

## Paper electrophoretic separation of some fission products

Ruthenium-106 has always been found to be one of the most difficult fission products to deal with in fission mixtures<sup>1-3</sup>, because of its wide range of stable valency states (0 to 8) and also because of its great tendency to form a great variety of covalent and coordination compounds. Even in solutions of nitric acid which is well known for its reluctance to enter into covalent linkage with other elements, fission product ruthenium has been shown<sup>3-5</sup> to occur as the nitrosylruthenium radical (RuNO)(III), complexed with nitrate, nitro, hydroxo and aquo ligands. Thus this element forms a series of mononuclear complexes from highly charged anions to the aquo complex with the maximum positive charge, to which stable polymers still add themselves and thus complicate the picture in the separation of fission products. It has been shown<sup>1</sup>, for example, that even the alkali element <sup>137</sup>Cs is contaminated with <sup>106</sup>Ru when it is separated from fission products.

For some time we have been making attempts to find a reaction that would yield a single ionic species of ruthenium, irrespective of its valency and complex state, which could then serve as starting point for a paper chromatographic or paper electrophoretic separation of this element. It was found<sup>6</sup> that the reaction of sodium or potassium nitrite with ruthenium salts is most suitable for this purpose. Simple heating on the water-bath for about half an hour with *N/2* solution of sodium or potassium nitrite in excess (about twice the amount of nitrite necessary to convert all the ruthenium into the hexanitrocomplex) was sufficient to transform all the nitrate- or chlorocomplexes of ruthenium into a single, highly charged (fast moving species in paper electrophoresis) anionic complex.

In the work presented in this paper we have examined the paper electrophoretic behaviour of some principal fission products in *N/2* NaNO<sub>2</sub> solution as electrolyte, in order to investigate the possibility of separating <sup>106</sup>Ru from these products by paper electrophoresis in this electrolyte.

### *Experimental*

The usual glass plate technique of paper electrophoresis described by LEDERER AND WARD<sup>7</sup> was employed. All electropherograms were carried out at 250 V, with *N/2* NaNO<sub>2</sub> as electrolyte on 2.7 × 40 cm paper strips (Papier Arches No. 302), which were sandwiched between two glass plates (8 × 31 cm).

The solutions of the fission products were dried on the water-bath and taken up again with *N/2* NaNO<sub>2</sub> solution. This solution was heated on the water-bath for half an hour and then applied, after cooling, to the paper strip with a micropipette along a previously marked line. After the electrophoresis the paper was dried and scanned, using a 2 mm wide slit. The position of the spots on the electropherograms was also located by autoradiography. Identification of the different elements on the electropherogram of the mixture was carried out by comparing the migration of each element on a separate electropherogram obtained under the same conditions.

### *Results*

Fig. 1 shows a typical electropherogram of <sup>137</sup>Cs, <sup>90</sup>Sr, <sup>90</sup>Y, <sup>95</sup>Zr, <sup>95</sup>Nb, <sup>147</sup>Pm, <sup>144</sup>Ce, and <sup>106</sup>Ru, applied as a mixture on the paper. Since zirconium, promethium, and cerium gave slightly soluble species on heating with *N/2* NaNO<sub>2</sub> solution, these elements were

