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Removal of Congo red using the chlorinated Ca-Al layered double hydroxide produced from the desulfurization circulating wastewater

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ABSTRACT

The recycling and utilization of the solid precipitate produced by the treatment of the chlorine-containing desulfurization circulating wastewater using ultra-high lime with the aluminum process were studied. By means of X-ray diffraction, Fourier-transform infrared, scanning electron microscopy and volumetric adsorption analyzer, it was proved that the main composition of the precipitation was the chlorinated Ca-Al layered double hydroxide (CaAl-LDH-Cl). This precipitation was named waste-CaAl-LDH-Cl in this paper. It was used as an adsorbent to remove Congo red (CR). The research showed that waste-CaAl-LDH-Cl is an effective adsorbent for the removal of CR dye from the aqueous solutions. Adsorption of CR was found to increase with the increase of contact time, initial dye concentration and solution temperature. The adsorption of CR on waste-CaAl-LDH-Cl was favored at an acidic medium. The adsorption kinetics followed the pseudo-second-order model, whereas Langmuir adsorption isotherm fitted better to obtained data. The highest adsorption of 123.9 mg/g was recorded at 90 min and 313 K. $\Delta G°$ = –2.6757, –6.8761 and –12.7107 kJ/mol, $\Delta H°$ = 301.1145 kJ/mol, these data suggested that the adsorption process was spontaneous and endothermic. The adsorption mechanism included the electrostatic interaction, hydrogen bond and surface complexation. The results suggested that waste-CaAl-LDH-Cl is an efficient material for the removal of anionic organic pollutants from the wastewater.

Keywords: Layered double hydroxide (CaAl-LDH-Cl); Congo red; Adsorption

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