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The performance of phosphate removal using aluminium-manganese bimetal oxide coated zeolite: batch and dynamic adsorption studies

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ABSTRACT

The discharge of wastewater containing excessive concentrations of phosphate is one of the main causes of eutrophication and can lead to serious downstream environmental effects. Adsorption technology has been recognized as a promising technology for phosphate removal from water, because of its low cost and ease of operation. In this study, we prepared an aluminum–manganese (Al–Mn) bimetal oxide-coated zeolite (AMOCZ) as a high-performance adsorbent for removing phosphate from aqueous solution. SEM and Brunauer–Emmett–Teller (BET) results showed that Al–Mn bimetal oxide was successfully coated onto zeolites, thus increasing the surface area. X-ray diffraction and Fourier transform infrared spectroscopy results demonstrated that AMOCZ has an amorphous structure and numerous active sites on its surface. The adsorption kinetic data were well fitted by the pseudo-second-order model, and the adsorption rate was retarded due to a high-concentration of phosphate. Thermodynamic results illustrated that phosphate adsorption onto AMOCZ can be satisfactorily simulated by the Langmuir model. The maximum adsorption capacity was calculated to be 7.56 mg g^{-1} at 298 K, and the adsorption process was supposed to be endothermic and spontaneous. By investigating the influences of water quality factors on phosphate adsorption, we found that phosphate removal can be facilitated under acidic conditions. In addition, phosphate adsorption is inhibited by the presence of sulfate or carbonate due to competition for active sites, whereas calcium cations are beneficial to phosphate adsorption through cation-bridging interactions. In order to evaluate the reusability of this material, we carried out reuse tests where AMOCZ was successfully used in five consecutive cycles using the recoating method for regeneration. Moreover, a satisfactory performance for phosphate removal from simulated wastewater was achieved in rapid small-scale column tests, indicating that AMOCZ has a high potential for engineering applications.

Keywords: Bimetal oxide; Zeolite; Adsorption; Phosphate

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