

Mg/Al LDH OBTAINED VIA TRANSFORMATION OF MINERALS FOR THE REMOVAL OF SELECTED ELEMENTS FROM ACIDIC AND ALKALINE WASTEWATERS

Karolina Rybka^{*1} and Jakub Matusik¹

¹AGH University of Science and Technology, Faculty of Geology, Geophysics and Environmental Protection, Department of Mineralogy, Petrography and Geochemistry, al. Mickiewicza 30, Krakow, 30 059, Poland

A growing water pollution can be a result of both natural and industrial processes. The structure of Layered Double Hydroxides (LDH) comprises of positively-charged brucite-like layers built of divalent (M^{II}) and trivalent (M^{III}) metals. The charge is balanced with the intercalated hydrated anions, what makes them perfect materials for the anions removal. Nevertheless, besides the effectiveness, the low price is also of interest for the industry. Therefore, the first goal of this study was to obtain Mg-Al LDH using magnesite and halloysite as cheap and abundant sources of Mg and Al, to substantially lower the final price of the material. LDH adsorption behavior is well known from many experiments, mostly in single element systems. In contrast, this study focused on using waters with multi-element chemical composition and extreme pH conditions (Acid Mine Drainage (AMD) water with pH = 2.2 and Industrial Water (IW) water with pH = 9.0). The used Mg-Al LDH was synthesized in three different variants, with varying contribution of minerals as sources of M^{II} or M^{III} . First, a reference sample (Mg/Al) was synthesized using only chemical reagents: $MgCl_2 \cdot 6H_2O$ and $AlCl_3 \cdot 6H_2O$ as Mg and Al sources. For the second material (M/Al), magnesite was used instead of Mg-chloride. For the third material (M/Hall), magnesite was used as a source of Mg, and Al-chloride was replaced by halloysite (Hall). All materials were synthesized by a co-precipitation method with prior dissolution of the minerals. All materials were characterized by XRD and FTIR before and after adsorption experiments. The adsorbent dosage was 5 g/L. Initial and equilibrium concentrations were measured by ICP-OES. Regardless of the material variant, the XRD patterns confirmed the presence of LDH. For the M/Al gibbsite admixture was detected. All materials showed the presence of carbonates in the interlayer space which was confirmed by the bands in the 1410-1365 cm^{-1} region of FTIR spectra. The chemical analysis of investigated waters showed, that main ions found in AMD were SO_4^{2-} (4052.45 mg/L) and Fe (1138.90 mg/L). SO_4^{2-} and V were present in the highest concentrations (801.16 and 168.13 mg/L, respectively) in the IW water. In general, even in a system with a lot of competitive ions, all materials effectively removed main pollutants from both waters. In particular, most of anionic forms, despite high concentration of sulphates, were almost completely removed. However, the initial pH of waters significantly affected the stability of the materials, which was indicated by the release of Mg. Also, the XRD patterns of all materials after AMD adsorption experiments confirmed dissolution of the LDH, as well as the shift of the basal peaks indicating the interlayer expansion. The FTIR spectra of all samples showed the band at 1110 cm^{-1} attributed to the presence of intercalated sulphates. Also, the band at 1365 cm^{-1} was replaced by the band at 1430 cm^{-1} , which indicates the change of carbonates species. The XRD patterns of samples treated with IW did not change significantly. Also the FTIR spectra did not exhibit any significant changes beside the SO_4^{2-} band at 1110 cm^{-1} in the Mg/Al spectrum.

This project was supported by the National Science Centre Poland, under a research project awarded by Decision No. 2017/27/B/ST10/00898.