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# Removal of uranium(VI) from aqueous solutions by magnetic Mg–Al layered double hydroxide intercalated with citrate: Kinetic and thermodynamic investigation

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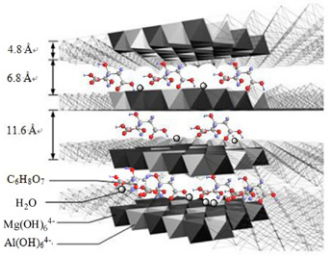
## HIGHLIGHTS

- We prepared magnetic citrate·Mg–Al LDH via ion-exchange technique.
- It can effectively removal uranium(VI) from aqueous solutions.
- Adsorption product is easily separated by the external magnetic field.
- The maximum adsorption capacity toward uranium(VI) is 180.00 mg $g^{-1}$ at 25 °C.

## GRAPHICAL ABSTRACT

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## ABSTRACT

Magnetic Mg–Al layered double hydroxide was modified with citrate acid using a ion-exchange technique. It showed higher adsorption capacity for the uranium(VI) ions compared with magnetic Mg–Al layered double hydroxide without intercalating with citrate. This increasing capacity was mainly attributable to the formation of the citrate–metal complexes in the interlayer of the magnetic citrate·Mg–Al layered double hydroxide. Batch experiments were conducted to study the effects of pH, adsorbent dose, shaking time, and temperature on uranium sorption efficiency. The results reveal that the maximum adsorption capacity is 180.00 mg $g^{-1}$ when the initial uranium(VI) concentration is kept as 200 mg $L^{-1}$ at 25 °C, displaying a high efficiency for the removal of uranium(VI) from aqueous solution. The sorption follows Freundlich model and pseudo-second-order kinetics. The thermodynamic parameters such as $\Delta H^\circ$, $\Delta S^\circ$ and $\Delta G^\circ$ show that the process is endothermic and spontaneous. In addition, the composite can be easily separated from the solution by a magnet after the adsorption process. This work provides an efficient, fast and convenient approach for the removal of uranium(VI) from aqueous solutions.



## 1. Introduction

Uranium is one of the most dangerous heavy metals in the environment because of its long half-life, high radioactivity and biological toxicity. Therefore, it is very important to choose a suitable and effective method to removal of uranium from water. So far, several methods, such as chemical precipitation, membrane separation, microbial removal, solvent extraction, electrodialysis, and adsorption [1–8], have been extensively applied for the removal of uranium(VI) from aqueous solutions. Among these methods, adsorption appears to be one of the most effective methods owning to its cost-effective, versatile and simple features to operate for removing trace levels of ions [9,10].

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