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Novel use of magnetic biochars for the remediation of soils contaminated by contaminants of emerging concerns (CECs)

Badruddeen Sani (1,2), Wojciech Mrozik (1), and David Werner (1)

(1) School of Civil Engineering & Geosciences, Newcastle University, Newcastle upon Tyne, NE1 7RU, England, United Kingdom, (2) (b.s.sani@newcastle.ac.uk)

The advantage of using magnetic biochar over nonmagnetic biochar in amendments of contaminated soils is in the fact that the former can be easily removed from the soil matrix whenever the need arises, using simple principles of magnetism. In this study, magnetic biochar was produced using a simple co-precipitation technique. The resulting composite has about 33% (w/w) magnetic iron oxides, the presence of which resulted in modification of the biochar's surface characteristics such as BET surface area, porosity and point of zero charge. Modifications in these properties will most likely alter the CEC sorption properties of the biochar, hence the necessity for the proper evaluation of the possible trade off that exist between the need for magnetisation and altered sorption characteristics of the biochar. To achieve this, bottle point sorption experiments in aqueous solutions were conducted using activated and non-activated biochars in magnetic and nonmagnetic forms as sorbents and two pharmaceuticals –ibuprofen and diclofenac- as representative CECs. Sorption isotherms were evaluated and the data was fitted to Langmuir, Freundlich, Redlich-Peterson, Dubinin-Ashtakov and Polanyi-Dubinin-Manes isotherm models. Removal efficiencies and sorption capacities correlated well with the effective mass of pristine biochar used, therefore the sorption characteristics of both magnetic and nonmagnetic biochars are not detrimentally affected by the magnetite impregnation. Biochars in activated form show superior sorption capacities due to amplified surface area and better developed pores. Also, non-activated biochars needed to be used in higher amounts to achieve considerable level of CEC removal, thus they are more easily exhausted. Sorption was observed to decrease with a corresponding increase in solution pH. This suggests that sorption is favoured within the acidic pH range when the surfaces of the sorbents have net positive charge and the sorbates are in their neutral forms.