

Effect of Temperature on Lubricant Films

THE friction apparatus developed by Bowden and Leben^{1,2} has shown that when clean steel surfaces slide on one another, the motion is not smooth but proceeds in a series of irregular jerks. This apparatus has also been used for comparing the lubricating properties of various substances. With the high loads and low speeds employed, the conditions which obtain correspond to boundary lubrication. Experiments show that when a non-polar lubricant such as medicinal paraffin oil is used, the motion still proceeds in stick-slips, though the average value of the friction is lower than for the dry surfaces. Certain long-chain fatty acids and small quantities of these acids in a non-polar oil will, however, cause continuous sliding^{1,3}. This property has been used to detect the oxidation of non-polar oils on heating. The original oil gives a jerky motion; when a certain amount of oxidation has occurred the motion becomes smooth. The rate of this oxidation becomes appreciable with most oils at temperatures above 150° C. and the change in the frictional behaviour is irreversible on subsequent cooling³.

Some recent work on commercial oils giving smooth sliding on steel surfaces at room temperature has revealed a new effect. As the surface is warmed (to temperatures usually ranging between 40° C. and 80° C.) stick-slips set in, which increase in size with temperature and decrease as the temperature is reduced. Provided the heating has not been sufficient to cause appreciable oxidation of the lubricant, this effect is reversible. Subsidiary experiments have

shown that it is not due to any change of viscosity with temperature, and the effect is to be attributed to a desorption or disorientation of the lubricant film. These results indicate that *in those cases where boundary lubrication occurs*, a lubricant which behaves well at room temperature (that is, which gives smooth sliding) may have poor lubricating properties at quite moderate temperatures of the running parts. The temperature at which this reversible effect occurs will be a measure of the strength with which the lubricant film adheres to the surface; the higher the temperature the more strongly is the film adsorbed on the surface. It is possible by such means to compare different lubricants in this respect.

Experiments have also been carried out with pure fatty acids, and similar effects have been observed, though the temperature at which stick-slips commence is appreciably higher than the values given above and increases slightly with the chain length of the acid.

These observations are of importance in any general consideration of the effect of temperature on the behaviour of adsorbed films.

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¹ Bowden and Leben, *NATURE*, **141**, 691 (April 16, 1938).

² Bowden and Leben, *Proc. Roy. Soc., A*, **169**, 371-391 (1939).

³ Bowden, Leben and Tabor, *Trans. Faraday Soc.*, **35**, 900-904 (1939).

Points from Foregoing Letters

C. B. Allsopp has found that photo-oxidation products of 3:4-benzpyrene, which can be extracted with water or dilute alkali, possess characteristic absorption spectra. The unstable extracted material, which was shown by Schulman and Rideal to react strongly with protein monolayers, is found to produce a high percentage of abnormal mitotic cells in embryonic chick heart tissue cultures.

After examining the oxidizing enzymes, named laccases, obtained from the latex of the Indo-Chinese, Japanese and Burmese lacquer trees, D. Keilin and T. Mann conclude that they are all copper-protein compounds containing a blue pigment the nature of which is under investigation.

A. C. Bottomley and S. J. Folley find that the pigeon crop stimulating activity of the anterior pituitary hormone prolactin disappears when the free amino groups react with phenyl isocyanate.

O. Thordarson finds that the prothrombin content of the blood plasma of pregnant women is higher than normal. A steady rise occurs from the third month of pregnancy until delivery; normal values are found again one month after delivery.

It is claimed by M. W. Mettenleiter that the density of blood serum incubated with an alcoholic extract of carcinoma of the breast, can be used as a test for cancer. When the observations are plotted, a characteristic difference between cancerous and non-cancerous sera is observed; this difference disappears after successful treatment and reappears

with recurrence. The test fails in cases of pregnancy and of certain diseases.

The experimental results of Raman and Nedungadi on the α , β transformation of quartz are reviewed by Prof. H. S. Allen. Two suggestions are put forward: (1) at any transition temperature (including the melting point) some kind of resonance occurs between two approximately equal frequencies characteristic of the phases concerned; (2) the Sutherland-Lindemann melting point formula may be applied to the transition point.

Experiments on the exchange of radiobromine between organic and inorganic bromides are described by F. Fairbrother. The radiobromine with a half-life of 18 min. can be separated almost completely from the others by extraction of a radioactive organic bromide with certain inorganic bromides and metals. Since the energy of mechanical recoil, from the γ -ray emitted during the isomeric transition of ⁸⁰Br, or from its conversion electrons, is too small to break the C-Br bond or to bring about the observed reactions, these are attributed to a fission of the bond by an intramolecular photo-dissociation.

Using the stick-slip friction apparatus developed by Bowden and Leben, D. Tabor finds that certain lubricants giving smooth sliding on steel at room temperature give stick-slip motion when heated to moderate temperatures. This effect is reversible with temperature and has been observed with pure fatty acids. It is attributed to a desorption or disorientation of the lubricant film.