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SYNTHESIS AND CHARACTERIZATION OF NEW MATERIALS FOR ADVANCED GROUNDWATER REMEDIATION

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Introduction

The clay is one of the most widespread minerals on the earth's surface being used by people since ancient times because of its characteristics that enable it to be used in a wide range of applications. This class of materials is divided into two broad groups, namely cationic clays, very widespread in nature, and anionic clays, more rarely found in nature, but inexpensive and relatively simple to synthesize.

Double lamellar hydroxides, known as "layered double hydroxides (LDHs)", are a large group of natural and synthetic materials that currently have come to the attention of researchers due to their special properties. Nanostructured LDHs are also known as hydrotalcite-like materials due to the hydrotalcite-like structure ($\text{Mg}_6\text{Al}_2(\text{OH})_{16}\text{CO}_3 \cdot 4\text{H}_2\text{O}$). From structural point of view, nanostructured LDHs are characterized by a lamellar structure similar to that of the brucite ($\text{Mg}(\text{OH})_2$). In addition, the hybrid systems such as LDH-polymer have attracted researchers' attention in the recent years due to their potential applications as biomaterials and biosensors in biotechnology.

Materials and methods

The major aim of this research was to obtain new formulations of LDHs that can be applied to advanced groundwater remediation. The synthesis of these materials was accomplished by the direct co-precipitation method at constant pH of the working solution, followed by the heat treatment at 550 °C. The conditions in which the co-precipitation occurs are as following: pH = 8, temperature 25 °C, low concentration of the precursors, and low flow of the two streams. The low oversaturation conditions give solids with high crystallinity. The morphology and the uniformity of the particles size of the clay as well as the ordering of the nanoparticles can be optimized depending on the oversaturation of the synthesis solutions and the experimental conditions during the synthesis, namely the stirring speed, temperature, and the aging period of the precipitate.

LDH hybrid system and the polyvinyl alcohol (PVA) were obtained by intercalating the polymer into the clay inter-layers through the reconstruction method based on the clays specific memory effect. LDH/PVA systems were obtained from a clay of MgAl type, and the polyvinyl alcohol (PVA) was used as polymer. These samples were synthesized by the reconstruction method which has as a principle the restoration of

the lamellar structure of the hydrotalcite-type material when the small oxides obtained by calcination are introduced into an aqueous medium containing the polymer.

Results and conclusions

The hybrid system based on polyvinyl alcohol/MgAlLDH was analyzed structurally in order to identify the presence of functional groups characteristic of each type of material. Initially, FTIR spectra of pure materials namely polyvinyl alcohol and double lamellar hydroxides of the MgAlLDH type were performed. To see if changes in the final structure occurred compared to the original structure of the materials used, FTIR spectra of the PVA/LDH hybrid material were then performed. The results revealed the presence of a layered structure of double lamellar hydroxides with different anions that are present in the interlamellar layers and other specific nanostructured assemblies. The results obtained from the Raman spectroscopy analyzes have brought important additions to the material characterization, confirming the obtaining of structures specific to the studied materials. X-ray diffraction (XRD) has highlighted the formation of the double lamellar hydroxide-specific structure by the presence of the reflection peaks characteristic of these materials. Thermogravimetric analysis has highlighted the stability of materials with the raising of temperature. It was identified the stages of mass loss characteristic to the double lamellar hydroxides by eliminating the interlamellar water, dehydroxylation and decarbonation of the samples, and the elimination of anions present between the lamellae.

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