

and reduced temperature, $T_{\text{red.}}$ ($= T/T_{\text{crit.}}$). It is also useful to compare graphs of these reduced variables of metals with various other substances for which similar information is available.

In the well-known book of HOUGEN and WATSON on *Chemical Process Principles*, WATSON presents,⁽⁶⁾ as part of his extremely useful correlation of many properties of substances in terms of reduced variables, also the reduced viscosity⁽⁶⁾ vs. reduced temperature (see Fig. 175, *loc. cit.*, p. 871); he states, "This relationship is based on consideration of all available data on the variation of viscosity with temperature and pressure in both the liquid and gaseous states. It is approximately the same for all substances."

In recent years CODEGONE⁽⁷⁾ developed Watson's concepts further and extended them to other properties such as thermal conductivity. He specifically uses liquid mercury as an example of a metal which conforms to the Watson viscosity relationship.

We have seen, however, that metals do not always fit, in view of the very nature of the metallic bond, correlations which do fit many other substances. Thus, for example, the critical temperatures of metals^(5,8) are 2.5-4 times higher than their N.B.P., whereas for all van der Waals liquids⁽⁹⁾

$$T_{\text{crit.}} \simeq 1.75 \cdot T_{\text{N.B.P.}}$$

Therefore, pertinent investigations should be made whether metals, as a class, *do* or *do not* follow a particular relationship. A large volume of experimental information is available over the whole liquid range—from the melting point to the critical point—for many properties of homopolar compounds, such as hydrocarbons (and recently fluorocarbons), CCl_4 , CO_2 , SO_2 , the nonmetallic elements— H_2 , O_2 , N_2 , Cl_2 —and the ideal liquids, such as the noble gases—all of them, either as molecules or atoms (in the case of the noble gases), being held together in the liquid by comparatively weak *van der Waals* forces.

We shall show presently that our three liquid metals (and presumably other typical metals) differ substantially from van der Waals substances (a comparison with a third type of compounds—*ionic salts* in the liquid state, such as NaCl —will have to be postponed to the future until more data on their entire liquid range becomes available⁽¹⁰⁾).

The experimental data on the viscosities and densities (or specific volumes) of the three metals and the procedures used and estimates made of the same properties, all the way up to the critical point, have been given in references (1) and (2). The reduced viscosities, both dynamic (absolute) and kinematic, of the three metals have been calculated from the above data and are presented, as a function of reduced temperature, in Table 1a and 1b for mercury, Table 2a and 2b for potassium and Table 3a and 3b for sodium. The absolute values of the critical viscosities and critical temperatures used in these calculations are correlated in Table 6.

⁽⁶⁾ O. A. HOUGEN and K. M. WATSON, *Chemical Process Principles*, p. 870, Vol. 3, J. Wiley, New York City (1944).

⁽⁷⁾ C. CODEGONE, *Allgemeine Waermetechnik*, 8, 49-53 (1957).

⁽⁸⁾ A. V. GROSSE, *J. Inorg. Nucl. Chem.* 22, 23-31 (1961).

⁽⁹⁾ A. V. GROSSE, *Inorg. Chem.* 1, 436-7 (1962).

⁽¹⁰⁾ See A. D. KIRSHENBAUM, J. A. CAHILL, P. J. MCGONIGAL and A. V. GROSSE, *J. Inorg. Nucl. Chem.* 24, 1287-1296 (1962).