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NEUTRON SOURCE PROGRESS REPORT

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NEUTRON SOURCE GROUP

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ABSTRACT

I. Postum-Beryllium Neutron Source

Neutron sources PB-118 and PB-119 were made and shipped to the Schnectady Area, August 30, 1948.

Neutron sources PB-124, PB-125, and PB-126 were made and shipped to Iowa State College, August 31, 1948.

An immersion alpha counter better shielded than the first has been tested. Using an alpha slide, it appeared to have a geometry factor of 10^5.

An arc apparatus has been assembled and some stable beryllium sols prepared. Their use in the preparation of small sources will be investigated.

II. Fluoborate Neutron Source

A simplified evaporation apparatus was built and the conditions for rapid evaporation of postum solutions determined. It will be used in preparing a 35 case mock fission sources.

III. Postum-Lithium and Postum-Sodium Neutron Source

Two postum-sodium sources were prepared by inserting microfoils in molten sodium. They had efficiencies of 112 and 120 per cent.

A postum-sodium source prepared by putting a microfoil in ammonia-sodium complex and evaporating the ammonia had an efficiency of 55 per cent. Approximately 0.2 case of postum dissolved in one ml. of 1.4 N hydrobromic acid. The upper limit of solubility was not determined. A sodium bromide-postum source prepared by dissolving postum in hydrobromic acid and evaporating it from the sodium bromide had an efficiency of 91.2 per cent.

Heating postum-lithium fluoborate sources to 160°C. improved the efficiency by driving off water. Heating to 200°C. decreased the efficiency, but there is no explanation for this as yet.

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DETAILED REPORT

I. Postum-Beryllium Neutron Source - Four Men

A. Preparation of Sources

Two pencil type neutron sources were prepared and shipped to the Schnectady Area on August 30, 1948.

Source PB-118 (JB-21) was prepared by volatilizing the postum on a platinum gauze into a quartz capillary and placing it with 0.4 gram of 230-325 mesh beryllium in a stainless steel container 2.53" x 0.27" O.D. and 2.12" x 0.13" I.D. The container was sealed with nickel and the postum distributed by volatilizing at 800°C. The source contained 5.56 cases of postum and had a neutron count of 1.24×10^7 n./sec. by standard AL-1 on August 27, 1948. This corresponds to an efficiency of 78.1 per cent.

Source PB-119 (JB-22) was prepared in the same manner as PB-118. It contained 6.51 cases of postum and had a neutron count of 1.36×10^7 n./sec. by standard AL-1 on August 27, 1948 for an efficiency of 73.8 per cent.

Three postum-beryllium neutron sources were made and shipped to Iowa State College on August 31, 1948.

It was specified that sources PB-124 and PB-125 should have a neutron flux of 10^2 to 10^3 n./sec. Two pieces of sintered beryllium rod 1/8" in length and 1/16" in diameter were dipped for thirty seconds in a solution containing approximately 50 millicuries of postum. One piece (WS-5) had a neutron count of 1.74×10^3 n./sec. and the other (WS-6) 1.77×10^3 n./sec. The first piece was cut in half and each of these pieces put in brass cylinders 0.12" x 0.12" I.D. by 0.5" x 0.5" O.D. These then had neutron fluxes in the desired range. Source PB-124 had a count of 8.81×10^2 n./sec. and PB-125 a count of 6.75×10^2 n./sec. on August 31, 1948.

Source PB-126 was prepared by placing two microfoils having 0.64 case of postum on August 30, 1948 in a beryllium cylinder 0.5" x 0.5" I.D. by approximately 0.7" x 0.7" O.D. with 1.38 grams of 230-325 mesh beryllium powder. The container was coated with 10 mils of nickel and heated to distribute the postum. The neutron count was 1.72×10^6 n./sec. by standard AL-1, giving an efficiency of 94.3 per cent.

