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Adsorption of hexavalent chromium by crushed brick: effect of operating parameters and modeling study

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ABSTRACT

The sorption of hexavalent chromium in aqueous solution using crushed Brick was carried out in batch mode. Powder of crushed Brick was prepared within a size between 500 and 800 µm. The crushed Brick was characterized by Fourier Transform infrared spectra (FTIR), BET surface area, X-ray fluorescence (XRF), Scanning Electron Microscopy (SEM),X-ray diffraction (XRD), Thermogravimetric analysis (TGA)and Zeta Potential. The results showed that the crushed Brick is a typical aluminosilicate mineral with SiO_2/Al_2O_3 ratio of 3.65. On the other hand, it has a surface area of 20.11 $m^2 g^{-1}$ and exhibits a net microporosity with a medium pore width of 2.26 Å. Batch experiments were conducted to study the effect of different operating parameters such as contact time, pH, stirring speed, temperature, adsorbent dose and initial Cr(VI) concentration on the adsorption of Cr(VI) by crushed Brick. The results showed that the maximum adsorption capacity was 3.06 mg g^{-1} at pH 3, adsorbent dose of 20 g L^{-1} and initial Cr(VI) concentration of 10 mg L^{-1}. Furthermore, the adsorption capacity increases in an acidic medium until it reaches pH 3 and afterwards it decreases due to the different speciation of hexavalent chromium with pH shifting. The equilibrium data were analyzed using three isotherm models such as Langmuir, Freundlich and Temkin by linear method. A satisfactory correlation coefficient value of the Langmuir isotherm demonstrates that the hexavalent chromium adsorption by crushed Brick is monolayer physical adsorption. The kinetic studies showed that the experimental data were best describing by pseudo- second-order model and intra-particle diffusion. It was observed from the values of thermodynamics parameters such as Gibbs free energy (ΔG°), enthalpy (ΔH°), and entropy (ΔS°), that the nature of adsorption is non-spontaneous, exothermic and reflects the decreased randomness at the solid/solution interface during the adsorption.

Keywords: Crushed brick; Hexavalentchromium; Adsorption; Modeling; Thermodynamics; Waste valorization

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