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Insights into adsorption mechanism for fluoride on cactus-like amorphous alumina oxide microspheres

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Abstract

Cactus-like amorphous alumina microspheres (CA-AlOx) were fabricated by a facile solvothermal method without templates. The as-prepared CA-AlOx material exhibited the amorphous structure which is beneficial to the large specific surface area, developed pore structure, abundant functional groups and high reactivity of coordinatively unsaturated Al species. The maximum adsorption capacity of CA-AlOx was calculated to be 129.4 mg/g for fluoride, which was higher than that of many adsorbents reported. Moreover, the CA-AlOx exhibited fast adsorption rate, high interference resistance and good reusable ability. Adsorption mechanism and relationship between amorphous structure and adsorption performance for fluoride on the CA-AlOx were investigated systematically by various characterization techniques. The adsorption mechanism of fluoride on the CA-AlOx was mainly through the chemical coordination of unsaturated Al-species AlO_4 and AlO_5 by fluoride ions to form the AlF_3 and $[AlF_6]^{3-}$ species by XPS and NMR analysis. Also, ion exchange, electrostatic adsorption and pore filling were also involved in the adsorption process. These results suggested that the CA-AlOx has great application potential for deep