A COMPARATIVE STUDY ON THE REMOVAL OF ANIONIC AND CATIONIC DYES FROM AQUEOUS SOLUTION BY LAYERED DOUBLE HYDROXIDES

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Abstract

Organic dyes that are generated from various industries have recently become a serious concern due to the increased quantity discharged into the environment. These dyes are very stable in the nature and therefore cause severe problems to the environment as well as to human health. Consequently, rapid and efficient approach for the removal of colored dyes from water is essential and has become an imperative in this field of research. Recently, layered double hydroxides (LDHs) have attracted much attention in the field of environmental friendly processes. They consist of stacked hydroxide layers with charge-balancing anions in the interlayer and have tailoring possibilities that enable the variation of numerous synthesis methods and parameters: The layered structure collapses after thermal treatment leading to the formation of non-stoichiometric metastable mixed oxides with developed surface area and specific acid-base and redox properties. Therefore, our work was aimed to investigate the behavior of synthesized ZnAl-LDHs and their mixed oxides (thermally treated at 500°C/5h) in the removal processes of anionic (Methyl Orange-MO) and cationic (Rhodamine B - RhB) dyes. Structural, textural and morphological analyses were carried out for the material characterization. Experiments were conducted in an open cylindrical Pyrex reaction vessel containing 100ml of solutions (C_{MO}=4μmol/l or C_{RhB}=10μmol/l) and 50mg of powdered materials. At defined intervals aliquots were centrifuged and MO/RhB concentrations were determined using UV-VIS spectrophotometer at 463.9nm and 554nm, respectively. The results showed that the LDHs and there derived mixed oxides exhibited high adsorptive capacities for MO removal from aqueous solutions (~50% of initial MO after 45min for LDHs and almost complete adsorption after only 10min of contact for mixed oxides). Interestingly, both materials did not show any adsorptive capacity for RhB removal, but after photoactivation of the reaction solution (UV light irradiation: 0.912mW/cm^2), both materials exhibited photocatalytic activity (~25% for LDHs and ~80% for mixed oxides after 300min). The investigation revealed that in the removal process of anionic dyes, the adsorption process is the dominant overall process due to the possibility of intercalation of MO molecules in the interlayers of layered hydroxides. On the contrary, for the removal of cationic dyes this is not the case, but interestingly enough the same synthesized materials showed very satisfying photocatalytic behaviour. It can be concluded that the synthesized materials can be used simultaneously as adsorbents for the removal of anionic dyes and as photocatalysts in the degradation of cationic dyes, making these materials multi-functional and vastly promising for their application in the field of environmental protection.

Key words: adsorption, photocatalytic reaction, anionic and cationic dyes

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