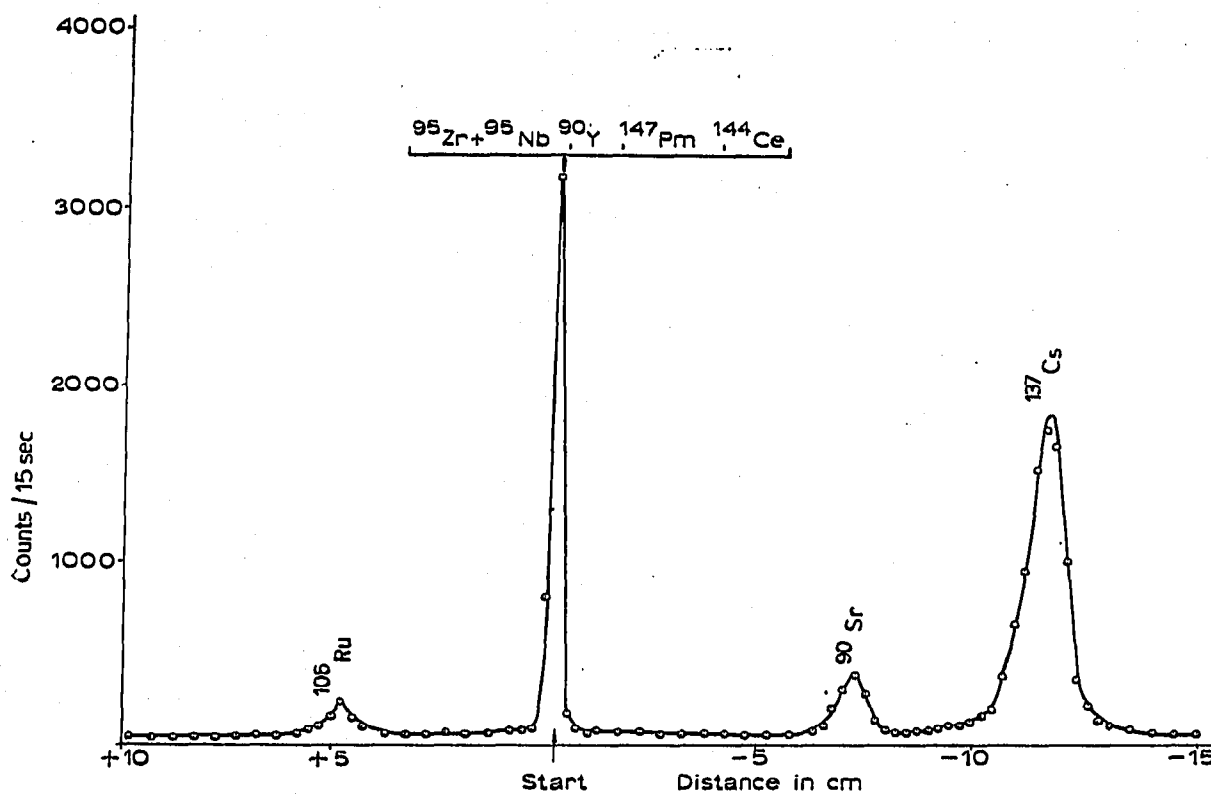


Fig. 1. Electropherogram (250 V; 50 min; electrolyte:  $N/2$   $\text{NaNO}_2$ ) of a mixture of  $^{106}\text{Ru}$ ,  $^{95}\text{Zr}$ ,  $^{95}\text{Nb}$ ,  $^{90}\text{Sr}$ ,  $^{90}\text{Y}$ ,  $^{147}\text{Pm}$ ,  $^{144}\text{Ce}$ , and  $^{137}\text{Cs}$ .

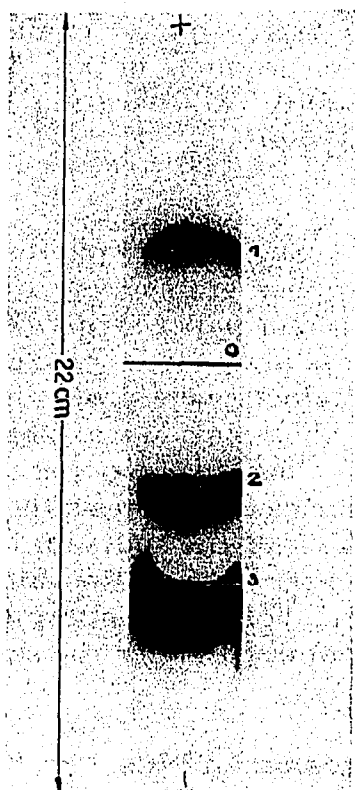


Fig. 2. Autoradiogram of the electropherogram (250 V; 30 min; electrolyte:  $N/2$   $\text{NaNO}_2$ ) of a mixture of  $^{106}\text{Ru}$ ,  $^{90}\text{Sr}$ , and  $^{137}\text{Cs}$ . (1)  $^{106}\text{Ru}$ ; (2)  $^{90}\text{Sr}$ ; (3)  $^{137}\text{Cs}$ .

