Application of layered double hydroxides for water purification

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Clay minerals such as swelling clays, organoclays and hydrotalcites can be made to function as water purifiers. Hydrotalcites or layered double hydroxides are specifically useful for anion removal from aqueous media. Red mud, the chemical waste from the bauxite in the alumina industry contains all of the chemicals required for the synthesis of these LDHs. Upon the reaction of red mud with sea water such LDHs are formed. Hydrotalcites have the useful ability of removing anionic species from solution either by anion exchange or through the initial formation process of the layered double hydroxide structure (Rives, 2001).

This research reports the removal of arsenate and vanadate anions using hydrotalcites prepared in two different ways: 1) co-precipitation and 2) thermal activation. The thermal activation method has been clearly shown to increase the number of anions removed from solution. This increase in effectiveness is due to the increased chemical reactivity of the hydrotalcite structure after dehydration. Hydrotalcites were prepared using synthetic materials, Bayer liquor, and seawater neutralised bauxite refinery residues.

This work shows that the intercalation of arsenate and vanadate increases the thermal stability of the hydrotalcite structure compared to carbonate hydrotalcites (Fig. 1). The Mg:Al ratio used for the removal of the toxic anions has been found to be dependent on the method used. For the co-precipitation method the formation of hydrotalcite in solution with a Mg:Al ratio of 3:1 is favoured over the 2:1 and 4:1, whereas for thermally activated hydrotalcites with a Mg:Al ratio of 4:1 is most favourable. Using a variety of techniques the mechanism for the inclusion of arsenate and vanadate has been determined. It has also been established that the removal of toxic anions in highly alkaline solutions is diminished. This investigation shows that Bayer refinery residues may be used for the treatment of solutions containing toxic anions. Thermally activated Bayer hydrotalcite has been shown to be highly effective in the removal of arsenate and vanadate, with 100 % removal being observed. The formation of hydrotalcite during the seawater neutralisation process removes anions via two mechanisms rather than one observed for thermally activated red mud.

Reference

Rives V (2001). Layered Double Hydroxides: Present and Future, Nova Science, New York.

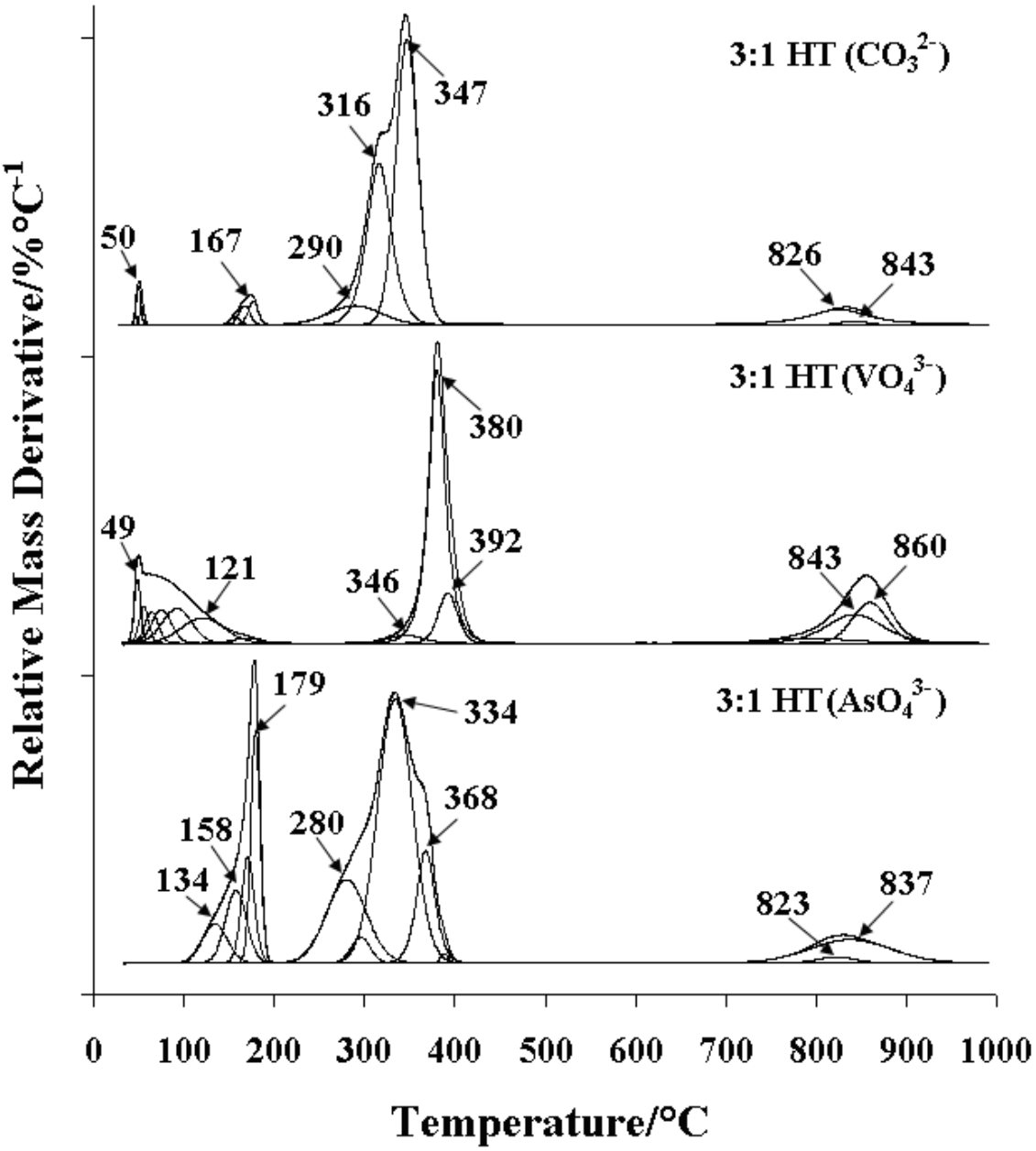

Fig. 1. Thermal analysis patterns of hydrotalcite with intercalated carbonate, vanadate and arsenate.