B. Immersion Alpha Counting Tube

Another counting tube has been constructed which is completely shielded. More care was used in its construction to keep ~~the background~~

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count as low as possible. A very brief test showed that the tube would count and that the plateau was in a usable range. Several counts were made with the quartz immersion tube attached, using a slide of $\sim 10^9$ d./min. instead of a solution. The counter registered 3.5 to 4.0×10^3 c./min. The effective count of the slide was $\sim 10^8$ c./min. giving a geometry factor of about 10^5. These data serve only as estimates. Accurate data will be taken when equipment is available.

C. Beryllium Sols

An arc apparatus for the production of beryllium sols was constructed. Vaporized beryllium, produced by the action of an A. C. electric arc between beryllium electrodes in an atmosphere of helium, was dispersed in an organic liquid to form a sol.

Sintered beryllium electrodes two to four millimeters in diameter were made by packing 325 mesh beryllium powder in the properly sized quartz tube and heating under vacuum to 1175°C. to 1200°C. Since quartz has an extremely small temperature coefficient of expansion, the expansion of the powder compresses it tightly in the tube, forming a sintered electrode with a density of approximately 1.40 gram per cubic centimeter and adequate mechanical strength. Upon cooling, the rod shrinks away from the tube, facilitating removal.

An apparatus modified from that of Svedberg (Colloid Chemistry, pp. 40-41) was constructed. A power supply capable of supplying 1000 volts A. C. at one ampere was obtained. It was found that 500 to 800 volts were necessary to strike the arc, while the best running condition was 200 volts at 1-1.5 amperes.

Water, ethyl alcohol, methyl alcohol and carbon tetrachloride were tested as dispersing agents. Water could not be used, since the beryllium vapor reacted with it to produce beryllium hydroxide. Carbon tetrachloride decomposed at the temperatures produced. Satisfactory sols were produced in both ethyl and methyl alcohol. Little sedimentation was produced by centrifuging for thirty minutes. From microscopic examination at 970 diameters it was evident that most of the particles were too small to be resolved clearly, probably less then 0.1 μ in diameter.

In a typical run the arc was operated at 200 volts and 1.25 amperes for thirty minutes. In this time the loss of weight from the electrode was 0.0687 gram, and 0.0271 gram of beryllium was dispersed in 42 ml. of methyl alcohol. The remainder of the beryllium lost from the electrodes was apparently deposited on the interior of the quartz tube enclosing the arc. The dispersed beryllium was recovered by evaporation.

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Future plans include submission of samples of the dispersed beryllium and the beryllium electrodes for spectrographic analysis and investigation of the possibilities of producing small sources from the finely divided beryllium.

II. Fluoborate Neutron Source - One Man

A high vacuum apparatus has been built to be used in preparing low boiling postum compounds. These compounds will be used in preparing neutron sources where the target material decomposes at low temperatures, such as fluoborates and fluoberyllates. The apparatus has been undergoing thorough tests for air leaks.

An order for a 35 case mock fission neutron source has been received. An apparatus has been built to prepare the source by evaporation. Several cold runs have been made on the apparatus. Two hundred and fifty lambda portions of 6 N HCl were added to a platinum tube. The tube was in a brass heating block kept at a temperature of about 87°C. The heating block was in a glass apparatus which could be kept under reduced pressure (approximately 460 mm. of Hg). Heated dry nitrogen kept at about 89°C. was fed into the top of the platinum tube and so directed that the gas stream would strike about half way down the tube. This hot gas prevented refluxing of the evaporating HCl in the tube. The average elapsed time of evaporation with this method for 250 lambda of 6 N HCl was 7.25 minutes. Without the heated gas stream in the tube the same amount of HCl with all other conditions as before evaporated in thirty-seven minutes.

III. Postum-Lithium and Postum-Sodium Neutron Sources - One Man

Two postum-sodium neutron sources (LB-45-0.290 c. 7/28/48 and LB-47-0.403 c. 8/12/48) were prepared by inserting a microfoil into a stainless steel cylinder of molten sodium. Stainless steel, instead of brass, is being used for sodium sources because of the great corrosive action of metallic sodium on brass. The efficiency of LB-45 was 111.7 per cent while that of LB-47 was 119.6 per cent. Both sources were prepared in an atmosphere of dry nitrogen. The active foil of LB-47 was neutron counted in the stainless steel cylinder in order to see if any neutrons were originating from the alpha-neutron reaction on the impurities in the stainless steel. The count was 5.27×10^2 neutrons per second, two per cent of the total neutron count. There are uncertainties in neutron emissions of the elements and in counting which can account for high efficiencies.

