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Al- and Fe-bearing layered double hydroxides as effective adsorbents of aqueous V(V): the effect of brucite-like layer and interlayer chemistry

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Vanadium is a strategic metal used in many industries, e.g.: steel, catalysis, pigment, and chemical. When introduced into wastewater and not effectively disposed prior to discharge into the environment, it can pose a threat to living organisms. Because of its high utility in industry, methods of vanadium removal from wastewaters should include its recovery. Adsorption-based methods often allow multiple regenerations of the adsorbent and sorbate recovery at the same time. Among the adsorbents suitable for anions removal, layered double hydroxides (LDH) represent a large group of effective anion exchangers. A variety of metals and anions can be incorporated into their structure. Their positively charged layered structure and weakly bonded charge-balancing interlayer anions make them promising candidates for the removal of anionic species. This is, however, strongly dependent on their chemical composition. The goal of this work was to investigate the efficiency of anionic species removal by LDH with various chemical composition and different interlayer anions. Four LDHs comprising structural Mg(II), Al(III) or Fe(III) and interlayer CO_3^{2-} or SO_4^{2-}, were obtained through co-precipitation synthesis and tested towards V(V) removal. The maximum capacity of the obtained materials and the kinetics of the V(V) adsorption process were investigated along with the stability of the adsorbents. All materials showed a high adsorption efficiency. However, the Al-bearing LDH were more effective than the Fe-bearing LDH in terms of both adsorption at various initial concentrations and the removal rate. The chemistry of the interlayer anion had a clear impact on their adsorption properties. However, the differences were less significant for the Fe-bearing LDH. The stability of the materials showed differences only at high initial concentrations (>10 mmol/L).

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