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Comparative studies on the adsorptive removal of Acid Violet-17 dye from aqueous solution by using zinc aluminium carbonate-LDH (ZAC-LDH) and modified LDH

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ABSTRACT

Removal of Acid Violet-17 (AV-17) from aqueous solution by using different adsorbents such as zinc aluminium carbonate–layered double hydroxide (ZAC-LDH) and its calcined sample (CZA-LDH) were studied through batch adsorption process. This study was carried out with different variables include contact time, initial dye concentration, pH, sorbent dose, and temperature. The pseudo-second-order kinetic model describes the kinetics of AV-17 adsorption by both ZAC-LDH and CZA-LDH with high correlation coefficient when compared with pseudo-first-order model. The equilibrium data was examined using Langmuir and Freundlich isotherm models. The Freundlich isotherm model described the heterogeneity and multilayer adsorption of dye by both the adsorbent. The optimum pH for the maximum adsorption of AV-17 dye was found to be 96.9% for ZAC-LDH and 99.06% for CZA-LDH at acidic pH = 3. The maximum adsorption capacities for the removal of AV-17 onto ZAC-LDH and CZA-LDH were found to be 114.94 and 454.55 mg/g at 30°C, respectively. The X-ray diffraction pattern of CZA-LDH before and after the adsorption emphasizes that the dye adsorption was significantly enhanced by reconstruction of its original layered structure by the intercalation of AV-17 dye molecule with memory effect. These results prove that the synthesized CZA-LDH was more efficient than the ZAC-LDH. The calculated thermodynamic parameters like $\Delta G°$ and $\Delta H°$ reveal that the adsorption process is spontaneous and endothermic in nature. The calculated Langmuir dimensionless separation factor R_L and n value of the Freundlich equation also supports the favourability of the adsorption process. Thermal regeneration and reusability of ZAC-LDH and CZA-LDH up to three cycles are remarkable for the removal of AV-17 dye. These results emphasize that the calcined product CZ-LDH is found to be a suitable adsorbent for AV-17 dye from aqueous solution.

Keywords: Layered double hydroxide; Langmuir separation factor; Kinetics; Thermodynamics; Acid Violet-17 dye

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