γ-uranium, the stable modification of the element at high temperatures, is body-centred cubic with a space lattice constant = 3·48 Å at 785°C.(11) This corresponds to a density = 18·78 g/cm³ at 785°C. At the melting point of U, = 1133 ± 2°C or 1406°K,(11) the density of the solid = 18·39 g/cm³, based on a linear coefficient of thermal expansion = $1{\cdot}92 \times 10^{-5}$/°K. *Assuming*, as is true for a number of metals, a volume increase on fusion = +2·5 per cent, the density of *liquid* uranium, at the melting point, should equal: 17·92 g/cm³, or have $V_A = 13{\cdot}28$ cm³/g atom. ANDRADE's formula for η at the melting point (see p. 333) applies to uranium, since it is body-centred cubic and leads to the value:

$$\eta_{\text{m.p.}} = \frac{5{\cdot}7 \times 10^{-4} \,.\, \sqrt{(238{\cdot}07 \,.\, 1406)}}{13{\cdot}28^{2/3}} = 5{\cdot}86 \times 10^{-2} \text{ poise}$$

$$= 5{\cdot}86 \text{ centipoise at } 1406°\text{K}.$$

The *interpolated* activation energy, H_η for a metal melting at 1406°K., from Fig. 2, = 4300 cal/g atoms. Thus the viscosity of liquid uranium, η_u,

$$\eta_u = a \,.\, \exp\,(4300/RT).$$

At the melting point or 1406°K.

$$\eta_u = 5{\cdot}86 \times 10^{-2} = a \,.\, \exp\,(4300/1{\cdot}99 \,.\, 1406)$$

and thus the constant a for uranium,

$$a = 12{\cdot}62 \times 10^{-3} \text{ poise}.$$

The final Andrade equation becomes:

$$\eta_u = 12{\cdot}62 \times 10^{-3} \,.\, \exp\,(4300/RT) \text{ poises}.$$

ε-plutonium, the high temperature modification, at 500°C., is body-centred cubic.(14) The same is true(15) for thorium. Thus the ANDRADE relationship (see p. 336) applies to both metals.

TABLE 2.—PHYSICAL CONSTANTS OF LIQUID URANIUM, PLUTONIUM AND THORIUM(12)

	A	$T_{\text{m.p.}}$ (°K)	$D_{\text{Liq. at m.p.}}$ (g/cm³)	V_A [illegible]	H_η (cal/g atom), from Fig. 2.	η, (centipoise) at m.p.	at 2000°K.
U	238	1406	17·92 (est.)	13·28	4300	5·88	3·71
Pu	239	912·7	16·639(13)	14·36	3200	4·51	1·72
Th	232	2020	10·79 (est.)	21·55	5300	5·04	—

(11) J. KATZ and E. RABINOWITCH, *National Nuclear Energy Series, The Chemistry of Uranium*, Div. VIII, Vol. 5, pp. 133–152. McGraw-Hill, New York (1951).
(12) See J. J. KATZ and G. T. SEABORG, *The Chemistry of Actinide Elements*. J. Wiley, New York (1957).
(13) C. E. OLSEN, T. A. SANDERNAW and C. C. HERRICK, Report LA-2358 (1959); in contrast to most other metals plutonium contracts on melting.
(14) J. J. KATZ and G. T. SEABORG, *The Chemistry of Actinide Elements*, pp. 266–267. J. Wiley, New York (1957).
(15) J. J. KATZ and G. T. SEABORG, *The Chemistry of Actinide Elements*, pp. 28, 29 and 30. J. Wiley, New York (1957).