Biodsorption as an Efficient Technology for the Removal of Phosphate, Nitrate and Sulphate Anions in Industrial Wastewater

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Abstract : Wastewater treatment is an issue of vital importance in these times where the impacts of human activities are most evident, which have become essential tasks for the normal functioning of society. However, they put entire ecosystems at risk by time destroying the possibility of sustainable development. Various conventional technologies are used to remove pollutants from water. Agroindustrial waste is the product with the potential to be used as a renewable raw material for the production of energy and chemical products, and their use is beneficial since products with added value are generated from materials that were not used before. Considering the benefits that the use of residual biomass brings, this project proposes the use of agro-industrial residues from corn crops for the production of natural adsorbents whose purpose is aimed at the remediation of contaminated water bodies with large loads of nutrients. The adsorption capacity of two biomaterials obtained from the processing of corn stalks was evaluated by batch system tests. Biochar impregnated with sulfuric acid and thermally activated was synthesized. On the other hand, the cellulose was extracted from the corn stalks and chemically modified with cetyltrimethylammonium chloride in order to quaternize the surface of the adsorbent. The adsorbents obtained were characterized by thermogravimetric analysis (TGA), scanning electron microscopy (SEM), infrared spectrometry with Fourier Transform (FTIR), analysis by Brunauer, Emmett and Teller method (BET) and X-ray Diffraction analysis (XRD), which showed favorable characteristics for the cellulose extraction process. Higher adsorption capacities of the nutrients were obtained with the use of biochar, with phosphate being the anion with the best removal percentages. The effect of the initial adsorbate concentration was evaluated, with which it was shown that the Freundlich isotherm better describes the adsorption process in most systems. The adsorbent-phosphate / nitrate systems fit better to the Pseudo Primer Order kinetic model, while the adsorbent-sulfate systems showed a better fit to the Pseudo second-order model, which indicates that there are both physical and chemical interactions in the process. Multicomponent adsorption tests revealed that phosphate anions have a higher affinity for both adsorbents. On the other hand, the thermodynamic parameters standard enthalpy ($\Delta H °$) and standard entropy ($\Delta S °$) with negative results indicate the exothermic nature of the process, whereas the ascending values of standard Gibbs free energy ($\Delta G °$). The adsorption process of anions with biocarbon and modified cellulose is spontaneous and exothermic. The use of the evaluated biomateriles is recommended for the treatment of industrial effluents contaminated with sulfate, nitrate and phosphate anions.