 and C2. Initially, each composite was added to synthetic waters with different PO₄ concentration, with a composite:water ratio of 1:1000. The initial concentrations of PO₄ were 10, 100 and 1000 mg/l. After treatment with the composite, regardless of whether C1 or C2 was used, the PO₄ concentration in the waters with initial concentration of 10 and 100 mg/L was nearly zero, with pH values at equilibrium around 11.9. The treatment of the water with initial PO₄ concentration of 1000 mg/l shows a reduction of 20% and 40% with C1 and C2, respectively, with final pH values around 7.8.

After addition of the composites to the water, the solutions present very high pH values except for the water with the highest concentration. Although this is an optimal situation for the removal of PO₄, it leads to two problems. First, the filtered water is not suitable for direct disposition in sewers, since the pH is higher than the limit established by the wastewater legislation (9.5). Second, a pH value larger than 9 determines the precipitation of PO₄ regardless of the presence of the composite, which suggests that the PO₄ is not adsorbed by the composites, thus not leading to the desired complex.

In order to quantify the exact amount of PO_4 adsorbed by the composite, the experiments have been repeated under controlled pH, keeping it around a value of 7 by the use of a mild acid. In this condition, after 1h treatment, 50% of phosphate was removed and bound to the composite

The work intends to present the results at laboratory scale and next steps at higher TRL.