Preparation of Chromium-51 of a High Specific Activity by the Szilard-Chalmers Process

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High specific activity ^{51}Cr has been prepared by neutron irradiation of electromagnetically enriched ^{50}Cr in a pile¹⁾; but this method offered only a small enrichment factor (about 23). The Szilard-Chalmers process of chromate or dichromate was investigated by Green and Maddock²⁾, and by Kahn, Freedman and Bryant³⁾, and it was found that about 30% and 8% tervalent chromium were formed from chromate, and dichromate, respectively (crystalline in both cases). This effect is applicable to the enrichment of ^{51}Cr but the yield is not very high.

In this paper, the authors studied the preparation of high specific activity ^{51}Cr by the Szilard-Chalmers process of neutron-irradiated, highly stable dye, Palatine Fast Blue GGN (Fig. 1), and succeeded in preparing highly enriched ^{51}Cr with a high yield.

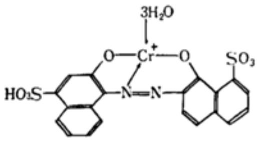

Fig. 1. Palative Fast Blue GGN.

This dye is water-soluble and slightly acid. It has an affinity to an anion- but not to a cation- exchange resin, whilst tervalent chromium is caught by the latter. The present separation is based on this difference.

The dye which was irradiated in the reactor, JRR-1 (neutron flux: 4×10^{11} n/cm² sec.), was dissolved in 0.01 N hydrochloric acid, passed through a resin column (10 mm. $\phi\times100$ mm. of Diaion SK#1, 100—200 mesh), and the column was washed with a sufficient volume of distilled water till the effluent became colorless. Then hydrochloric acid of various concentrations was passed through the column. The ^{51}Cr on the resin was eluted dy this procedure. Elution curve is shown in Fig. 2 in which many peaks appear. As the sample is dissolved in hydrochloric acid, complicated chloro-complexes of chromium may be formed. When the histogram is compared with the elution curves of a few chloro-aquo chromium ions, the first peak in Fig. 2 seems to be ascribed to the dichloro-tetra-aquo, the second to the monochloro-penta-aquo, and the third to the hexa-aquo chromium ion. It is not clear to which chemical forms the fourth and the fifth portion are to be assigned, but they were co-precipitated together with tervalent chromium. Thus 77~83% of the total activity was eluted from the resin in cationic forms.

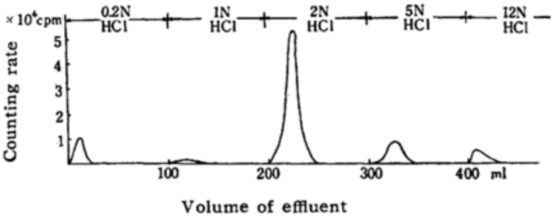

Fig. 2. Elution curve of chromium-51 formed in Palative Fast Blue GGN by hydrochloric acid.

Harbottle⁴⁾ investigated the Szilard-Chalmers process of some tervalent chromium salts, and found that about 10% of the neutron-captured atoms are present in sexivalent form. In the present case, whether tervalent chromium of Palatine Fast Blue GGN is oxidized to sexivalent or not was investigated as follows. Potassium chromate carrier was added to the dye solution which had passed through the cation exchanger, as well as tervalent chromium as hold-back carrier. Lead acetate solution was added to this mixture to precipitate chromate as lead chromate. The activity observed in the procipitates was about 6 to 8% of the total activity. It is considered that this quantity corresponds to that of chromate formed on the present nuclear transformations.

For the preparation of high specific activity ^{51}Cr, it is considered to be convenient to utilize tervalent chromium which is caught by the cation exchanger, because it is difficult to separate the anionic part of chromium from the dye and from the contaminating activities (^{35}S and ^{32}P formed from the sulfonic sulfur).

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1) Oak Ridge National Laboratory; "Radioisotopes, Special Material and Services".

2) J. H. Green and A. G. Maddock, *Nature*, **164**, 788 (1949).

3) M. Kahn, A. J. Freedman and E. A. Bryant, AECU-2329 (1949).

4) G. Harbbottle, *J. Chem. Phys.*, **22**, 1038 (1954).

The solution of neutron irradiated dye is passed through the cation exchanger column, and the column is washed with distilled water sufficiently. Tervalent chromium absorbed on the column is eluted by 200 ml. of 5N hydrochloric acid. Then, sulfric acid is added to the effluent and the mixture is dried up. This must be repeated decompose of micro quantities of organic substances. Then the sample is treated with silver peroxide to oxidise tervalent chromium to chromate. The product is sufficiently pure and impure activities were not detected by the inspection of its γ-ray spectrum and decay curve (by the Geiger tube). The yield is 69 to 75%, and the enrichment factor is 915 for 15 hr. irradiation and is 1150 for 5 hr. irradiation. This preparation method of enriched ^{51}Cr is considered to be useful. And the hot-atom chemistry of chromium complexes of diazo-compounds in detail is to be published at hand.

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