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UNIVERSITY OF CALIFORNIA

Radiation Laboratory

BERKELEY, CALIFORNIA

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4. XC Calutron

Duano Sowell

Design and Construction

The design of the water cooling system for the calutron and for its associated electrical parts has been completed. This includes systems for two types of treated water with the associated voltage insulating Lapp coils and fittings, as well as a system for circulating hot water. The installation of this piping is proceeding at the present time.

The design is also completed for the magnet coil cooling system. Most of the oil piping and filter system has been fabricated. The heat exchanger is on order and should be delivered some time next month.

The vacuum system is designed and the parts are now being fabricated. Both diffusion pumps have been remodeled and vacuum tested. The large manifold to which the diffusion pumps attach has also been vacuum tested. The gate valves and the pneumatic gate control pistons with the associated equipment are now being installed on the manifold.

The transformers and control panels which will supply 240 and 480 volt power to the building are about eighty percent installed.

The two stainless steel acid tanks and the associated stainless steel piping for the unit washing system are about seventy-five percent installed and should be completed some time this month.

Requests have been made for bids for the completion of the concrete floor in the south end of the building. It is planned to complete this job within the next five weeks.

Development

Model magnet measurements have been made on the existing XC model to determine the shape and size of pole tips that will give a usable field with a seven inch air gap in the tank. It has been found that with the gap reduced to seven inches over a thirty by fifty-four inch area, a usable field of 17,700 gauss can be obtained with a magnet current corresponding to one thousand amps per square inch of conductor on the full scale magnet. The magnet cooling that is now being installed will allow the full scale magnet to be operated continuously at this current.

The forces on the magnet coils at this high field have been measured on the model and were not found to be too large for the present bracing and insulating blocks.

5. JA Calutron

W. L. Whitson

Operation

Two successful runs were made that yielded C^{14} samples of approximately 3 micrograms and 8 micrograms on aluminum backing plates for the use of Prof. Jenkins. The mass deposited was determined by counting beta particles. In the original material the abundance of C^{14} in C^{12} was approximately 3 1/2 percent. The smaller sample was separated from $BaCO_3$ of approximately 1 millicurie C^{14} activity with an efficiency of 1/2 percent. The efficiency was greater for the larger sample for which 2 millicuries of $BaCO_3$ were used.

Proceeding the separation runs considerable effort was made to secure optimum conditions of operation. The vacuum in the tank was improved so that with no gas to the arc the pressure was 3 to 8 x 10^{-7} mm Hg. The operating pressure was 2 to 8 x 10^{-5} mm Hg. Extreme care was taken to eliminate air from the gas leak lines. As a result residual mass 14 current attributed to N^{14} was no more than 10 percent of the total mass 14 current during the C^{14} separation. The arc operated on CO_2 since it had been determined that for the conditions used, chlorine gas was not needed either for arc stability or to maximize the carbon beams. A gas leak system was designed with a rapid switch over from CO_2 derived from dry ice to the limited supply of CO_2 containing C^{14}. It is important to maintain thermal equilibrium in the arc for it was found that any change in pressure or kind of gas in the arc during the switchover decreased the efficiency permanently during the subsequent C^{14} separation run. The relation between the carbon beam current and the design and material of the collector system will be reported separately. Conditions were determined for which the sputtering of carbon at the collector by the beam was minimized.

The mass of C^{14} deposited in each run is shown below.

	E Current											
Run	C^{12}	C^{13}	C^{14}	Mass 14 Residual	Time of Run (min)	Operating Pressure	Vol Active CO_2 (1 atm.)	Leak Rate CO_2	J amps.	J volts	G volts	M volts
1	1.8 ma	-	60 μamp	15 μamp	12	3 x 10^{-5} mm Hg.	30 cc	2.5 cc/min.	1.8	350 vp	17 kv	9.0 kv
2	4.2	20 μamp	85	12	21	5x10^{-5}	60	2.9	3	310	15	8.6

The mass of C^{14} deposited in each run is shown below.

Run	C^{14} Current	Time	C^{14} mass from charge Collected	C^{14} mass from Beta Counts	C^{14} Mass Before Separation	Efficiency
1	60 μ amp.	12 min.	6.3 μ gram	3 μ gram	3.6 μ gram	.5%
2	85	21	15.5	8($\pm$20%)	1.12	.7

Improvements in the vacuum in the JA tank has made the mass separation of radioactive isotope much more successful. It is possible to separate at mass 110 with less than 1 percent overlap between two mass positions as determined by ion current readings. A copper plate which had been bombarded by deuterons in the 184-inch cyclotron was placed in a chlorine arc in the JA unit and the masses 62,63,64 collected using Cu^{65} to monitor the beam. A cu^{65} current of 100 μa was secured for 30 minutes. Activity measurements showed that the separation was satisfactory. Two attempts to collect masses 107-111 have been only partially successful. The current was monitored on Ag^{107} and masses 108,109,110, and 111 were collected. The equipment and technique are adequate and another attempt is to be made. A silver plate bombarded by alpha particles in the 60-inch cyclotron was used.

Development

The problem of collecting carbon on a metal plate from an ion beam of 10 kv energy has been investigated in a preliminary way. Conditions have been determined under which the deposit of carbon on a plate directly in a carbon ion beam can be made to vary from zero (by visual inspection) to more than 50 percent (by activity measurements of C^{14}). The residual deposit depends on the beam current and the design and material of the collection system.

The effect of beam current on the deposit was observed by directing the beam at a flat Al plate at ground potential with no entrant slit definition. A beam of 3 ma at 7 kv impinging on the plate for several minutes left no visible carbon deposit. A beam of 0.7 ma gave a slight discoloration after 2.5 minutes, while a beam of 65 μ amp showed immediate blackening. However the blackening was not proportional to time after the first 3-4 minutes.

In another experiment the beam was passed through a slit in an Al plate and allowed to deposit on a "V" shaped Al collector. (Both the slit and the collector were at ground potential.) Only half the "V" was directly in view of the beam. A beam of 70 μ amp. at 9 kv gave much more blackening on the portion of the collector in view of the beam than was observed for the deposition without the slit. The slit defined the deposit on this part of the collecter and there was no evidence of blackening of the other half. Repeated trials with approximately the same beam current showed no visible sputtering of carbon by the carbon beam onto the adjacent plate. Of course, for large beam currents sputtering of carbon in all directions is evident.

Previous to these experiments a beryllium "V" had been used. Some of the carbon beam deposited directly but more was sputtered to the adjacent half of the "V". When, after a carbon deposit was made, an O^{16} beam was substituted, the carbon in view of the beam was cleaned off and the blackening on the blind half of the "V" greatly increased. Unfortunately the carbon beam current was at an intermediate value so that it has not yet been determined whether the sputtering was characteristic of the material or the beam current.

The problem of collecting material of a given mass on a thin foil has been studied. Since suitable foil material or technique was found which would allow even a minute ion current to be collected at 10 kv, the technique of deleration before collection is being studied. A suitable slit system for deceleration has been built and operated using a C^{12} beam. The interpretation of current measurements is being studied and preliminary work indicates that it will be possible to decelerate beams of low mass ions without too severe a loss in beam strength and to determine the mass deposited from current measurements.

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