Iron-doped natural clays: Low-cost inorganic adsorbents for phosphate recovering from simulated urban treated wastewater

Abstract

Natural inorganic adsorbents are attractive for pollutants removal due to the easy operation, non-toxic characteristics and low cost. In this study, two raw clays (C_1 and C_2) were doped with iron and evaluated for the recovery of phosphate from simulated urban treated wastewater. The adsorbents' performances were evaluated through batch adsorption assays. Iron was stably retained in doped clays (C_1-Fe and C_2-Fe) at basal and edge surface at adsorption and desorption stages. Clay adsorbents were effective for adsorption of phosphate at neutral pH 7 and in broad range of phosphate concentrations. The maximum phosphate adsorption capacity values were 21, 38, 21 and 38 for C_1, C_1-Fe, C_2 and C_2-Fe, respectively. The equilibrium sorption data of raw and iron-doped clays were well described by the Langmuir isotherm model ($R^2 > 0.97$). Therefore, monolayer phosphate adsorption occurred through hydrogen bonding and complexation between protonated hydroxyl groups and phosphate anions. The raw and iron-doped clay adsorbents reached the equilibrium within 10 min and the equilibrium attainment data were well described by the intraparticular diffusion model ($R^2 > 0.96$). The phosphate monolayer adsorption was followed by diffusion through the internal clay pores. The phosphate adsorption by clays in presence of competing ion was inhibited by the higher ionic charge of sulphate. Besides, the less hydrated chloride and bicarbonate anions promoted the reduction of the sorption capacity of phosphate. Finally, the reusability of iron-doped clays is limited. Therefore, saturated iron-doped clays as single-use adsorbents can be disposed for soil amendment applications.

Diana Guaya, Rocío Jiménez, Janeth Sarango, César Valderrama, José Luis Cortina, Iron-doped natural clays: Low-cost inorganic adsorbents for phosphate recovering from simulated urban treated wastewater, Journal of Water Process Engineering, Volume 43, 2021, 102274, ISSN 2214-7144, https://doi.org/10.1016/j.jwpe.2021.102274.