Two postum-sodium neutron sources were prepared (LB-46-0.12 c. 8/2/48 and LB-48-0.028 c. 8/13/48) by dissolving the postum in a sodium liquid ammonia solution. The active foil of LB-46 was inserted in the sodium liquid ammonia solution about one minute and then removed. The liquid ammonia was

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vaporized slowly until all of it was volatilized, then the source was capped, heated to 300°C. plus and mixed on the mechanical vibrator. The neutron count was equivalent only to a background. Source LB-48 was prepared in the same manner as LB-46 with the exception that the active foil was inserted into the ammonia-sodium complex and permitted to remain in the source. The efficiency of this source was 55.0 per cent, the highest to date on a metal liquid ammonia source.

Solubility of Postum in N Hydrobromic Acid

A microfoil 0.209 c. 8/23/48, was transferred to 1.0 ml. of 1.4 N hydrobromic acid and allowed to remain in the acid for three hours. Slides were then prepared from the solution and counted on the Logac. At the end of three hours 0.196 c. 8/23/48 had gone into solution (94 per cent of the original activity). From the above data it can be said that postum is soluble in normal hydrobromic acid.

Postum-Sodium Compound Sources

A postum-sodium bromide source was prepared (LB-49-0.394 c. 8/27/48) by dissolving the postum in 1.4 N hydrobromic acid and the evaporating the acid from the sodium bromide. The neutron efficiency was 91.2 per cent.

Work is in progress for the preparation of a sodium compound source by volatilizing postum on to the sodium compound in a quartz capsule.

Effect of Temperature on Efficiency of a Lithium Fluoborate Source

In order to determine the effect of temperature on drying a lithium fluoborate source, a definite plan of neutron counting, heating, and calorimetering was set up. The source (LB-39-1.168 c. 5/28/48) was neutron counted, calorimetered, dried at 150°C.-160°C., neutron counted, calorimetered, dried at 200°C.-210°C., neutron counted and finally calorimetered. Results of these operations are tabulated as follows:

REMARKS	CASE VALUE	NEUTRON VALUE	EFFICIENCY
Calorimeter value when made	1.168 c. 5/28/48	3.34×10^5 5/26/48	62.0%
Calorimeter value 7/28/48	0.861 c. 7/28/48	2.11×10^5 7/28/48	53.7%
By decay from 5/28/48	0.860 c. 7/28/48		53.7%
Drying 48 hrs. 150°C.-160°C.			
Calorimeter value 8/10/48	0.820 c. 8/6/48	2.24×10^5 8/6/48	59.6%
By decay from 7/28/48	0.823 c. 8/6/48		59.7%
Drying 24 hrs. 200°C.-210°C.			
Calorimeter value 8/13/48	0.795 c. 8/12/48	1.87×10^5 8/12/48	51.5%
By decay from 8/10/48	0.796 c. 8/12/48		51.4%
Drying 18 hrs. 150°C.-160°C.			
By decay from 8/13/48	0.775 c. 8/17/48	1.82×10^5 8/17/48	51.4%

Each time the source was calorimetered the decay value from the previous calorimeter value was calculated and tabulated for purpose of comparing. In each case the decayed value checked the calorimeter value. The efficiency increased after being dried 48 hours at 150°C.-160°C., this was probably due to losing moisture since lithium fluoborate is very hygroscopic. The decrease in efficiency after being heated 24 hours at 200°C.-210°C. cannot be explained. It was thought that the last neutron count might have been in error, a second neutron count, five days later, checked the efficiency of the previous count. From the above data it would appear that no activity is lost by heating sources at 200°C-210°C. while drying.

JLR/rcc