added to the above mixture without previous heating with sodium nitrite solution. Technetium moves also as an anion but is slower than ruthenium. Fig. 2 gives the autoradiogram of the electropherogram of a mixture of  $^{137}\text{Cs}$ ,  $^{90}\text{Sr}$  (+  $^{90}\text{Y}$ ), and  $^{106}\text{Ru}$ . The autoradiogram was taken after about one month when  $^{90}\text{Y}$ , which stays at the point of application, had already decayed (its half-life is 62 h). A complete separation of  $^{106}\text{Ru}$ ,  $^{90}\text{Sr}$ , and  $^{137}\text{Cs}$  from  $^{95}\text{Zr}$ ,  $^{95}\text{Nb}$ ,  $^{90}\text{Y}$ ,  $^{147}\text{Pm}$ ,  $^{99}\text{Tc}$  and  $^{144}\text{Ce}$  is thus possible by paper electrophoresis using  $N/2$   $\text{NaNO}_2$  solution as electrolyte.

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- <sup>1</sup> A. F. RUPP, *Proc. Intern. Conf. Peaceful Uses At. Energy, Geneva, 1955*, United Nations, New York, 1956, P/314, Vol. 14, p. 68.
- <sup>2</sup> O. E. ZVIAGINTSEV, *Actes Conf. Intern. sur l'Utilisation de l'Énergie Atomique à des Fins Pacifiques, Genève, 1955*, Nations Unies, Genève, 1956, P/670, Vol. VII, p. 196.
- <sup>3</sup> J. M. FLETCHER AND F. S. MARTIN, *Proc. Intern. Conf. Peaceful Uses At. Energy, Geneva, 1955*, United Nations, New York, 1956, P/437, Vol. VII, p. 141.
- <sup>4</sup> J. M. FLETCHER, I. L. JENKINS, F. M. LEVER, F. S. MARTIN, A. R. POWELL AND R. TODD, *J. Inorg. Nucl. Chem.*, 1 (1955) 378.
- <sup>5</sup> P. G. M. BROWN, J. M. FLETCHER, C. J. HARDY, J. KENNEDY, D. SCARGILL, A. G. WAIN AND J. L. WOODHEAD, *Proc. U.N. Intern. Conf. Peaceful Uses At. Energy, 2nd, Geneva, 1958*, United Nations, 1959, Vol. 17, p. 118.
- <sup>6</sup> M. LEDERER AND S. K. SHUKLA, *J. Chromatog.*, 6 (1961) 429.
- <sup>7</sup> M. LEDERER AND F. L. WARD, *Anal. Chim. Acta*, 6 (1952) 355.

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## **Système simple pour création d'un gradient de concentration de la phase mobile**

Le système de deux réservoirs superposés explicité par la Fig. 1 ne nécessite aucun système d'agitation et aucune surveillance en cours de chromatographie. L'installation de ce système sur une colonne à chromatographie ne présente aucune difficulté particulière.

Dans le réservoir supérieur, on place un volume variable de la phase qui induit le gradient. Dans le réservoir inférieur, on place un volume donné de la phase de départ.

L'ordre le plus rationnel des manipulations est le suivant: Remplissage du réservoir supérieur. Création d'un vide partiel à la bouche par l'intermédiaire du bec. Remplissage du réservoir inférieur. Solidarisation hermétique des deux réservoirs par le rodage de jonction. Création d'un vide partiel dans le réservoir inférieur après avoir retourné l'ensemble du système.

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