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Engineered biochar as a tool for nitrogen pollutants removal: preparation, characterization and sorption study

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ABSTRACT

In this study, engineered (chemically modified) biochars (pyrolyzed bamboo biomass) were used for the removal of oxidized and reduced nitrogen species from an aqueous solution. The physicochemical properties of the prepared materials, such as surface functional groups, elemental composition, morphology, and specific surface area were investigated. The biochar surfaces were covered with Mg and Fe particles. The particles containing Mg and Fe species were observed in the form of nanoflakes within the biochar matrix. The efficiency of nitrate and ammonium removal was examined by sorption studies. The experimental data were fitted with sorption isotherms (Langmuir, Freundlich, and Dubinin–Raduskievich) and with kinetic models. The obtained data presented a higher sorption capacity for nitrate removal in the case of the engineered Fe-biochar and the engineered Mg-biochar compared to unmodified bamboo-based biochar. The maximum sorption capacity of modified samples decreased in the order Fe-biochar (Q_e = 10.35 mg g^{-1}), Mg-biochar (Q_e = 9.13 mg g^{-1}), and the lowest capacity was found in the unmodified biochar (Q_e = 4.41 mg g^{-1}). In the case of ammonium removal, unmodified biochar with maximum sorption capacity (Q_e = 12.60 mg g^{-1}), was more efficient than Fe-(Q_e = 5.66 mg g^{-1}), and Mg-engineered biochars (Q_e = 3.23 mg g^{-1}). The pseudo-second-order kinetic model and Langmuir isotherm model proved to be the most appropriate for the experimental sorption data. In addition, engineered Fe-biochar presented magnetic properties due to the presence of Fe_2O_3 and therefore, may be easily separated from the reaction mixtures.

Keywords: Biochar; Modification; Characterization; Sorption; N-pollutant

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