Geophysical Research Abstracts
Vol. 20, EGU2018-10457, 2018
EGU General Assembly 2018

Biochars made from agro-industrial by-products remove chlorine and chlorination by-product (chloroform) from water and wastewater

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For drinking water and for water in food production, disinfection with chlorine can add undesired taste and odor. For this reason, removal of chlorine is desired for some consumers and food industries that use municipal tap water. For treated wastewater discharge or reuse, chlorine can be toxic to the receiving aqueous systems and can interact with metals in soil and cause toxicity to the irrigated plants. In all the above cases, removal of chlorine is also required. In addition, chlorination can cause the formation of toxic by-products such as chloroform. Traditionally, activated carbon is used as the ideal material for the removal of chlorine through the formation of surface oxides on its surface. The present study proposes the use of agro-industrial by-products to produce biochars that will be used for the removal of chlorine and chloroform from water and treated wastewater. Different raw materials such as malt spent rootlets, coffee residue, olive and grape seeds, etc. are used to produce biochar. Various temperatures and air-to-solid ratios are tested for optimizing biochar production. Batch tests are employed to study the kinetics of removal using different raw and biochar materials as well as those of commercial activated carbons. The chlorine removal kinetics are faster during the first hour; then, removal continues but with a slower rate. Most of the biochars tested (with 3 mg of solid in 20 mL of chlorine solution at initial concentration Co=1.5 mg/L) demonstrated removal efficiencies with an average of 9.4 $\pm$ 0.5 mg/g. For the two commercial activated carbons, removal efficiencies were 11.4 $\pm$ 0.2 mg/g. The first-order constant k1 ranged between 0.001 and 0.014 (min-1) for the biosorbents and the biochars and it was equal to 0.017 (min-1) for the commercial activated carbons. The first-order constant k1 for chlorine removal was lower for treated wastewater and activated carbon (0.013 min-1) or biochar (0.0082 min-1) than for deionized water. For chloroform, the fastest kinetics were observed for the biosorbents and especially for coffee residue.