A study on the intercalation of heavy metal ions in a wastewater by synthetic layered inorganic adsorbents

Agne Bankauskaite*, Anatolijus Eisinas, Kestutis Baltakys, Skirmante Zadaviciute

Department of Silicate Technology, Kaunas University of Technology, Radvilenu 19, Kaunas, LT 50270, Lithuania,
Tel. +370 67423935; Fax: +370 7300152; email: agnebankauskaite@gmail.com (A. Bankauskaite), Tel. +370 68916035;
email: anatolijus.eisinas@ktu.lt (A. Eisinas), Tel. +370 68789856; email: kestutis.baltakys@ktu.lt (K. Baltakys), Tel. +370 67301952;
email: zadaviciute.skirma@gmail.com (S. Zadaviciute)

Received 2 December 2013; Accepted 12 July 2014

ABSTRACT

This study examined the intercalation mechanism of Co^{2+}, Ni^{2+}, Zn^{2+}, Mn^{2+} and Fe^{3+} ions into synthetic layered inorganic adsorbents—hydrotalcite and gyrolite under different conditions. It was observed that the process parameters above depend on the chemical nature of both solutions and adsorbents. An extremely high and selective uptake of Fe^{3+} ions was observed in both cases (~98–99%). The selectivity sequence of studied metal ions by gyrolite can be written as follows: Co^{2+} > Zn^{2+}/Mn^{2+}/Ni^{2+} > Fe^{3+}, while with calcined hydrotalcite: Co^{2+}/Ni^{2+}/Mn^{2+} > Zn^{2+} > Fe^{3+}. It was determined that, during simultaneous adsorption, the intercalation of heavy metal ions into the structure of gyrolite or calcined hydrotalcite proceeds differently, because the amount of adsorbed Me^{x+} ions is higher than the amount of leached Ca^{2+} and Mg^{2+} ions, resulting in the occurrence of two types of chemical reactions – substitution and addition. It should be noted that almost all heavy metal ions (~99.84%) are chemisorbed by both adsorbents. Moreover, after chemisorption, no other compounds were observed in X-ray powder diffraction patterns of both adsorbents. It was observed that hydrothermally treated and calcined hydrotalcite reconstructs its structure during the chemisorption process, while the structure of gyrolite remains stable.

Keywords: Waste management technologies; Hydrotalcite; Gyrolite; Synthetic layered inorganic adsorbents

*Corresponding author.