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Adsorption Equilibrium Studies on the Raw Çaldıran Diatomite (Çaldıran/Van) of Heavy Metal (Lead)

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Aim of the study: The aim of the present investigation was to study the sorption mechanism of Lead(II) ions onto original diatomite and to determine the equilibrium and kinetic parameters of the process. With this aim in mind, sorption isotherms have been measured at different temperatures and the Langmuir, Freundlich and Dubinin–Radushkevich (D–R) model parameters and the thermodynamic parameters determined. The kinetic adsorption results have been analyzed using pseudo-first-order, pseudo-second-order reactions, intra-particle diffusion model and elovich kinetic model, respectively.

Material and Methods: Washing process; diatomite sieved at a mill and then passed through a 230 mesh sieve was dried at an oven for 5.5 h. 100 g diatomite was mixed with a stirrer in 1.7 L distilled water for 12 h. Then, the mixture was left 12 h. The solid phase was then separated by filtration, which was left at room temperature for 168 h to dry. The dried diatomite was passed again from a 230 mesh sieve. Adsorption of lead ion to original diatomite at 25 ^{O}C, 35 ^{O}C and 45 ^{O}C was investigated at three different concentrations (25,40,55 ppm) and pH 5.5. After adding 2.5 g diatomite (adsorbent) to metal solutions (1L) whose concentrations and pHs were fixed, they were placed in a thermostatic water bath to keep temperature constant and mixed constantly by mechanic stirrers for 360 min to achieve adsorption. After 5 to 360 minutes periods, the solution was filtered and then the remained heavy metal amount in the solution was detected by AAS. From these data, adsorption isotherms as well as kinetic and thermodynamic parameters were calculated.Diatomite was characterized by several techniques such as FTIR, X–Ray, SEM, BET, TGA, surface area and chemical analysis etc.

Results: The surface are of diatomite used in this study was calculated as 48 m^2/g. The adsorption capacities of the original diatomite Pb(II) ions increased linearly with increasing initial concentrations of these ions.It was found that adsorption process fitted Freundlich isotherm. In Temkin isotherm model, increase in K_T values as temperature increases leads to increasing of maximum adsorption capacity and strengthening of relationship between adsorbent and adsorbate. In Dubinin-Radushkevich (D-R)isotherm, an E value of higher than 16 kJ/mol indicates that sorption process is chemical adsorption. From of kinetic models, it fits pseudo second order kinetic model.ΔG^0valutes are negative for Pb(II) adsorption on original diatomite and these values indicate that adsorption is spontaneous. These values decrease with an increase of temperature. Furthermore, better adsorption is obtained at higher temperature.In conclusion, it was found that diatomite can be used for removal of heavy metals (lead) from wastewaters.

Keywords: Environmental toxicology, Diatomite, Lead, Adsorption.