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NEUTRON SOURCE GROUP


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<th>Man-Months</th>
<th>Job Classification</th>
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ABSTRACT

1-A. Postum-Beryllium Neutron Sources

Sources of 8.1 and 9.73 cases were prepared and shipped to Oak Ridge National Laboratories and Carbide and Carbon Chemicals Corporation, Oak Ridge, respectively.

Sources of 7.64 and 7.17 cases were prepared and shipped to the Chalk River Laboratory, Ontario, Canada.

An attempt was made to prepare a source from flocculated beryllium sol by the volatilization method. Excessive pressure developed and burst the can. The most probable cause of the pressure was adsorbed water vapor.
Calculations are given showing the pressures that may be developed from water vapor, postum, and nickel carbonyl.

Two types of immersion alpha counters are described. One of these had a plateau and counted about 25,000 counts per minute in a solution containing 0.025 c./ml. The other had no plateau. Two new counters are under construction incorporating the best features of the counters tested.

II-B

Nothing to report.

II-C

Nothing to report.

II. Engineering Study of Dryboning and Shielding

Preliminary designs were made for remote control of an apparatus for decomposition of nickel carbonyl and an apparatus for general mechanical manipulations.

III. Neutron Counting

Equipment is still being assembled. Special high melting paraffin has been ordered for a Hanson counter.

DETAILED REPORT

I-A. Postum-Beryllium Neutron Sources

1. Sources for Shipment

A total of four sources was prepared this month.

PB-112

A postum-beryllium source, PB-112, was prepared for shipment. A platinum gauge with 8.51 cases of postum on November 1, 1948 was coated with nickel until a zinc sulfide screen ceased to glow when placed near the
gauche. This gauge, along with 1.235 grams of 230 - 325 mesh beryllium powder, was placed in a beryllium right cylinder with an I.D. of 0.50" x 0.50" and C.D. of 0.650" x 0.650". The container was coated with nickel and heated to volatilize the postum through the nickel on the gauge into the beryllium powder. The source had a count of $1.25 \times 10^7$ n/sec. by standard 49 and $1.45 \times 10^7$ n/sec. by standard AL-1. The calorimeter value was 8.10 cases on November 5, 1948, so that the efficiency by AL-1 was 63 per cent.

The source was shipped November 10, 1948 to Oak Ridge National Laboratories.

**PB-131**

A postum-beryllium source, PB-131, was prepared for shipment. This source was prepared exactly as PB-112 was prepared.

<table>
<thead>
<tr>
<th>Grams of Beryllium</th>
<th>1.2355 grams</th>
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<tbody>
<tr>
<td>Cases of Postum</td>
<td>11.23</td>
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<tr>
<td>Neutron Count</td>
<td>$1.929 \times 10^7$ n/sec. by AL-1</td>
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<tr>
<td>Calorimeter Value</td>
<td>9.73</td>
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<tr>
<td>Efficiency</td>
<td>70 per cent</td>
</tr>
</tbody>
</table>

On November 10, 1948 the source was shipped to Carbide and Carbon Chemicals Corporation at Oak Ridge.

**PB-132**

A postum-beryllium source, PB-132, was prepared for shipment.

The source was prepared with the same manner as PB-112.

<table>
<thead>
<tr>
<th>Grams of Beryllium</th>
<th>1.352 grams</th>
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<tbody>
<tr>
<td>Cases of Postum</td>
<td>3.10</td>
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<tr>
<td>Neutron Count</td>
<td>$1.09 \times 10^7$ n/sec. by AL-1</td>
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<tr>
<td>Calorimeter Values</td>
<td>7.64</td>
</tr>
<tr>
<td>Efficiency</td>
<td>5.3 per cent</td>
</tr>
</tbody>
</table>
PB-133

A postum-beryllium source PB-133, was prepared for shipment. The source was prepared in the same way as PB-112 was prepared.

<table>
<thead>
<tr>
<th>Grams of Beryllium</th>
<th>1.4128 grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cases of Postum</td>
<td>8.01 November 11, 1948</td>
</tr>
<tr>
<td>Neutron Count</td>
<td>$1.49 \times 10^7$ by AL-1</td>
</tr>
<tr>
<td>Calorimeter Value</td>
<td>7.17 November 19, 1948</td>
</tr>
<tr>
<td>Efficiency</td>
<td>65 per cent</td>
</tr>
</tbody>
</table>

On November 23, 1948 this source and PB-132 were shipped to the Chalk River Laboratory, Ontario, Canada.

