

We choose argon and water as representatives of van der Waals liquids and their vapours; *argon* (and the other noble gases) because it is an *ideal liquid* from a physico-chemical standpoint, and *water* because it is a "slightly polar" homopolar compound and because most homopolar substances (such as hydrocarbons, i.e.,  $C_2H_6$ ,  $CO_2$ ) will lie between the curves of these two substances, when their reduced viscosities are plotted against their reduced temperatures.

Although CODEGONE<sup>(7)</sup> gives the reduced properties of argon and water in his curves, the actual values used in his plots are lost because of the small scale of reproduction; furthermore, the sources of his experimental data are not given.

Therefore, and because argon and water are also *standard substances* useful for many comparisons, experimental data have been collected, evaluated and the reduced viscosities calculated. In the case of these two substances, *all* their properties have been determined *experimentally up to the critical temperature*.

The viscosities of *argon* were calculated from the  $\eta$  and  $D$  data presented by HOLLIS HALLET.<sup>(11)</sup> The data for *water* were obtained from the most comprehensive and complete compilation of the properties of  $H_2O$ , namely, the "water volume" of the *Gmelin Handbook*,<sup>(12)</sup> i.e., section (Lieferung) 5 of the oxygen volumes (System No. 3) ( $\eta$  and  $\nu$ —pp. 1451–1465, particularly p. 1457; \* for  $D$ —pp. 1317–1331, particularly 1324).

The critical viscosity of water, 1.27 ms, is based on the Gmelin data of 0.413 mp for  $\eta_{crit.}$  and  $D_{crit.} = 0.3250 \text{ g/cm}^3$ . The most recent and excellent review of THEISS and THODOS<sup>(13)</sup> on the viscosity properties of water gives 0.430<sub>0</sub> mp for  $\eta_{crit.}$ , which is in good agreement with the above GMEIN value.

The reduced dynamic and kinematic viscosities of argon, both for the liquid and saturated vapour, are presented in Table 4a and 4b; the corresponding data for water and saturated steam are given in Table 5a and 5b, respectively. Again the absolute values of  $\eta_{crit.}$ ,  $\nu_{crit.}$  and  $T_{crit.}$  for Ar and  $H_2O$  are presented in Table 6.

It is not our purpose here to re-evaluate critically the reduced data on many homopolar substances used by WATSON<sup>(6)</sup> and CODEGONE<sup>(7)</sup>; this has been adequately done by these two authors. CODEGONE<sup>(7)</sup> has specifically considered the  $\eta$  of liquid  $H_2$ ,  $O_2$ ,  $N_2$ , He, Ne, Ar, CO,  $CO_2$ ,  $H_2O$ ,  $NH_3$ ,  $SO_2$ ,  $CCl_2F_2$ ,  $CH_3Cl$ ,  $C_2H_4$ , benzene, the paraffin hydrocarbons from  $CH_4$  to  $C_8F_{18}$  and *mercury*. WATSON's and CODEGONE's data fit the points of argon and water of our Fig. 1, the only exception being the metal *mercury*, as we shall discuss later.

The combined data of our ten tables are graphed in Fig. 1 and Fig. 2; the reduced dynamic viscosities are plotted in Fig. 1 and the reduced kinematic viscosities in Fig. 2.

A perusal of the *upper* half of Fig. 1, showing the curves of the *liquids*, immediately demonstrates that liquid metals form a set of curves *far apart* from the van der Waals liquids, where  $\eta_{red.}$  rise steeply with decreasing reduced temperatures; all of these three metals have *much smaller*  $\eta_{red.}$  at the same  $T_{red.}$  than the van der Waals liquids.

\* There is an error in the decimal power factor (p. 1457) *loc. cit.*; actually the  $\eta$ 's, as given, are in  $10^{-2}$  centipoises and  $\nu$  in centistokes!

<sup>(11)</sup> A. C. HOLLIS HALLET: Argon, Helium and the Rare Gases I. (Ed. by G. A. COOK), Chap. IX, pp. 313–385. Interscience, New York (1961).

<sup>(12)</sup> *Gmelin Handbook of Inorganic Chemistry*, (8th Ed.), 1963, Verlag Chemie, Weinheim, Germany (1963).

<sup>(13)</sup> R. V. THEISS and G. THODOS, *Chem. Engng. Data* 8, 390–5 (1963).