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# SEPARATION OF RADIONUCLIDES BY PAPER ELECTROPHORESIS METHOD*

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ABSTRACT

The aim of this work was to investigate separation of Cs-137 and Ce-144 radionuclides to find out the best conditions by using paper electrophoresis. These conditions were verified with autoradiography and gamma-scanning and gamma spectroscopy. It was found that oxalic acid solution was the best agent for the seperation of Cs-137 and Ce-144 ions.

ÖZET

Bu çalışmada, radyoaktif Cs-137 ve Ce-144 iyonları Kağıt Elektroforezi yoluyla birbirlerinden ayrılmış ve en uygun ayrılma koşulları araştırılmıştır. Ayrılma olayı, otoradyografi ve gama-tarama yöntemlerinin yardımı ve gama spektroskopisi ile bağlantı içersinde incelenmiştir. Cs-137 ve Ce-144 iyonlarının ayrılması için en uygun elektrolitin okzalik asit çözeltisi olduğu bulunmuştur.

## INTRODUCTION

There are many factors effect the separation of ions. In an electric field, velocity of an ion is given by the formula /1/,

$$V = \frac{eE}{6\Pi\eta r}$$

where V is the velocity of the ion
e is the charge of the ion
$\eta$ is the viscosity of the electrolyte
r is the radius of the ion.

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The velocity of ions do not strongly depend on lectrolyte temperature, but the effect of adsorption in cellulose is considerable. The velocity has a close relation with the complex formation of ions. Ion radius and charge are changed by this complex formation and therefore they move slowly in the opposite directions /2/.

Concentrations of the electrolytes were chosen to reach a constant current for an arbitrary constant voltage of 150 V.

The radionuclides were separated with chemical methods. For their localization autoradiography and gamma-scanning and for their identification gamma spectroscopy techniques were used.

## EXPERIMENTAL

The concentration of electrolyte during electrophoresis should be kept constant to prevent current variations. Separation experiments should be carried out under the same conditions for different electrolytes to find out the best electrolyte.

Preliminary experiments showed that 1 Molar lactic acid solution gave a constant current of 1.3 mA at 150 V. The concentrations of other electrolytes were determined under these conditions. The results are given in Table-1. These results lead us to carry out all experiments at 1.3 mA and 150 V.

TABLE-1. Concentration of Various Electrolytes at 1.3 mA and 150 V.

| Electrolyte | Molar Concentration |
|---|---|
| Lactic acid | 1 |
| Chloric acid | 0.018 |
| Oxalic acid | 0.025 |

After the electrophoresis experiments, the localizations of radionuclides in cellulose paper were performed with autoradiography and gamma-scanning techniques. In gamma-scanning technique, radionuclides were identified with their peaks. Autoradiography technique could give a qualitative result about radionuclides, because in this technique, radioactive substances only leave dark spots on the film. The results of one of the experiments carried out are given in Table-2 and Fig.1.

TABLE-2. The results of the experiment carried out with oxalic acid.

| | | |
|---|---|---|
| Electrolyte | : | 0.025 M oxalic acid |
| Separated substances | : | Cs-137, 0.04 ml (2μCi/ml) |
| | | Ce-144, 0.04 ml (1μCi/ml) |
| Current | : | 1.3 mA |
| Temperature | : | 19 °C |
| Duration of experiments | : | 45 minutes |

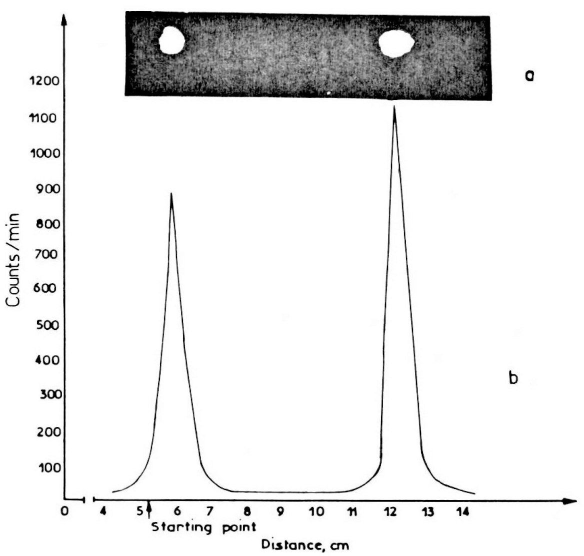


**Fig.1. Localization of radionuclides by a) autoradiography, b) gamma-scanning.**

Slow-moving and fast-moving radionuclides were determined with the gamma spectroscopy method. The pulse height spectrum of the radionuclide samples are given in Fig.2.

