The influence of the vermiculite template on the morphology of manganese dioxide with enhanced immobilization for thallium

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Vermiculite coupled with manganese dioxide (VER-MnO_2) was fabricated by synthesizing MnO_2 on the vermiculite (VER) template and used for immobilization of Tl(I). The VER exhibited typical layered structure and MnO_2 possessed a flower-like structure with serious reunion phenomenon, while VER-MnO_2 illustrated fish-scale shard spread evenly over a large sheet, suggesting that MnO_2 had triumphantly anchored on the VER template and the aggregation of MnO_2 was prevented. The VER Template effect contributed higher BET(298.18$m^2 \cdot g^{-1}$) and degree of oxidation of MnO_2. VER-MnO_2 showed the highest fixation capacity (144.29 $mg \cdot g^{-1}$) than other two materials in the order VER-MnO_2 > MnO_2 > VER, and there was no risk derived from dissolution of Mn. The mechanism of removal Tl(I) was mainly adsorption, ion exchange, and the oxidizability. Fixed-bed column adsorption experiments demonstrated that VER-MnO_2 can be used for purifying drinking water spiked with Tl (20 $\mu g \cdot L^{-1}$) and the effective breakthrough volumes were 900 bed volumes until reaching the maximum limits allowed in drinking water (0.1$\mu g \cdot L^{-1}$). The advantages of high efficiency, nontoxic, renewability, low-cost and environmentally friendly materials confirm the great potential application of VER-MnO_2. This study would provide a new thought for developing effective, low-cost and environmentally friendly materials for removal of environmental pollution.

Keywords: vermiculite; manganese dioxide; thallium