ORNL/TM-5345

Isotope Separations Section Progress Report for Quarter Ending December 31, 1975

E. Newman

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5285 Port Royal Road, Springfield, Virginia 22161
Price: Printed Copy $3.50; Microfiche $2.25

ORNL/TM-5345

Contract No. W-7405-eng-26

CHEMICAL TECHNOLOGY DIVISION

ISOTOPE SEPARATIONS SECTION PROGRESS REPORT FOR QUARTER ENDING DECEMBER 31, 1975

E. Newman

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APRIL 1976

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STABLE ISOTOPE SEPARATIONS

Isotopic separations of mercury, thallium, tin, and ytterbium were continued throughout the quarter, using the twenty-four 180° electromagnetic separators. All separations were conducted on a 24-hr, 5-day-week basis. The mercury and thallium separations, which occupied two and six calutrons, respectively, of an eight-tank segment with common magnetic field, were terminated at the end of December after attaining quantities of ^{202}Hg and ^{203}Tl expected to provide at least a two-year Sales supply. A chlorine isotope separation is planned to replace the mercury-thallium separations in an eight-tank segment beginning in January. This separation is expected to provide $\geq$55 g of >98% ^{37}Cl for Sales and for Research Materials Collection (RMC) replenishment.

At the end of the report period, approximately 70% of the needed ^{112}Sn and 75% of the required ^{168}Yb had been monitored into collector pockets. The ytterbium separation is scheduled for completion at the end of March 1976, while the tin separation is planned to continue until the middle of May 1976.

DEVELOPMENT ACTIVITIES

255^{o} Separator Studies

Since the last report, a study of the characteristics of the 255^{o} separators has been made using SnS, $SnCl_4$, $PbCl_2$, CCl_4, and BCl_3 as charge materials. Two types of ions were collected: Sn^+ from the SnS charge, and Cl^+ from all other charges.

The studies were made to compare two different arc-electrode geometries: the standard 12-in.-radius ion exit slit, and a 40-in.-radius ion exit slit which matches the radius of curvature of the magnetic field at the reference-radius position. The main objective of these studies was to increase the ion current to the receiver while maintaining good isotopic resolution.

System response in the collection of Sn^+ showed a slight ($\sim$15%) preference for the use of the 40-in. geometry over the 12-in. geometry (see Table 1). In the standard geometry, the Sn^+ output was an inverse function of the area of the ion exit slit between limits of 4-1/2 x 3/16 in. and 3 x 1/8 in. However, the Sn^+ output increased only slightly with increased exit-slit area when the 40-in. system was used. The decrease in Sn^+ with decrease in ion-exit-slit length was less pronounced with the 40-in.-radius geometry, indicative of the detrimental effects introduced by the mismatch between magnetic field and ion-exit-slit curvature in the standard system.

In the collection of Cl^+ ions, $PbCl_2$ performed very poorly, yielding less than one-half the Cl^+ output achieved from $SnCl_4$, BCl_3, or CCl_4 feeds. Contrary to the results with Sn^+, a maximum Cl^+ output was achieved with maximum ion-exit-slit area (to the limit of 4-1/2 x 3/16 in.) in

Table 1. Collected ion current as a function of source geometry

Ion collected	Ion-exit-slit area ($in.^2$)	Maximum ion current collected[a] (mA)	
		12-in. geometry	40-in. geometry
Sn^+	3/8	1.7	1.5
Sn^+	13/16	1.0	2.3
Cl^+	3/8	1.1	1.2
Cl^+	13/16	1.4	1.7

[a]Current normalized with 14 mA (average for last collection series using 13/16 sq. in. ion exit slit) being set equal to unity.

both systems. Smaller slits, down to 3 x 1/8 in. in either electrode system, yielded less Cl^+ than was obtained from the 4-1/2 x 3/16 in. slit.

The maximum outputs achieved with Sn^+ and with Cl^+ approach 75 to 80% of calutron outputs with these ions. Although a higher output was achieved from the 40-in.-radius ion-exit-slit geometry, the beam quality (as determined from peak-to-valley current ratios) was reduced during use of this geometry.

At the present time, it might be concluded that the ion output of the 255° system could be marginally improved by conversion to 40-in.-radius source geometry. On the other hand, each system must be carefully optimized with respect to ion-exit-slit size to match the operational characteristics of the particular ion species being separated. One specific problem, the rapid onset of sparking as the ion output is increased, remains to be solved. No changes incorporated thus far have effectively reduced the tendency of the ion source to undergo high-voltage breakdown between the 40-kV positive ion exit slit and the 20-kV negative electrode. This breakdown tendency must be reduced before the capability of the 255° separator can be increased by an appreciable extent.

TARGET PREPARATION BY ION IMPLANTATION

Developmental efforts are continuing to enhance the capability of the 180° sector isotope separator to prepare highly enriched isotopic targets directly for all isotopes without the need to use preenriched charge materials. Efforts are also being made to provide high-purity

material in situ in the directly prepared targets so as to avoid the chemical contamination that often results from electroplating, evaporation, and chemical procedures.

Surface-deposited thin targets of ^{150}Sm (two) and ^{115}Sn (four) were prepared in the sector separator during the quarter. Thicknesses of 25 and 75 $\mu g/cm^2$, respectively, were produced on 90-$\mu g/cm^2$ carbon foils by decelerating the ion beam to 175 to 225 eV. The isotopic purity in each case was estimated to be $\geq$99%, based on contamination factors obtained in earlier separations. These targets were prepared for use in physics research at ORNL.

CHEMICAL PROCESSING

Material in Process

The following elements were in chemical processing during the quarter: mercury, tellurium, thallium, tin, and ytterbium.

Material Added to Inventory

Table 2 identifies the isotopic material that was released or made available to Sales during this report period; the appropriate separation data are also included. In addition to the eight new lots of isotopes released to Sales, 15 loan-return samples were processed and returned to inventory (RMC).

Table 2. Operations status for the period October-December 1975

Isotope	Series	Series Schedule		Hours		Charge material	Recovery (g)	Purity (%)	Requirements	
		Start	Finish	Innage	Tank		Actual	Actual	Grams	Purity (%)
^{40}Ca	NI	1/9/67	7/5/67	27,060	34,104	Ca	40.0[a]	99.991	40	>99.99
^{57}Fe	OQ	6/23/69	2/26/71	61,231	85,128	$FeCl_2$	1.988[b]	42.84	1	40-70
^{120}Te	PS	3/15/74	3/21/75	22,817	27,340	Te	1.136	51.38	1.9	>50
^{120}Te	PS	3/15/74	3/21/75	22,817	27,340	Te	0.563	38.63		
^{122}Te	PS	3/15/74	3/21/75	22,817	27,340	Te	21.089	94.71	90	>90
^{123}Te	PS	3/15/74	3/21/75	22,817	27,340	Te	2.735	85.40	6	>80
^{123}Te	PS	3/15/74	3/21/75	22,817	27,340	Te	12.878	76.67		
^{112}Sn	PZ	6/9/75	c	c	c	SnS	5.155[d]	80.52	30	>75

[a]Partial recovery of by-product material.

[b]Low-quality face-plate sample previously unwanted in inventory.

[c]Series incomplete.

[d]Recovered prior to end of series to fill Sales requests.

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