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Zn-, Mg- and Ni-Al-NO_3 Layered Double Hydroxides Intercalated by Nitrate Anions for Treatment of Textile Wastewater

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Abstract : Industrial effluents are one of the major causes of environmental pollution, especially effluents discharged from various dyestuff manufactures, plastic, and paper making industries. These effluents can give rise to certain hazards and environmental problems for their highly colored suspended organic solid. Dye effluents are not only aesthetic pollutants, but coloration of water by the dyes may affect photochemical activities in aquatic systems by reducing light penetration. It has been also reported that several commonly used dyes are carcinogenic and mutagenic for aquatic organisms. Therefore, removing dyes from effluents is of significant importance. Many adsorbent materials have been prepared in the removal of dyes from wastewater, including anionic clay or layered double hydroxyde. The zinc/aluminium (Zn-$AlNO_3$), magnesium/aluminium (Mg-$AlNO_3$) and nickel/aluminium (Ni-$AlNO_3$) layered double hydroxides (LDHs) were successfully synthesized via coprecipitation method. Samples were characterized by XRD, FTIR, TGA/DTA, TEM and pHPZC analysis. XRD patterns showed a basal spacing increase in the order of Zn-$AlNO_3$ (8.85Å)> Mg-$AlNO_3$ (7.95Å)> Ni-$AlNO_3$ (7.82Å). FTIR spectrum confirmed the presence of nitrate anions in the LDHs interlayer. The TEM images indicated that the Zn-AlNO3 presents circular to shaped particles with an average particle size of approximately 30 to 40 nm. Small plates assigned to sheets with hexagonal form were observed in the case of Mg-$AlNO_3$. Ni-$AlNO_3$ display nanostructured sphere in diameter between 5 and 10 nm. The LDHs were used as adsorbents for the removal of methyl orange (MO), as a model dye and for the treatment of an effluent generated by a textile factory. Adsorption experiments for MO were carried out as function of solution pH, contact time and initial dye concentration. Maximum adsorption was occurred at acidic solution pH. Kinetic data were tested using pseudo-first-order and pseudo-second-order kinetic models. The best fit was obtained with the pseudo-second-order kinetic model. Equilibrium data were correlated to Langmuir and Freundlich isotherm models. The best conditions for color and COD removal from textile effluent sample were obtained at lower values of pH. Total color removal was obtained with Mg-$AlNO_3$ and Ni-$AlNO_3$ LDHs. Reduction of COD to limits authorized by Moroccan standards was obtained with 0.5g/l LDHs dose.

Keywords : chemical oxygen demand, color removal, layered double hydroxides, textile wastewater treatment
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