Desalination and Water Treatment
www.deswater.com

doi: 10.5004/dwt.2017.21223

85 (2017) 226–236
August

Adsorptive removal of Direct Red-7 from aqueous solution by uncalcined and calcined zinc aluminium carbonate layered double hydroxide — kinetics and isotherm study

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Received 27 December 2016; Accepted 14 July 2017

ABSTRACT

In this paper, two materials, namely zinc aluminium carbonate layered double hydroxide (ZAC-LDH) and calcined LDH (CZA-LDH) are prepared and employed for the removal of Direct Red-7 (DR-7) dye from aqueous solution. Batch mode studies are carried out for the removal of DR-7 using different parameters such as initial dye concentration, adsorbent dosage, contact time, temperature and pH. The adsorption kinetics is studied using classic equations of pseudo-first-order, pseudo-second-order and intraparticle diffusion models. The pseudo-second-order kinetic model fits well with the high correlation coefficient for the removal of DR-7 by both ZAC-LDH and CZA-LDH. The equilibrium data are examined using Langmuir and Freundlich isotherm models. The maximum adsorption capacity for the removal of DR-7 onto CZA-LDH is found to be 666.67 mg/g which is higher than the ZAC-LDH (357.14 mg/g) at 30°C. X-ray diffraction and Fourier transform infrared spectroscopy analysis also have been carried out to confirm the interaction of dye molecule onto the adsorbents. The evaluated thermodynamic parameters of $\Delta G°$ and $\Delta H°$ indicate that the adsorption process is spontaneous and endothermic in nature. The ZAC-LDH and CZA-LDH are thermally regenerated and reused for the dye removal of DR-7 from aqueous solution. The enhanced dye removal of DR-7 by CZA-LDH proves that the CZA-LDH is a more suitable adsorbent for the removal of DR-7 compared with ZAC-LDH from aqueous solution.

Keywords: Calcined layered double hydroxide; Direct Red-7; Isotherm; Memory effect; Kinetics; Thermodynamics

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