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Effect of environmental conditions on the sorption behavior of radiocobalt(II) onto permutite studied by batch experiments

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Discharge of aqueous radioactive waste from nuclear industry has become a major concern all over the world due to its potential to pollute portable water sources. Radiocobalt is one of the most problematic radionuclides in the effluent from nuclear industry because of its high gamma decay energy. A number of methods have been developed to remove these radionuclides from the discharge of nuclear industry. Among these methods, adsorption is one of the cost-effective approaches used to treat the radioactive waste. In this work, the stable cobalt was chosen as adsorbate to simulate the radiocobalt in the adsorption process. The radiocobalt has similar chemical characteristics as stable cobalt. Permutite, a man made zeolite, was employed an adsorbent to remove Co(II) from synthetic solution. The adsorption of Co(II) onto permutite was studied as a function of contact time, solution pH, ionic strength and solid content by using batch technique. Permutite was selected because it contains little impurities and has almost the same particle size as natural zeolites, furthermore it has better cation exchange capacity compared with natural zeolites. The results revealed that the adsorption behavour of Co(II) was significantly dependent on the solution PH and ionic strength under ambient conditions. The adsorption efficiency grew as the solution pH increased at pH<8.0, and dropped slightly as the solution pH increased at pH>9.5. The adsorption of Co(II) achieved the equilibrium quickly, and the kinetic sorption was fitted well by a pseudo-second-order rate equation. The main mechanism of Co(II) adsorption on permutite at low pH values was ion exchange and/or outer-sphere surface complexation, while at high pH values was inner-sphere surface complexation. The adsorption isotherms were simulated by the Langmuir model at three different temperatures of 298.15, 318.15 and 338.15 K. The thermodynamic data which were calculated from the temperature dependent adsorption isotherms suggested that adsorption behavior of Co(II) on permutite was spontaneous and endothermic process. From the experimental results, permutite can be a cost-effective adsorbent for disposal of the effluent of nuclear industry.We thank the finical supports by the National Natural Science Foundation of China (Grant No. 11275147).

Key words: Adsorption, Co(II), Permutite, Kinetic, Thermodynamic data

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