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Hierarchically Porous Zeolite X Composites for Manganese Ion-exchange and Solidification: Equilibrium Isotherms, Kinetic and Thermodynamic Studies

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Abstract

This paper deals with the kinetic and isotherm studies of manganese ion removal by zeolite X and its hierarchically porous composites as ion-exchange materials. A hydrothermal treatment was applied to grow a layer of zeolite X over diatomite and carbon surfaces. The hierarchically porous composites used for Mn^{2+} ion removal showed higher ion-exchange capacity when compared to pure zeolite X under same conditions. A thermodynamic study of the rate of ion-exchange revealed that the intra-particle diffusion rate constant of zeolite X/carbon and zeolite X/diatomite was higher than that of pure zeolite X indicating that the intra-particle diffusion was enhanced when zeolite was prepared in form of hierarchically porous composites. The study showed that the thickness of boundary film of zeolite X/carbon and zeolite X/diatomite was less than that of pure zeolite X indicating ion diffusion resistance to the active sites was reduced when the composites were utilised. The experimental data showed good agreement with Freundlich model. The calculated thermodynamic parameters such as $\Delta G°$, $\Delta H°$ and $\Delta S°$ indicated the ion-exchange process of Mn^{2+} ion by zeolite X and its composites was spontaneous, endothermic and the randomness increased at the liquid/solid interface under the conditions studied. The results of kinetic study showed that the ion-exchange of Mn^{2+} ion by zeolite X and its composites followed a pseudo second order