A. K. LAVRUKHINA, A. A. POZDNYAKOV, S. S. RODIN, and L. P. MOSKALEVA

1960

SovietRxiv

Abstract

Full Text

CHEMISTRY

A. K. LAVRUKHINA, A. A. POZDNYAKOV, S. S. RODIN, and L. P. MOSKALEVA

CHROMATOGRAPHIC SEPARATION OF FRANCIUM FROM CESIUM AND RUBIDIUM

(Presented by Academician A. P. Vinogradov, 19 VIII 1959)

One of the problems in the chemistry of francium that had until recently remained unsolved was that of separating it from cesium and rubidium. The most promising method for separating them is ion-exchange chromatography. However, for these elements the methods of complex-forming chromatography that ensure rapid separation of other elements cannot be applied. All the methods described in the literature for separating cesium and rubidium ($^{1-4}$), based on displacement chromatography, are very time-consuming and not always effective. They cannot be used for separating francium from cesium and rubidium, since the longest-lived isotopes of francium, Fr^{212} and Fr^{223}, have half-lives of about 20 min.

In order to find conditions for a rapid and effective method of separating francium from cesium and rubidium, we studied, under static conditions, the distribution coefficients between the cation exchanger KU-2 and solutions of various electrolytes as a function of their concentration (^{5}). Although on this resin a considerable difference is observed in the distribution coefficients of francium and cesium in hydrochloric-acid solutions, it was not possible to achieve their separation.

Recently B. K. Preobrazhenskii reported (^{6}) that with the aid of the resin KU-1 it appears possible to separate cesium and rubidium rapidly. The resin KU-1 is a bifunctional strongly acidic cation exchanger in which the principal active groups are SO_3H and OH (^{7}). To find the optimal conditions for effective separation of francium, cesium, and rubidium using this cation exchanger, we determined the distribution coefficients between the KU-1 resin and HCl solutions of various concentrations. A resin with a particle size of 200-250 mesh in the H^+-form was used; separate portions of it were previously brought into equilibrium with the solutions under study. Indicator amounts of Fr^{212}, isolated from products of irradiation of Th with protons of energy 660 MeV by the procedure described in (^{8}), were used, as well as 10^{-8}-10^{-6} M solutions of cesium and rubidium containing Cs^{134} and Rb^{86}, respectively. As was determined by preliminary experiments, 5-10 min of shaking the resin with the solution was sufficient to

Fig. 1. Curves of the dependence of the distribution coefficients of Fr, Cs, and Rb between KU-1 resin and HCl solutions on the concentration of the latter

Figure 1: Fig. 1. Curves of the dependence of the distribution coefficients of Fr, Cs, and Rb between KU-1 resin and HCl solutions on the concentration of the latter

Fig. 2. Chromatogram of the separation of Fr, Cs, and Rb with a 5.5 M HCl solution. Flow rate 3 drops/min. 1 $-\beta$-activity; 2 $-\alpha$-activity

Figure 2: Fig. 2. Chromatogram of the separation of Fr, Cs, and Rb with a 5.5 M HCl solution. Flow rate 3 drops/min. 1 $-\beta$-activity; 2 $-\alpha$-activity

establish equilibrium. The β-activities were measured on an end-window counter T-25 BFL, and the α-activities on a scintillation counter with a ZnS(Ag) crystal and an FEU-19 photomultiplier.

The results of the experiments are presented in Fig. 1. A considerable decrease in the value of K_d is observed with increasing HCl concentration up to 5-6 M. In the concentration range 6-11 M, K_d remains practically constant, which is due to partial dehydration of the ions. The greatest difference in the values of K_d for pairs of neighboring elements occurs at HCl concentrations of 5-6 M and in dilute solutions ($\simeq 0.7$ M); the separation factor for francium and cesium, equal to the ratio of their K_d, amounts to-

is, for these concentrations, 2 and 3, respectively. This fact gave us the basis for carrying out experiments on chromatographic separation on a column using the solutions indicated above.

KU-1 resin with a particle size of 200-250 mesh was loaded into columns 13 × 0.3 cm in size and brought into equilibrium with HCl solutions, after which sorption of Fr, Cs, and Rb was carried out from a solution with a volume of 0.05-0.1 ml. In all these operations, including elution, the same HCl concentrations were used.

Fig. 1. Curves of the dependence of the distribution coefficients of Fr, Cs, and Rb between KU-1 resin and HCl solutions on the concentration of the latter.

Fig. 2. Chromatogram of the separation of Fr, Cs, and Rb with a 5.5 M HCl solution. Flow rate 3 drops/min. 1 $-\beta$-activity; 2 $-\alpha$-activity.

Figure 2 presents a chromatogram of the separation of francium, cesium, and rubidium by elution with a 5.5 M HCl solution, which indicates the high efficiency of their separation. The separation time for all three elements, depending on the rate of flow of the solution, is 30-50 min.

Separation of Cs and Rb with a 0.7 M HCl solution was also effective, but required several hours (4-5 h). Therefore, for the rapid separation of francium, cesium, and rubidium, 5.5 M HCl solutions are the most suitable.

Thus, for the first time, the separation of the most active metal in D. I. Mendeleev' s periodic system from its analogs—cesium and rubidium—has been accomplished.

The authors express their gratitude to M. N. Povysheva for assistance in the work.

Institute of Geochemistry and Analytical Chemistry
named after V. I. Vernadsky
Academy of Sciences of the USSR

Received
11 VIII 1959

CITED LITERATURE

1. G. Kayas, *J. Chim. Phys.*, **47**, 408 (1950).
2. W. Brooksbank, G. Leddicotte, *J. Phys. Chem.*, **57**, 819 (1953).
3. S. A. King, *Anal. Chem.*, **28**, 1200 (1956).
4. M. M. Senyavin, *Collection: Isotopes and Radiation in Chemistry*, Publ. House of the Academy of Sciences of the USSR, 1958, p. 186.
5. A. K. Lavrukhina, S. S. Rodin, A. A. Pozdnyakov, Abstracts of reports of the VIII Mendeleev Congress on General and Applied Chemistry, Section of Radiochemistry and Isotope Chemistry, Publ. House of the Academy of Sciences of the USSR, 1958, p. 7.
6. B. K. Preobrazhenskii, Conference on Neutron-Deficient Isotopes of Rare Earths, Joint Institute for Nuclear Research, Dubna, 25 VI–2 VII 1959 (in press).
7. A. B. Pashkov, V. S. Titov, *Zh. Prom. No. 5*, 12 (272) (1958).
8. A. K. Lavrukhina, S. S. Rodin, *Proceedings of the Commission on Analytical Chemistry*, Publ. House of the Academy of Sciences of the USSR, **9** (12), 1958, p. 274.

Note: Figure translations are in progress. See original paper for figures.