

Treated Clay Mineral as Adsorbent for the Removal of Heavy Metals from Aqueous Solution

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Abstract

The decontamination of heavy metals present in aquatic bodies is a significant challenge that requires urgent attention. Analytical methods such as BET, XRF, SEM-EDX, and XRD was employed to characterize the raw clay (NT) and acid treated clay (AT). The adsorption of Cr (VI) and Fe (III) onto AT was performed using the batch method. The effects of time, adsorbent dose, temperature, and pH show that the optimal conditions are 50 min, 0.3 g, 35°C, and pH 6. The surface area of AT was 389.37 m²/g, and the adsorption equilibrium time of AT was 50 min. Langmuir isotherms had the best fit. Adsorption capacity is 18.15 and 39.80 mg/g for Cr (VI) and Fe (III) ions, respectively. An increase in area considerably improved the adsorption capacity of AT in the surface specific area. The interaction of Cr (VI) and Fe (III) ions onto AT indicated spontaneous and endothermic reaction. The chromium (VI) kinetic constant ($k_2 = 1.679$) was faster compared to Fe (III) rate constant ($k_2 = 0.0526$). It agreed correctly with the pseudo-second-order equation. The sum square error (SSE) value obtained confirmed the best-fit equations. The percent adsorbed for Cr (VI) and Fe (III) is 74 and 90%. The results revealed that iron has a higher affinity towards AT than chromium. The study revealed that AT could be suitable and effective in the adsorption of chromium and iron in the wastewater medium.

Keywords: Reated clay, Kinetic, Isotherm, Thermodynamic, Adsorbent, Chromium, Iron

1 Introduction

The heavy metals present in water bodies above the acceptable limit are severe hazards to humans and ecosystems. They are non-biodegradable and can persist in different environmental conditions. Therefore, this calls for urgent attention for adequate treatment and regulations concerning the amount of chromium (VI) and iron (III) present in the aquatic medium. The permissible limit for chromium and iron is 0.1 and 0.3 mg/L as recommended by the United States Environmental Protection Agency

(USEPA) [1]. Therefore, to keep the public and their environment safe, it is necessary to remove these pollutants from the aquatic ecosystem.

The primary source of ferric metallic ions is the ore mining activities, which comprises various minerals and heavy metals. The mining waste at an oxidized state is corrosive and leads to acid mine drainage. It contains arsenic, copper, lead, cadmium, iron, and sulfates. Ferric ions are highly present in acid mine drainage waters in a concentration of several 100 mg/L [2], [3]. Therefore, it is essential to treat any ferric ion