

Dynamic sorption of ionizable organic compounds (IOCs) and xylene from water using geomaterial-modified montmorillonite

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Abstract

Adsorption of phenols and xylene onto composite material, Na-montmorillonite, activated carbon, cement and water mixture, 70%, 7%, 7% and 16% (w/w/w/w), respectively, was studied at pH values of 5.15, 4.55, 5.2 and 4.9, respectively, of phenol, 2-CP, 2-NP and xylene. Equilibrium isotherms and fixed-bed column studies were undertaken to evaluate the performance of clay-active coal-coated cement (CACC) in removing phenols from aqueous solution.

Investigations revealed CACC to be a very efficient media for the removal of phenols from water. The suitability of the Langmuir adsorption model to the equilibrium data was investigated for all phenols–adsorbent systems. At the maximum sorption capacity of the composite material it was found that the uptake (mg phenols/g) of phenols increased in the order 2-CP > 2-NP > phenol ~ *m*-xylene as do their solubilities. The LUB design approach was used to determine the equivalent length of unused bed. The lower LUB values imply a better utilization of CACC composite. A model, which considered the effect of axial dispersion, was successfully used to describe the fixed-bed operation, the axial dispersion coefficient increased significantly with solubility.

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1. Introduction

Phenolic compounds are considered to be hazardous wastes that are released into the aquatic environment by industries such as coke ovens in steel plants, petroleum refineries, petrochemical, phenolic resin, fertilizer, pharmaceutical, chemical, and dye industries and have been reported in hazardous wastes sites. The literature reports many studies concerning the optimization of adsorption onto new adsorbent products and elucidating the mechanism of the process [1–3]. This study concerns the applicability of bentonite as an alternative adsorbent for the removal of substituted phenols [4–6].

Clays are widely used as adsorbents due to their high specific surface area. On the other hand, their sorption capacity is very low for organic molecules that are highly water soluble,

polar, or cationic. This is due to the hydrophilic nature of the mineral surfaces. Natural clay has a negative charge that is compensated by exchangeable cations, such as Na⁺ and Ca²⁺ on their surfaces.

Over the last 20 years, several studies have been carried out on the use of quaternary ammonium salt exchanged clays (QASCs) as adsorbents of many organic compounds from water, as well as on their application as pre-solidification agents in cement-based stabilization processes [7,8]. Furthermore, patents have been filed using QASCs as adsorbents in view of their application in waste disposal [9,10]. The use of QASCs as pre-solidification agents in cement-based stabilization of organic-containing wastes relies on the high adsorption power of these clays and their compatibility with the cementations matrix [11].

In previous work, Montgomery et al. [12] carried out a microstructural study using scanning electron microscopy (SEM) and X-ray diffraction analysis (XRD) of solid mixes of QASCs containing organics and ordinary portland cement

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