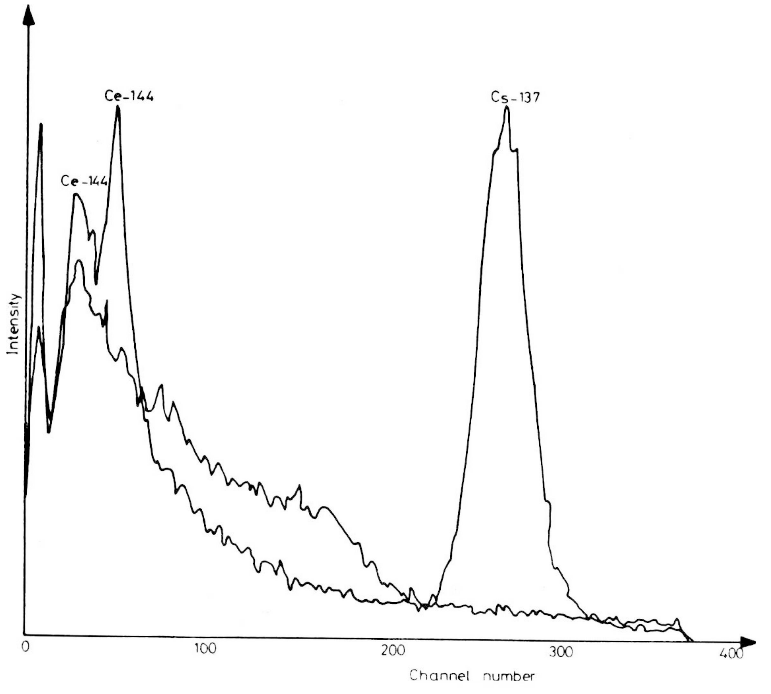


**Fig.2. Gamma Spectra of Radionuclides.**

## RESULTS AND DISCUSSION

When the electrolytes are compared, in Table-3 it is seen that the velocity of Cs is much faster than Ce in oxalic acid solution. Since the velocity separation factor, $V_{Cs}/V_{Ce}$ is 9.3, a good separation was obtained. Alkali metals and metals having more valency form complexes with oxalic acid solution. Alkali metal complexes are soluble in water but others are not. For this reason, most probably $Ce^{+3}$ ions form nonsoluble complexes but $Cs^{+3}$ ions move as free ions or solvated ions.

TABLE-3. Comparison of the velocity of Radionuclides for different conditions.

| Electrolyte | Duration of experiment (min.) | Distance (cm) Cs | Ce | Velocity (cm/h) $V_{Cs}$ | $V_{Ce}$ | $\frac{V_{Cs}}{V_{Ce}}$ |
|---|---|---|---|---|---|---|
| 1 M lactic acid | 60 | 5.5 | 1.7 | 5.5 | 1.7 | 3.2 |
| 0.025 M oxalic acid | 45 | 7 | 0.7 | 9.3 | 1 | 9.3 |
| 0.018 M chloric acid | 35 | 5.7 | 2.5 | 9 | 4.3 | 2 |

Since the velocity separation factor is 3.2 for lactic acid solution it does not show a good separation compared to oxalic acid. This means that $Ce^{+3}$ ions form nonsoluble heavy complexes but $Cs^{+1}$ ions move as free ions or solvared ions.

In hydrochloric acid solution, since $Ce^{+3}$ and $Cs^{+1}$ ions do not form complexes, they move only according to their charge and radius.

All complexes moved towards cathode, so it has been understood that they were carrying positive charges.

Because the radii of complexes are larger than that of free or solvated ions, their weights are also heavier than that of free or solvated ions. Therefore, their speed is less than that of free or solvated ions. Since the solvated ion radius of $Ce^{+3}$ is larger than that of $Cs^{+1}$, the velocity of $Cs^{+1}$ is much faster than that of $Ce^{+3}$ as in hydrochloric acid solution /3/.

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