CRITICAL MASSES OF SPHERICAL SYSTEMS
OF ORALLOY REFLECTED IN BERYLLIUM

H. Robert Ralston

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ABSTRACT

The critical thickness of beryllium reflector was determined for oralloy (uranium, enriched to 93.17% \(^{235}U\)) spheres ranging from 10.765 kg to 32.654 kg. Four points which were determined by other experimenters were normalized to the data and are included in the curves.
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Introduction

The critical thickness of beryllium reflector was determined for oralloy spheres ranging from 10.765 kg to 32.654 kg.

The critical thicknesses of beryllium in all cases was determined by extrapolating the inverse leakage multiplication to zero, at which point the corresponding beryllium thickness is that which will be required to bring the assembly to delayed critical. No assembly was operated at critical since the control system used did not permit a multiplication in excess of 100. Four points on a core mass vs reflector thickness curve for beryllium were determined by other experimenters and are included in the table of data as indicated. All of the data that is presented in Fig. 1 has been corrected to a U\(^{235}\) concentration of 93.17% and an oralloy density of 18.6 g/cc in accordance with the following relationships: U\(^{235}\) critical mass \(\propto (U^{235} \text{ concentration})^{-0.7}\) and U\(^{235}\) critical mass \(\propto (\text{oralloy density})^{-x}\).

Values of x as a function of beryllium thickness are given in Fig. 2 (25 cm of Be is considered to be infinite for purposes of the plot). The material that was used at this laboratory was composed of a central sphere of oralloy which contained a 7/16-inch spherical cavity in its center for the inclusion of a PoBe neutron source. The over-all worth of this missing material has been assumed to be six times the amount of material which was removed.

Experimental Procedure

The oralloy used consisted of hemispherical nesting shells which allowed 10.765-kg, 16.267-kg, 21.780-kg, 27.991-kg, and 32.654-kg spheres to be constructed. The beryllium reflector consisted of a similar set of nesting shells which allowed reflector to be added in approximately 0.25-inch steps.
The maximum allowable multiplication for the particular control system was 100. Since the beryllium thickness was variable only in discrete steps, some of the assemblies had to be stopped at relatively low multiplications because the next available beryllium thickness would have caused the multiplication to exceed 100. The lowest multiplication was 29, which corresponds to an accuracy of extrapolation to critical of about 3.5%.

The counting equipment consisted of two CH₂-moderated LiI, scintillation counters and two Hanson-Mckibben-type BF₃ proportional counters. A PoBe source supplied neutrons to the assembly and served as a calibration standard for the counters.

Results

The data is summarized in Table I and shown graphically in Fig. 1. The limits of error are also shown in Table I.

Table I. Summary of Results

<table>
<thead>
<tr>
<th>%U²³⁵</th>
<th>Oy (g/cc)</th>
<th>Mₗ Oy (kg)</th>
<th>Corrected Mₗ Oy (kg)</th>
<th>Be critical thickness (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>93.17</td>
<td>18.49</td>
<td>10.765</td>
<td>10.6*</td>
<td>7.98 ± .16</td>
</tr>
<tr>
<td>93.5(1)</td>
<td>18.8</td>
<td>15.1</td>
<td>15.4*</td>
<td>4.0</td>
</tr>
<tr>
<td>93.17</td>
<td>18.58</td>
<td>16.267</td>
<td>16.187*</td>
<td>3.65 ± .07</td>
</tr>
<tr>
<td>93.5(1)</td>
<td>18.8</td>
<td>22.3</td>
<td>22.8*</td>
<td>2.0</td>
</tr>
<tr>
<td>93.17</td>
<td>18.59</td>
<td>27.991</td>
<td>27.911*</td>
<td>1.285 ± .013</td>
</tr>
<tr>
<td>93.5(1)</td>
<td>18.8</td>
<td>31.2</td>
<td>31.9*</td>
<td>1.0</td>
</tr>
<tr>
<td>93.17</td>
<td>18.59</td>
<td>32.654</td>
<td>32.574*</td>
<td>0.875 ± .026</td>
</tr>
<tr>
<td>93.8(1)</td>
<td>18.8</td>
<td>51.3</td>
<td>52.4*</td>
<td>0.000</td>
</tr>
</tbody>
</table>

* Corrected to a U²³⁵ concentration of 93.17% and an oralloy density of 18.6 g/cc, as indicated in the text.

# Corrected for a central source cavity 7/16 inch in diameter, assuming a central material worth of 6 times the mass removed.

Fig. 1. Oralloy mass vs beryllium reflector for delayed critical spherical assemblies. Oralloy density = 18.6 g/cc; oralloy concentration of U$^{235} = 93.17\%$; beryllium density = 1.84 g/cc.
Fig. 2. Values of $x$ vs beryllium reflector thickness in the relationship, $\text{U}^{235}$ critical mass $\propto (\text{Oy density})^{-x}$. (Data supplied by L. S. Germain of UCRL-Livermore).