Separation of ^{90}Sr and ^{90}Y by Paper Electrophoresis with Very Dilute Hydrochloric Acid Background Electrolyte

By Shoichi KAWAMURA and Masami IZAWA

Chemistry Division, National Institute of Radiological Sciences, Anagawa-cho, Chiba

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Many methods have been employed for the separation of ^{90}Sr and ^{90}Y. One of them is paper electrophoresis, by which ^{90}Sr-^{90}Y have been separated by using lactic acid, ammonia,[1] ammonium acetate or ammonium citrate[2] as background electrolytes. The present paper will report on the successful use of 10^{-3} N hydrochloric acid as the background electrolyte for the separation of ^{90}Sr and ^{90}Y. The use of hydrochloric acid eliminates the trouble of removing the organic ingredient after the extraction of the ^{90}Sr or ^{90}Y fraction from the filter paper.

Experimental

The sample without a carrier was prepared by diluting ^{90}Sr-^{90}Y, obtained from the Oak Ridge National Laboratory, with redistilled water, while the one with a carrier was prepared by adding ^{90}Sr-^{90}Y to Sr or Y ($SrCl_2$ or YCl_3) to make 0.05 M solution. The filter paper used was Tokyo filter paper No. 3 (2×40 cm.) supplied by the Tokyo Roshi Kaisha, Ltd. The sample to be separated was applied at 10 cm. from an end of the paper. After the paper was sandwiched between plastic plates,[3] a d. c. potential of 20 V./cm. was applied to it for 30 min. After drying, the paper was cut into strips 1 cm. in length, and the activity of each strip was determined by a G. M. counter.

The relative distance, R_D, was also determined according to a slight modification of Bermes method.[4] The filter paper was sandwiched between plastic plates and arranged as is shown in Fig. 1. The background electrolyte was allowed to soak through the paper until it reached point B. When the background electrolyte reached this point, the sample to be determined was applied to point A through a hole above A. The background electrolyte was then permitted to continue its flow without the application of a d. c. current until it almot reached the other end of the paper strip, B'. Meanwhile, the sample moved to point A'. R_D was calculated from the following equation.

$$\text{Relative distance, } R_D = \frac{\text{Migrant movement}}{\text{Solvent movement}}$$

The electrosmotic flow was determined by using glucose as an indicator under the same conditions as were employed for the separation of ^{90}Sr and ^{90}Y.

1) T. R. Sato, W. P. Norris and H. H. Strain, *Anal. Chem.*, **26**, 267 (1954).
2) S. Kawamura, *Japan Analyst* (*Bunseki Kagaku*), **10**, 975 (1961).
3) S. Kawamura, ibid., **11**, 814 (1962).
4) E. W. Bermes, Jr., and H. J. McDonald, *J. Chromatog.*, **4**, 34 (1960).

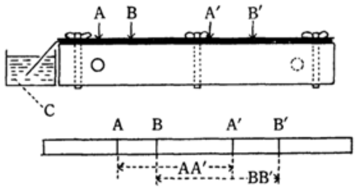

Fig. 1. Arrangement for measuring relative distance, R_D of ^{90}Sr.

$$\text{Relative distance, } R_D = \frac{AA'}{BB'} = \frac{^{90}\text{Sr movement}}{10^{-3}\text{ N HCl movement}}$$

where A : initial ^{90}Sr position, A' : final ^{90}Sr position, B : initial 10^{-3} N HCl front, B' : final 10^{-3} N HCl front, C : 10^{-3} N HCl

Results and Discussion

As is shown in Fig. 2A, the separation of ^{90}Sr and ^{90}Y was accomplished by using 10^{-3} N hydrochloric acid as the background electroyte.

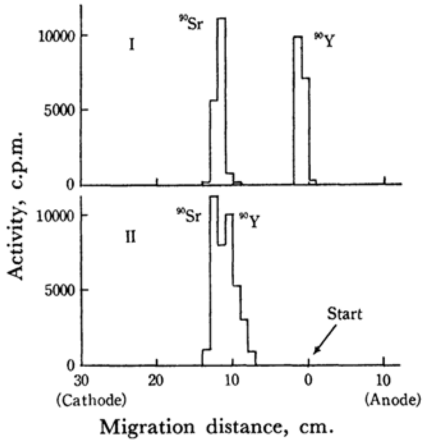

Fig. 2. Electrophoregram (20 V./cm., 30 min.) of ^{90}Sr and ^{90}Y.
I 10^{-3} N HCl II 10^{-2} N HCl

It was difficult to separate ^{90}Sr and ^{90}Y in 10^{-2} N hydrochloric acid, in which Sr and Y migrate at almost the same speed (Fig. 2B). The use of 10^{-1} N hydrochloric acid as the background electrolyte made it impossible to carry out the experiment because of the over-heating of the filter paper. When the hydrochloric acid concentration is reduced to 10^{-4} N, the current through the paper strip becomes negligible; therefore, the use of 10^{-4} N hydrochloric acid made it impossible to carry out the experiment.

In these experiments, the behavior of ^{90}Sr and ^{90}Y without a carrier was almost identical with those of the substances with a carrier. Sr and Y immersed in a filter paper strip migrate toward the cathode against the barrier effect due to the filter paper. In order to determine this effect, the relative distances suggested by Bermes were determined; the results are shown in Fig. 3.

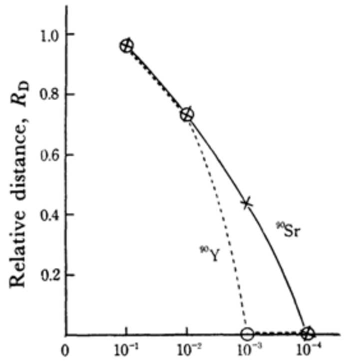

Fig. 3. Relation between relative distance and concentration of hydrochloric acid.

The results shown in Fig. 2A may be explained by the fact that the R_D value of ^{90}Y in 10^{-3} N hydrochloric acid is 0; therefore, the ^{90}Y in the solution remains at the starting point, being absorbed by the filter paper, while ^{90}Sr, on the other hand, migrates to the cathode. The migration distance of ^{90}Sr in a free solution of 10^{-3} N hydrochloric acid at 20 V./cm. was calculated from the above data as follows:

$$A = \frac{B - C}{R_D} = \frac{11 - 2.5}{0.45} = 19 \text{ (cm.)} \quad (1)$$

where

A: the migration distance of ^{90}Sr in a free solution of 10^{-3} N hydrochloric acid

B: the migration distance of ^{90}Sr in 10^{-3} N hydrochloric acid by paper electrophoresis 11 cm.

C: the migration distance due to electrosmosis 2.5 cm.

The migration distance of ^{90}Sr in a free solution is calculated as follows:

$$D = \frac{l_{Sr} \times V \times t}{F} = 22 \text{ (cm.)} \quad (2)$$

where

l_{Sr}: the ionic conductance of Sr, 59.5 coulomb, cm./V.sec.

V: the applied voltage, 20 V./cm.

t: the migration time, 30 min.

F: the Faraday constant

The migration distance in a free solution as calculated from Eq. 1 agreed fairly well with the one obtained from Eq. 2. This means that Sr migrates in the form of a divalent cation in a 10^{-3} N hydrochloric acid-background electrolyte, and that the value of R_D determined is reasonable.