HYDROTHERMAL RECYCLING OF ACTIVATED BIOCHAR

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Emerging pollutants such as pharmaceuticals are of increasing concern in wastewaters. Carbon materials such as activated carbons prove to be effective filter materials for the removal of these pollutants, but regeneration of the adsorbents is necessary to improve their economic efficiency. However, common thermal regeneration methods using dry adsorbents and high treatment temperatures are expensive and hinder large scale applications in wastewater treatment plants [1]. Novel adsorbents such as biochars are seen as an alternative due to their lower production costs [2]. However, considering their generally lower adsorption capacity, costly regeneration will abolish the initial economic advantage of biochar. In contrast to fully regenerating the original adsorptive properties, we argue that a recycling step to prepare biochar for different subsequent applications can produce a higher value product. In this study we propose a method using hydrothermal treatment to decontaminate activated biochars. Two standard biochars from the UK Biochar Research Centre produced at 550°C from softwood and wheat straw were activated in CO_2 at 800°C. Additionally, the same raw feedstocks were mixed with 5% Ochre, pyrolyzed and activated at the same conditions to produce two activated mineral biochar composites. The biochars were loaded with 10 pharmaceuticals commonly found in wastewaters and decontaminated in a hydrothermal reactor at temperatures ranging from 160 to 320°C for 4 hours at autogenic pressure. To avoid catalytic effects from the reactor walls, a novel experimental design based on standard borosilicate test tubes was developed. The sample is placed into a test tube, filled with water, flame sealed and placed into a hydrothermal reactor. The outer reactor is filled to the same level as the sample tube to counterpressure the glass and avoid bursting during the experiment. With this set-up, an inert and disposable reactor liner ensures comparable reaction conditions between runs and eliminates potential cross contamination. After the hydrothermal treatment, the biochars as well as the process water were analyzed by LC-MS/MS for remaining pharmaceuticals. Hydrothermal treatment was found to fully degrade 8 out of 10 investigated pharmaceuticals at a treatment temperature of 200°C, with almost complete degradation of the remaining pharmaceuticals at 320°C. The results show that hydrothermal treatment has the potential to recycle activated biochar and enable its use in subsequent applications such as gas filtration systems for the removal of H_2S or as an additive for increased gas production in anaerobic digestion plants.

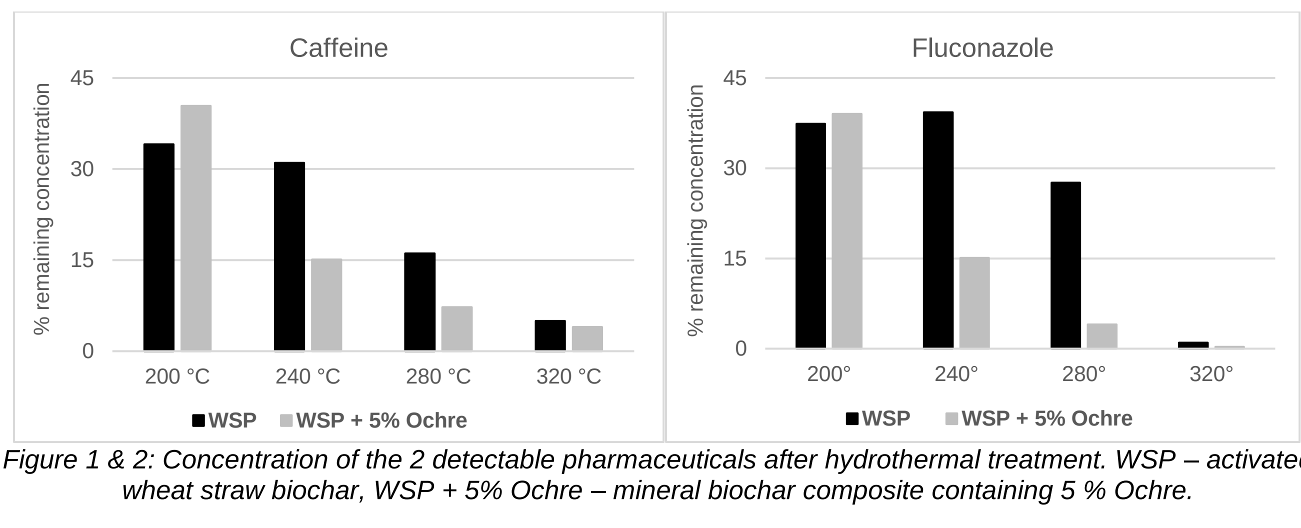

Figure 1 & 2: Concentration of the 2 detectable pharmaceuticals after hydrothermal treatment. WSP – activated wheat straw biochar, WSP + 5% Ochre – mineral biochar composite containing 5 % Ochre.

1. Santadkha T, Skolpap W. Economic comparative evaluation of combination of activated carbon generation and spent activated carbon regeneration plants. *J Eng Sci Technol*. 2017;12(12):3329-3343.
2. Ahmed MB, Zhou JL, Ngo HH, Guo W. Adsorptive removal of antibiotics from water and wastewater: Progress and challenges. *Sci Total Environ*. 2015;532:112-126. doi:10.1016/j.scitotenv.2015.05.130