SUMMARY OF KNOWN CRITICAL MASSES OF 25 AND 49

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The following tables summarize our present knowledge of the critical masses of active materials in various configurations. By critical mass is meant the amount of active material (25 or 49) required to produce a chain reaction which will just maintain itself on all the neutrons (including the delayed) emitted in fission. The figures quoted have been experimentally determined whenever possible; where theoretical figures are the only ones available, an attempt is made to include a configuration which has also been investigated experimentally and for which the theoretical value has been calculated in the same way. Unless otherwise stated, the core of active material is spherical in shape.

In cases where it has not been possible to assemble enough material to reach criticality, the maximum amount of material assembled is given and, if measured, the multiplication of the assembled configuration is included. The multiplication, $M$, of an assembly may be connected with the multiplication constant, $k$ ($k = 1$ is critical), by the formula

$$M = \frac{1}{1-k}.$$  

The tables run from the case of complete hydration (water boiler) through the hydrides to metal assemblies containing no hydrogen in the core of active material. In the case of metal dispersed in a hydrogenous medium, the mass of metal effective in producing a water boiler has been found to be approximately that contained in a surface layer of thickness equal to a quarter of the mean free path of thermal neutrons in the metal ($\lambda/4$ equals approximately $0.01 \text{ cm}$ in 25 metal of density 18.8 and $0.005 \text{ cm}$ in 49 metal of density 19.4).
The figures quoted represent the work of many individuals and groups; references to reports in which the experiments have been discussed in detail are given wherever such reports are available.
25 CRITICAL ASSEMBLIES

CORE COMPOSITION

\[ \text{UO}_2 \text{SO}_4, 14.7\% \text{ in } 15 \text{ liters H}_2\text{O solution} \]

TAMPER

\[ \text{BeO, 1 ft thick, density 2.7 gms/cm}^2, \text{ effectively infinite} \]

CRITICAL MASS OF 25

565 gms

COMMENTS

Low-Power Water Boiler (Lo Po) (IA-134)

\[ \text{UO}_2\text{(NO)}_2, 14.7\% \text{ in } 13.6 \text{ liters same conditions as Lo Po except for the nitrogen} \]

\[ \text{H}_2\text{O, effectively infinite} \]

760 gms

Lo Po extrapolation (IA-134)

\[ \text{BeO, density 2.7, effectively infinite} \]

1200 ± 50 gms

Lo Po extrapolation (IA-244)

The measured value of the critical mass of the High Power Water Boiler (Hi Po) is 806 gms. This is for a 25 concentration of 14.0% and includes the effect of a cooling coil, a central empty tube, and a thicker wall than was used in the Lo Po (the net effect of these additions corresponds to about 130 gms of 25). By courtesy of L.P. King and Group F-2

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Pure 25 in H\text{O} solution

11.4 liters

H\text{O}, infinite tamper

600 gms

Calculated, Christy (LAMS-18)

Pure 25 in H\text{O} solution

18.3 liters

None

1500 gms

BeO, density 2.7, thick tamper

1.4 kg

All the hydride experiments were performed by Group G-1 under the supervision of Holloway. The active material was in the form of \( \frac{1}{2} '' \) cubes of UH\text{10} of density 3. The rest of the hydrogen was introduced as polyphene. The self absorption effects for this high hydrogen concentration were rather large. For a homogeneous mixture, the critical mass is probably much closer to 1 kg.
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CORE COMPOSITION

Tu, infinite
BeO, density 2.7, infinite
9.4 kg
9.6 kg
8.4 kg
8.5 kg
7.6 kg
7.0 kg
6.2 kg
6.0 kg
5.5 kg
5.3 kg
3.3 kg
2.9 kg
2.65 kg
2.3 kg
1.5 kg

Fe, density 7.8
4.0 kg
3.4 kg
3.0 kg
2.7 kg
2.4 kg
2.1 kg
2.0 kg
2.0 kg
1.8 kg
1.7 kg
1.5 kg
1.4 kg
1.25 kg
1.1 kg
1.0 kg
0.9 kg

Cu, density 11.0
Perfect

BeO, density 2.7
Thick tamper; Cu between core and tamper
12" tamper thickness
6" tamper

BeO, density 2.7
Thick tamper

2.5 CRITICAL ASSEMBLIES (Cont.)

COMMENTS

Calculated value 6.0 kg (LAMS-201)
Calculated value 4.5 kg (LAMS-201)
Calculated value 2.97 kg
Calculated value 2.76 kg

There are no experiments on UH-5 and values are calculated by Feynman and his group (LAMS-419)