9-9 Effect of High Pressure on Low-Temperature Liquid Viscosity

The viscosity of liquids below the normal boiling point is not particularly affected by moderate pressures, but under very high pressures, large

increases have been noted.† The pressure effect is illustrated for some simple liquids in Fig. 9-16; it is obvious that under large pressures order-of-magnitude increases in liquid viscosity are possible. It seems to be a rather general rule that the more complex the molecular structure the larger the effect of pressure [10, 79, 106, 122, 130, 168]. For example, from the detailed experiments of Bridgman [21] carried out to pressures of about 12,000 atm, the fractional increase in the viscosity of liquid mercury was only about 0.32, for isobutyl alcohol 790, and for the complicated molecule eugenol, about 10^7. Figure 9-16 illustrates similar increases. Water presents an anomaly, increasing only a little over twofold from 1 to 10,000 atm. Most of Bridgman's results indicate that a viscosity-pressure graph is linear to a few thousand atmospheres, but at higher pressures, it would be nearly linear if ln η_L were plotted against pressure.

There seems to be no reliable way of estimating low-temperature high-pressure liquid viscosities. Andrade [8] suggested a relationship involving the ratios of the specific volumes and adiabatic-compressibility factors for the compressed and uncompressed liquids, but the relationship is only approximate in the linear portion of the η_L-vs.-P curve and does not even approximate the true situation at high pressures. This formula is also discussed briefly by Gambill in a review article [70].

†The discussion in this section is limited to low temperatures, since practically all experimental very-high-pressure data have been obtained in this temperature region; also, high-pressure, high-temperature liquid viscosities are estimated by different types of correlations, i.e., those discussed in Sec. 9-12.

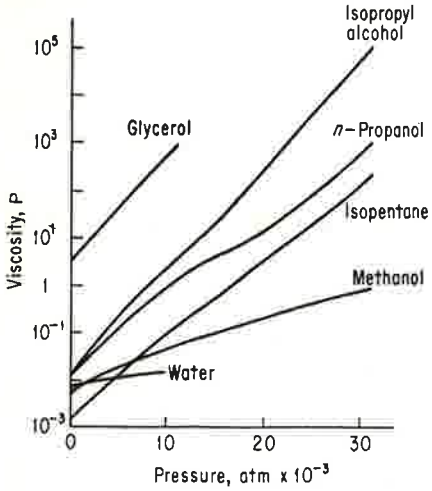

Fig. 9-16 Approximate variation of liquid viscosity with pressure at room temperature. (*From Ref.* 19.)

9-10 Effect of Tempera

The viscosity of liquids
logarithm of the vis
temperature in Fig. 9-
somewhat above the no
plot is linear, i.e.,

This equation is commo
first suggested this fo
viscosity [6, 7]. In the
proposed, literally hur
have been suggested.

where the functions
220]. Other variations
more additional const
214]. One form [58] w
temperatures resemble

Regardless of the ma
most widely used co
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temperatures, as liquid