Adsorption of heavy metals onto natural Greek bentonite in single and multi component systems

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As environmental pollution becomes of greater concern, alternative methods to clean wastewaters are being studied. The interest on cheaper and more efficient adsorbents is mounting causing greater amounts of research to be conducted about adsorption. Clay minerals of low cost and ubiquitous presence in most soils, are widely used to study the adsorption of metals. Bentonite a representative clay material mainly composed of montmorillonite, a 2:1 type aluminosilicate, is highly valued for its sorption capacities. In the present study, the removal of Cd^{2+}, Cu^{2+}, Ni^{2+} and Pb^{2+} from single and multi metal ion aqueous solutions using natural bentonite was studied. This bentonite is mined from Milos island, Greece by the S&B Industrial Minerals A.E. company and about 1 million tons are annually produced. Removal efficiency was investigated under various conditions such as variable concentration of metal ion, amount of clay, pH and mixing time. Increasing pH favours the removal of metal ions while the removal is rapid with maximum adsorption being observed within 30 min. Langmuir and Freundlich isotherms were used to interpret the adsorption data of the investigated systems. The results indicate that the Langmuir isotherm fits the data better in both single and multi component systems. The monolayer adsoprtion capacities (qi,o)of bentonite for Cd^{2+}, Cu^{2+}, Ni^{2+} and Pb^{2+} in single metal system were found as 31.25 mg/g, 32.26 mg/g, 26.32 mg/g and 85.47 mg/g, respectively. The competitive adsorption equilibrium on a multi component system (Cd^{2+}/Cu^{2+}/Ni^{2+}/Pb^{2+}) with different initial metal ion concentrations was also determined. For all studied metal ions the adsorption capacities in the case of multi component system ($q_{i,mix}$) are lower than those obtained for the single metal system. It was observed that the equilibrium uptake amounts of each metal Cd^{2+}, Cu^{2+}, Ni^{2+} and Pb^{2+} in the multi-component system onto bentonite decreased considerably with increasing concentrations of the other metals due to their antagonistic effect. Bentonite displays a high selectivity toward one metal in a multi-component system with an affinity order of Pb^{2+}>Cu^{2+}>Ni^{2+}>Cd^{2+} which is related to the first hydrolysis equilibrium constant. The values of $q_{i,mix}$ /$q_{i,o}$ <1 demonstrate the mutual competitive effect between heavy metals in multi-component systems.

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