



Fig. 1 (left). Dynamic viscosities of sodium and potassium in the form of an Andrade plot (8). Fig. 2 (right). Experimental and calculated viscosity of sodium from the melting point to the critical point.

We proceeded as follows. First we correlated all available liquid  $\eta$ -measurements over the whole experimental temperature range (6) by using Andrade's so-called II-equation (8), that is,

$$\eta v^{1/3} = A e^{c/T}, \quad (1)$$

where  $A$  and  $c$  are constants of a particular liquid,  $\eta$  (in poises) being its viscosity and  $v$  (in  $\text{cm}^3/\text{g}$ ) its specific volume at the temperature  $T$  in degrees Kelvin. A plot of  $\log(\eta v^{1/3})$  versus  $1/(vT)$  is a straight line.

The data for  $\eta$  and  $v$  for liquid sodium were taken from Sittig's monograph (9), from the chapter on carefully evaluated physical properties of sodium. For  $\eta$  of liquid potassium we depended primarily on the measurements of Ewing *et al.* (1, 2) up to approximately  $800^\circ\text{K}$  and on those of Lemmon *et al.* (3) from approximately  $800^\circ$  to  $1400^\circ\text{K}$ ;  $v$  or  $D$  (its density), up to about  $1500^\circ\text{K}$ , are from Ewing *et al.* (3). The densities beyond the experimental up to the critical point were estimated as described earlier (5, 7).

When the II-Andrade equation had been set up from the experimental data, it was extrapolated to the critical point and values of viscosity were calculated at set temperatures. All of the experimental data and the variables—that is,  $\eta v^{1/3}$  and  $1/(vT)$  calculated and  $\eta$  and  $v$  data estimated—

are tabulated in Tables 1 (for Na) and 2 (for K).

The two II-Andrade equations—that is, for K and Na—are plotted in Fig. 1; both Na and K, like Hg and most other liquids, follow the relationship demonstrated by Andrade's second (II) equation. Since Andrade showed that this relationship holds up to the critical point, we also extrapolated the Na- and K-lines to their respective critical temperatures ( $\times D_{\text{crit}}$ , or critical density). The extrapolated range, because of the

nature of the Andrade equation, is very short compared to the experimental range. The viscosities (see column 2 of Tables 1 and 2) up to the critical point were then calculated from the values of  $(\eta v^{1/3})$ , as read off a large-scale plot of Andrade's straight line, and the estimated  $v$  (or  $D$ ) of Na and K, respectively (see column 3 of Tables 1 and 2).

Both the experimental and calculated viscosities of Tables 1 and 2 are plotted against  $T$  in Figs. 2 and 3. The lower curves in these figures are for the viscosity of the saturated vapor, in equilibrium with the liquid metal. No experimental data on these viscosities are available, to our knowledge; work was stopped on this program at Battelle (see 3, p. 58). Fortunately, metal vapors can be expected to behave as the simple kinetic theory predicts (see 10), at least in the low temperature range, thus

$$\eta_{\text{sat vap}} \text{ (in poises)} = 2.6693 \times 10^{-5} \sqrt{AT/\sigma^2} \quad (2)$$

Table 3. Viscosities of saturated vapor ( $\eta_{\text{sat vap}}$ ) of sodium and potassium at set temperatures, calculated with the use of Pauling's diameter of the sodium atom, 3.46 Å, and potassium atom, 4.374 Å, in centipoises.

$T$ ( $^\circ\text{K}$ )	Na	K
400	0.021 <sub>s</sub>	0.017 <sub>s</sub>
1000	.033 <sub>r</sub>	.027 <sub>n</sub>
1600	.042 <sub>r</sub>	.034 <sub>n</sub>
2500	.053 <sub>z</sub>	

Table 4. Absolute  $\eta_{\text{crit}}$ , in micropoises ( $\mu\text{p}$ ) (14) of various substances.

Noble gases	$\eta_{\text{crit}}$ ( $\mu\text{p}$ )	Hydrides	$\eta_{\text{crit}}$ ( $\mu\text{p}$ )	Oxides and chlorides	$\eta_{\text{crit}}$ ( $\mu\text{p}$ )
He	25.4	H <sub>2</sub> O	495	CO <sub>2</sub>	334
Ne	156	CH <sub>4</sub>	159	SO <sub>2</sub>	411
Ar	264	<i>n</i> -octane	259	CCl <sub>4</sub>	413
Kr	396	NH <sub>3</sub>	309		
Xe	490				