2. Sources from Beryllium Sol

Source, H-3, was made by flocculating a beryllium sol in CH$_3$OH with 90 v. D.C. simultaneously with depleting postum from the anode. The flocculated beryllium was then filtered into a sintered beryllium can 5/32\" in diameter and 1/2\" high. The neutron count was $1.382 \times 10^5$ n./sec. and the calorimeter value 0.1676 case, corresponding to an efficiency of 27.2 per cent. Due to the difficulties in obtaining satisfactory filtration and the low efficiency obtained this method was temporarily abandoned.

An attempt was made to make source H-4 by the volatilization method using beryllium powder obtained by evaporating beryllium sol. A microfoil containing 0.420 c. was placed in a cut-down platinum microfoil calorimetry can. The can was then packed with the fine beryllium powder closed and coated with 15 mils of nickel by Ni(CO)$_4$ deposition. The neutron count after sealing was $6.90 \times 10^4$ while the calorimeter value was 0.410 c. The can was 0.419 cm. in diameter and 0.500 cm. in height before sealing with nickel. Upon attempting to volatilize postum the can apparently developed excessive internal pressure and exploded.

An attempt was made to evaluate the possible causes of excessive internal pressure:

1. Pressure in the can at time of sealing. It is possible that there might have been up to 100 mm. pressure in the can when sealed. This would expand to produce 394 mm. pressure at 900\degree C., the maximum volatilization temperature. This alone should not be sufficient to cause it to explode.
2. Pressure due to vaporization of postum. Assuming gaseous postum to form a diatomic molecule the amount of postum in the source volatilized in the free volume in the source would produce 0.66 atmospheric pressure at the boiling point of postum. This in itself or in combination with the residual pressure should be insufficient to cause the source to explode.

3. Pressure due to vaporization of water vapor adsorbed on the finely divided beryllium particles. Inasmuch as the source was placed in the apparatus, pumped down, and nickel deposition started rather rapidly, it is quite probable that very little of the adsorbed water vapor was removed before sealing, especially considering that the beryllium powder was tamped down tightly into a pellet and there was a fairly long leakage path past the cover of the can. Assuming that the particles were 500 Å in diameter (from electron microscope photos) and that there was a monomolecular layer of water molecules adsorbed on the powder particles, there could have been sufficient water vapor present to produce 94.9 atmospheric (1395 p.s.i.) pressure upon heating to 900°C. This is believed to be the reason for the explosion.

In order to prevent recurrence of the explosion with source H-5 which is being made in a similar manner to H-4 the source was pumped down 36 hours in the vacuum apparatus during 15 hours of which the source was being heated slightly with the induction heater, before nickel deposition was begun. This should have removed water vapor.

Application of above data to standard sources:

1. Pressure at time of sealing would be the same as for the small source - possibly 394 mm. (0.5 atm.) at 900°C.

2. Pressure of postum 0.485 atm./case at 950°C. (boiling). If the source contained 10 cc, the pressure would be 4.85 atm. (71 p.s.i.); or for 50 cc., 24.2 atm. (335 p.s.i.) enough to be definitely dangerous.

3. Water vapor. If source was filled with 230 - 320 mesh beryllium powder with an adsorbed monomolecular layer of water the pressure due to water vapor at 900°C would be 0.83 atm. (12.2 p.s.i.) or not enough to be dangerous in itself.

3. Immersion Counting Tube (Solution Counting Tube)

A drybox has been constructed and is in use. An I.D.I. scaler (Model 162) has been obtained for use in this work. All necessary construction and adaptation has been made and the set-up is operating.
The counting tube mentioned in the Neutron Source Progress Report, August 1-31, 1948, MIV-178, was tested in solution. It definitely had a good plateau, and the background was approximately 192 c./min. The solution used was 6 N HCl containing ~0.25 c./ml. This solution counted about 25,000 c./min.

The window of the immersion tube was broken during a mechanical cleaning operation. This means that only solutions should ever touch the window. The tube was hopelessly contaminated by the break.

Another immersion counter has been made with different design. It employed a single-window quartz tube 2 cm. long, the open end of which entered the counter on the side, thus permitting methane to enter the quartz tube. A tall glass cup with bottom drain at the side and a hole in the center of the bottom to slip over the quartz tube was sealed on with De Khotinsky cement. The cup was filled with the liquid to be counted and drained off after the count was taken. The inside of the cup and the quartz window were rinsed with 6 N hydrochloric acid and dried with acetone. Single drops can be counted by this method if evaporation can be prevented. The thickness of the window and the two centimeters of dead methane were so chosen to give an appreciable path inside the counter.

This counter did not have a plateau. The ions formed in the short quartz tube were collected in greater and greater degree as the voltage was increased. It is very improbable that a counter of this design would ever have a plateau.

Sections I-B, I-C, II, and III - see Abstract.

JLR/MIV