

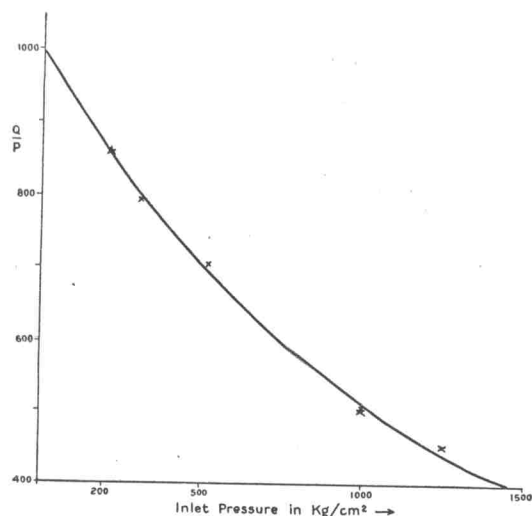


FIG. 3. Experimental results at 359 C. Q/P in arbitrary units. The smooth curve is calculated from the expression, $\eta = \eta_0 e^{0.0015P}$.

kg/cm^2 to that at 1 kg/cm^2 , at the same temperature. The most suitable expression appears to be $\eta = \eta_0 e^{\alpha P}$; this is consistent with the results at both temperatures and has received a certain amount of theoretical justification in Andrade's theory of viscosity.¹⁰ Of the other expressions which are consistent with the high temperature results, the straight line interpretation of Q/P versus P , leads to an infinite viscosity at 2860 kg/cm^2 ; this is certainly incorrect. The linear increase of viscosity with pressure gives a satisfactory fit at 516°, but not at 359°.

It is of some interest to compare these results with those of Bridgman and others for organic liquids. At 516°, the initial rate of increase of viscosity of B_2O_3 is about the same as that of methyl alcohol at 30°; at 359°, the initial rate

of increase of viscosity of the glass is greater than that of eugenol or of oleic acid, the pure liquids which showed the greatest effects among Bridgman's materials, and even greater than that of castor oil, studied by Hersey and Snyder. The viscosity of castor oil could also be represented approximately by an exponential expression up to 3000 kg/cm^2 . Several lubricating oils studied by Dow¹¹ showed increases of viscosity by factors of ten or more in the first thousand kg/cm^2 . In Bridgman's work, the rate of increase with pressure of the *logarithm* of the viscosity generally fell off appreciably in the first few thousands of kg/cm^2 , remaining relatively constant thereafter to 12,000 kg/cm^2 . Caution is therefore recommended in applying the present results to pressures higher than 2000 kg/cm^2 .

No general law for the effect of temperature upon the pressure coefficient can be derived from Bridgman's measurements at 30° and 75°; in some cases the increase of viscosity with pressure was greater at 30°, in others, at 75°. Dow's results for lubricating oils showed marked decreases of the pressure effect as the temperature increased, from about 40° to 100°. For B_2O_3 glass, the pressure coefficient α is about three times as great at 359° as at 516°. This is very much greater than might be anticipated on the basis of Andrade's theory, which gives a pressure coefficient roughly inversely proportional to the absolute temperature. The "reaction rate" theory of viscosity, recently reviewed by Ewell,¹² which gives a very satisfactory account of the initial effect of pressure on the viscosity of pure liquids, may prove adequate to deal also with the more complicated case of vitreous materials, although, for the moment, data for a quantitative application to glasses are lacking.

¹⁰ E. N. da C. Andrade, *Nature*, Mar. 1 and Apr. 12 (1930); *Phil. Mag.* 17, 497 and 698 (1934).

¹¹ R. B. Dow, *J. App. Phys.* 8, 367 (1937).

¹² R. H. Ewell, *J. App. Phys.* 9, 252 (1938).