

drawn to smooth or average the results. In no case did the computed value of μ deviate by more than 1 percent from the value read from the curve which was drawn through the same pressure ordinate. In compiling the data of Table I, only three figures have been considered as significant.

DISCUSSED RESULTS

The data of Table II show significant differences for the viscosity of the three oils under pressure. Perhaps one of the most striking is the viscosities of the oils at 130°F at a pressure of 26,000 lb./in.²; at atmospheric pressure the oils have a matched viscosity of 0.4 poise but at the higher pressure the change amounts to a 25-fold increase for the Pennsylvania sample, a 35-fold increase for the Oklahoma sample, and an increase greater than 100-fold for the California oil. Further inspection of Table II shows that, likewise, the data at 100° and 210.2°F indicate that the effect of pressure is the greatest on the viscosity of the California oil and the least for the Pennsylvania oil. Assuming that the California oil is of more complicated composition from the standpoint of viscosity, due to the probable greater number of ring compounds or cycloparaffins (C_nH_{2n}), it is not surprising that the effect of pressure is greatest for this sample. It has been previously mentioned that the viscosity of liquids under pressure is a strong function of composition and one must admit that the viscosity effects in these oils are exceedingly complicated due to the corresponding complication of chemical makeup or structure.

The second order effects are: that of pressure on the average temperature coefficient of viscosity, and that of temperature on the average pressure coefficient of viscosity. Considering the effect of pressure on the *temperature* coefficient of viscosity computed between 100° and 210.2°F,

it has been found that for the Pennsylvania oil an increase of 20,000 lb./in.² increases the coefficient by 5 percent, for the Oklahoma sample an increase of 18,000 lb./in.² increases the coefficient by 7.8 percent, and in the case of the remaining oil, the increase amounts to 10 percent for a pressure difference of only 14,000 lb./in.². Now the effect of temperature on the *pressure* coefficient of viscosity, averaged over 10,000 lb./in.², is more noticeable although the changes occur in the same order; an increase of 110.2°F decreases the pressure coefficient by 18 percent for the Pennsylvania oil, 53 percent for the Oklahoma oil, and 76 percent for the California oil. Qualitatively, these oils show the same abnormality as pure liquids at high pressures in the relative change of viscosity with temperature,⁵ most temperature effects being less at high pressures due to the constraining action of the high pressure on the normal thermal agitation in the liquid. These considerations show clearly that the influences of temperature and pressure on the first order effects of viscosity are correspondingly greater for the California oil than for the Pennsylvania oil.

In conclusion, it may be said that the changes of viscosity of these oils are remotely connected with the volume changes that occur in the pressure range of these experiments. For a pressure of 28,400 lb./in.² at 210°F the change of volume of these oils is about 10 percent, as contrasted to a change of viscosity which may be as high as 80-fold. It has been shown¹² with the available data on volume and viscosity that Batschinski's relation, which states that viscosity is a function of volume alone, is not valid for fluid lubricants at high pressures. The data of this paper likewise show the invalidity of the relation when viscosity is found as a function of volume.

¹² R. B. Dow, *Physics* 6, 270 (1935).

THE Summer Session of the University of Rochester, College of Arts and Science, announces two summer courses in photography to be given under the joint auspices of the Institute of Applied Optics of the University of Rochester and the Eastman Kodak Research Laboratory and under the immediate supervision of Dr. T. R. Wilkins and Dr. Walter Clark. These courses, concentrated each into three weeks, will be similar to those given in the regular curriculum of the Institute of Optics. The elementary course will run from June 22-July 13 and the advanced from July 5-23. The lectures in the advanced course will be given by C. E. K. Mees, L. A. Jones and W. Clark of the Kodak Research Laboratories. The courses overlap by a week in which topics common to both (such as the making of emulsions and color photography) will be covered. Registration may be for either one or both courses.

The advanced course will cover such topics as the production and physical characteristics of the developed image, the theory of tone reproduction, the nature of the latent image, color sensitive emulsions, filters and various methods of practical sensitometry. In addition there will be an opportunity for those wishing to gain some acquaintance with the techniques in two specialized fields:

July 5-9 Photographic photometry and spectrophotometry.

Brian O'Brien.

July 12-16 The photographic emulsion as a tool in atomic nuclear research. T. R. Wilkins.

Trips of inspection of the Kodak Park Laboratories and the Kodak Camera Works will be featured. A detailed announcement may be obtained by addressing the Institute of Applied Optics, or the director of the Summer Session of the University of Rochester.