Application of Li/Al LDH to Recover Cr(VI) from Wastewater

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Adsorption or precipitation is a common task for removing contaminants from drinking water and industrial wastewater. Many studies have suggested that layered double hydroxides (LDHs) are potential adsorbents for anionic contaminants, such as the oxyanions of Cr, As, Se and Tc. One of the unique compounds in the LDH group is Li/Al LDH, which has a formula of $[LiAl_2(OH)_6]^+A^-{\cdot}xH_2O$. Our preliminary studies showed that intercalated LiCl in the structure of Li/Al LDH could be released after the material is washed with water. If deintercalation reaction can occur with contaminant-bearing Li/Al LDH, the products of deintercalation will include gibbsite and aqueous solution containing mainly Li and contaminants. These products can be further treated for recovering contaminants and possibly regenerating adsorbents. Therefore, the objectives of the study is to evaluate the sorption of Cr(VI) by Li/Al LDH and the thermal stability of the Li/Al LDH in aqueous solutions. Our purpose is to appraise the possible post-treatment to recover Cr(VI) from wastewater.

Li/Al LDH was synthesized by adding 5 g of synthetic gibbsite into 25 ml 10 M LiCl solution and the temperature of the suspension was maintained at 90 ^oC during the synthetic process. The suspension was then centrifuged and the solids collected after centrifugation was washed with iced water until free of chloride. The adsorption of Cr(VI) on Li/Al LDH was conducted at various temperatures. Samples were periodically withdrawn and filtered. Thermal stability of Li/Al LDH and the release of Cr(VI) from the LDH structure were investigated using the batch method. The Li^+, Al^{3+}, Cl^- and chromate in the filtrate were periodically determined. In the end, the solids was collected, air dried, grounded, and analyzed using XRD, FTIR and EXAFS.

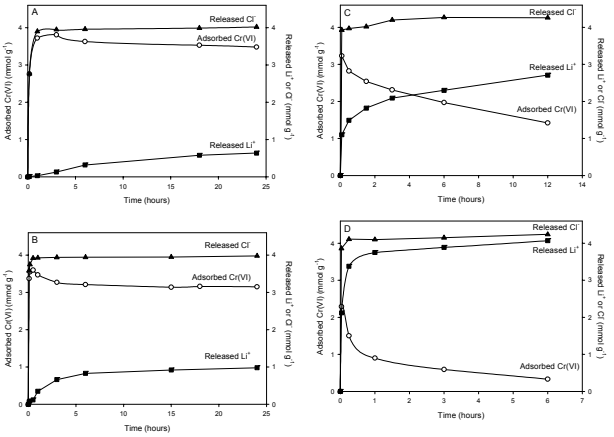

Figure 1. The concentrations of chromate, Li^+ and Cl^- during the adsorption of chromate on Li/Al LDH at (A) 10, (B) 25, (C) 60 and (D) 90 ^oC

Adsorption of chromate on Li/Al-LDH at pH 4 was observed as a function of time at various temperatures (Fig. 1). A fast removal of chromate from the solution was seen in the first several minutes at any temperature (open circles in Fig. 1). The high reaction rate is due to ion exchange reaction and chromate is adsorbed through the displacement of Cl^- in the interlayers of LDH. At low temperature, the reaction rate is higher than that of releasing adsorbed chromate due to the deintercalation of its counterbalanced Li^+. As the reaction temperature further increases, the deintercalation rate increases and becomes comparable with the chromate adsorption rate.

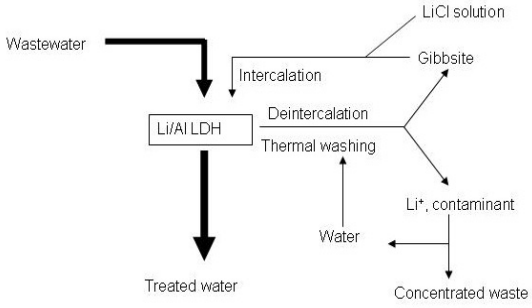

Figure 2. Schematic representation for the proposed processes to recover Cr from contaminated water using Li/Al LDH and to regenerate the used material

We propose a scheme of applying Li/Al LDH in treatment of water containing chromate (Fig. 2). Treatment of water containing Cr can be conducted at low temperature to inhibit deintercalation reaction and increase adsorption capacity of Li/Al LDH (thick lines in Fig. 2). After Li/Al LDH adsorbs contaminants, the fixed contaminant can be recovered through thermal washing the contaminant-bearing material at an elevated temperature (thin lines in Fig. 2). The final products of thermal washing are gibbsite and aqueous solution mainly containing Li^+ and contaminants. Gibbsite may be reused to synthesize Li/Al LDH through LiCl intercalation. The solution containing contaminants may be concentrated to eliminate water and reduce the volume of waste. Water may be recovered for the use in thermal washing; concentrated waste may be further treated to recover contaminant (Fig. 2).