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Pyrolysis of Greek sewage sludge to produce biochars for soil amendments

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The effective management of sewage sludge is one of the most difficult issues that have to be addressed, due to the great sludge quantities produced and the presence of several contaminants (i.e. heavy metals) in it. However, the pyrolytic conversion of sewage sludge to biochar is considered as a promising alternative and environmental friendly technology to manage this waste.

In this study, Greek pre-dried sewage sludge was used as feedstock in order to examine the effect of different pyrolysis conditions on biochar production. More specifically, the parameters examined were: the pyrolysis temperature, the residence time of the feedstock in the pyrolysis unit and the presence of a chemical reagent in the raw biomass. The ultimate goal was to study the effect of the aforementioned pyrolysis parameters on biochar yield. Biochars with the highest yields were analysed further in order to examine their heavy metal retention capacity.

The experiments were carried out in a muffle furnace, in a nitrogen atmosphere and at a constant heating rate of 6 °C/min. The pyrolysis was performed at 300, 400 and 500 °C for 30, 60 and 90 min residence time of the solid feedstock. The feedstock used for the pyrolysis was raw biomass as well as biomass impregnated with K_2CO_3 or H_3PO_4.

Although residence time of the feedstock did not have significant impact on the amount of biochar produced, biochar yield was found to decrease with increasing the pyrolysis temperature. For instance, in the case of biomass that no reagent had been added, biochar yield was 62.5% of the original feedstock at 300 °C, 28.5% at 400 °C and 27.5% at 500 °C. Biochar yield for samples impregnated with H_3PO_4 was 63% at 300 °C and remained at rather high levels at 400 °C reaching 49%. The leaching tests that were conducted for the biochars with the highest yields, showed that biochars had a significant retention capacity of the heavy metals examined (Cd, Cu. Ni, Pb). Biochars with no reagents added, were found to retain the 100% of heavy metals, implying that there is no environmental risk when they are applied to soils.

The present study showed that biochar yield increased with decreasing temperature, and samples impregnated with H_3PO_4 had a slower rate of weight loss. High yield biochars could be used for soil amendments, as there is no risk for soil heavy metal contamination.