

ectrocardiogram. (a) Cathoda a ord. (b) Ink writer record.

me voltage give the Karte have

litude linearity characteristics. s., is shown in Fig. 8. At the darge amplitudes Regard teresis effect similar to the appreciable error in the his countered in biological value.

ectrocardiograms

fore, probably the best too georder is comparison of the ith a known wave form of the ed. Electrocardiograms must orded in biological work, and a wide range of companishave been used to check the nstrument. Fig. 9 shows the rocardiogram, as recorded in cillograph at a and by the ed.

AND ACKNOWLEDGMENT

ink-writing oscillograph in in the recording of biorherite alysis of the electromechanis ument is simplified by derving ctrical network. From the de implitude-frequency, and was ics can be calculated. White proved by inserting a week amping cannot be achieved be n a piezoelectric device les Black efficient of coupling, greater btainable in a crystal. ig and best frequency frequency y equivalent. The best tree a rison of records with the ware ed potential. Such comparison with the instrument described ess my gratitude to Dr 4 at stance in the theoretical profiles on, and to Dr. R. W. Grand ba

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Computation of Some Physical Properties of Lubricating Oils at High Pressures

I. Density

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From a survey of available data on the density of fluid lubricants as a function of pressure and temperature, the following empirical equation has been derived:

$$\rho = \rho_0 (1 + ap - bp^2)_{\iota}.$$

 ρ is the density at a given pressure (gage) p and temperature t; ρ_0 is the corresponding density at atmospheric pressure. The constants a and b are evaluated over a temperature range extending from 20° to 220°F and the density equation is valid over a pressure range of 50,000 lb./in.². While the equation was derived from data on mineral oils it has been found to hold equally well for animal, vegetable, and fish oils. The variation of density with pressure is independent of the nature of the oil.

when to compute the thermodynamic charprestics of an oil at high pressure it is that the specific volume or density be 31 18 a function of temperature and pressure. in problems of lubrication design it is pressary to convert from the dynamic to and vice and in order to do this at high pressures Ansities must be known over the range of involved. It is the purpose of this paper ment a practical means for calculating over a pressure range up to 50,000 lb./in.2 imperatures between 20 and 220°F. These and pressure and temperature are those encountered in many problems of on in the fields of engineering and of physics, and although data could be readily at higher pressures, provided be temperature was also raised so that the remain fluid, the investigation would wome one of academic interest rather than and importance.

resties of five petroleum lubricants have restired by Hyde¹ at 104°F over a pressure 125,000 lb./in.². Similar data were observed in four petroleum oils by Dow² at 77°F, and 167°F at pressures up to 50,000 lb. Dow and Fenske³ obtained data on an oil

Hole, Proc. Roy. Soc. A97, 240 (1920).

Now, J. Wash. Acad. Sci. 24, 516 (1934).

Dow and M. R. Fenske, Ind. and Eng. Chem. 27,

at 104°F and 167°F at pressures up to 50,000 lb./in.², and then fractionated the oil into narrowboiling cuts and obtained data on ten of these cuts.

The striking result of all these investigations is the fact that, within the range of experimental error, all of the oils have the same compressibility. Thus the oils studied in Europe by Hyde, who used the moving piston type of apparatus to make his measurements, showed the same behavior in this respect as the oils studied in this country by Dow who used the sylphon apparatus. Furthermore, the work of Dow included extreme types of oils such as a typical Pennsylvania oil which is noted for its high paraffinicity and low temperature coefficient of viscosity, and a typical Gulf Coast oil which is characterized by the fact that it contains large amounts of naphthenic and aromatic types of molecules and has a relatively high temperature coefficient of viscosity. The work of Dow and Fenske, moreover, shows that the generality in regard to compressibility may be extended to narrow-boiling fractions which vary considerably in boiling point and molecular weight. This insensitivity of compressibility, within the range of experimental error, among the wide variety of oils studied is strikingly different from other properties that have been studied under pressure, as, for example, viscosity.4

From an experimental standpoint, therefore,

⁴ R. B. Dow, J. App. Phys. 8, 367 (1937).