REMOVAL OF Co AND Cd BY ZEOLITE X

I. NAVA, I. GARCÍA-SOSA, M. SOLACHE-RIOS*

Institute Nacional de Investigaciones Nucleares, Departamento de Química,
A. P. 8-1027, Col. Escándón, Delegación Miguel Hidalgo, C. P. 11801 (México, D.F.)

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The use of NaX zeolite, in the sorption of cobalt and cadmium from aqueous solutions has been investigated. Ion exchange experiments were performed with cobalt and cadmium solutions at various pH and concentration. The cobalt, cadmium and sodium content were determined by neutron activation analysis. It was stated that the selectivity for cadmium is higher than for cobalt.

The industrial activities have produced increasing concentration of toxic elements in the environment. One of these elements found in the industry waste is cadmium, which its toxicity is as high as mercury and lead. They can be accumulated in the living organisms causing its damage.1

On the other hand, radioactive cobalt is a common constituent of liquid radioactive waste arising from nuclear facilities. Removal of $^{60}$Co by zeolite Y, erionite and clays has been studied2 and the retention sequence reported was as follows: bentonite < erionita < zeolita Y. Therefore, the aim of the present work, was to study the behavior of Co and Cd uptake by zeolite X which has higher cation and sorption capacity sites than the aluminosilicates mentioned above.

Experimental

Material and equipment: Analytical grade reagents were used without further purification for both, analyses and ion exchange processes. Synthetic zeolite NaX supplied by Sigma was used in its hydrated form. The samples were treated first with a 5N NaCl solution during 8 days, the zeolite was washed until no presence of chloride was observed in the washing solution with silver nitrate. Then it was dry at 110 °C during 5 hours and the zeolite was left in a humid medium to equilibrate it with water. The content of water was determined by weight loss at 300 °C.

*To whom correspondence should be addressed.
Isotherms: Solutions of cadmium or cobalt were prepared, all of them 1N in nitrates, and the following concentrations: 0.001, 0.003, 0.005, 0.01, 0.03, 0.05, 0.1 and 0.5N cobalt or cadmium at pH 5.6. 20 ml of each solution were added to different samples of 200 mg of zeolite. After 72 hours the liquid was separated by centrifugation and the solid was washed with 5 ml of deionized water. The samples were dried and they were left in a humid medium for equilibration, before sodium, cobalt or cadmium were analysed by neutron activation analysis.

Uptake curves

Cadmium uptake at different concentrations: Solutions 0.03, 0.05 and 0.07N of cadmium nitrate (20 ml) were put in contact with samples of 200 mg of zeolite X, and left for 72 hours. Then the zeolite samples were washed and dried, and finally they were left in a humid medium to equilibrate with water.

Cadmium uptake at different pH: Solutions 0.05N of cadmium at pH 3.0, 5.0 and 7.0 were used to exchange with zeolite X as described above.

Cobalt uptake at different pH: Solution 0.05N of cobalt nitrate at pH 3.0, 5.0, 6.6 and 7.0 were used for the ionic exchange and it was done as described before.

Determination of Na, Cd and Co in the exchanged samples: The behavior of Na⁺, Cd²⁺ and Co²⁺ ions during exchange in the aluminosilicate was determined by neutron activation analysis. Samples of the exchanged zeolites together with reference standards were irradiated in the Nuclear Reactor Triga Mark III as follows: Sodium was determined by irradiating the samples for 1 minute with a neutron flux of $10^{13} \text{ n} \cdot \text{cm}^{-2} \cdot \text{s}^{-1}$. The samples for the determination of cadmium and cobalt were irradiated for 10 minutes with neutron flux of $10^{12} \text{ n} \cdot \text{cm}^{-2} \cdot \text{s}^{-1}$.

Radioactive measurements: $^{24}\text{Na}$ (1.368 MeV), $^{60}\text{Co}$ (1.17 and 1.34 MeV) and $^{111m}\text{Cd}$ (0.247 MeV) were measured with a Ge/hyperpure solid state detector coupled to a 2048 channel pulse height analyzer.

Results and discussion

The composition of the zeolite X, after it was treated with 5N NaCl solution, washed and left in a humid medium to equilibrate with water was as follows:

$$(\text{H}_3\text{O})_{37}\text{Na}_{49}(\text{AlO}_2)_{86}(\text{SiO}_2)_{106} \cdot 319\text{H}_2\text{O}$$

which had a relation Si/Al = 1.2

The quantity of sodium diminished when the zeolite was treated with 5N sodium chloride solution. It has been suggested that ion exchange of Na⁺ by hidronia may occur.³