conditions, however, when waves of much greater length are dominant, then in the expression for Doppler shift $\Delta f = \sqrt{\frac{g}{\pi}} \cdot \frac{n}{\lambda}$, n will be large and a continuous spectrum may result if the mechanism suggested above is responsible.

I am indebted to Mr. N. F. Barber for valuable discussions on sea waves and to Mr. W. H. Ward under whose direction this work was undertaken.

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Effects of Temperature and High-speed Sliding on the Friction of 'Teflon' on 'Teflon'

IN a recent study in this laboratory of the frictional properties of 'Teflon' (polytetrafluoroethylene) two experimental results stand out: (1) the coefficient of friction at low sliding speeds is very low (0·05–0·08), as reported in the literature, only if the surfaces have not previously been subjected to high-speed sliding; (2) with rising temperature, there is a marked increase in the friction of 'Teflon' on 'Teflon' in the vicinity of 20° C., where a phase transition in 'Teflon' is known to occur.

The observation was made by causing a 'Teflon' rider to bear against a rotating 'Teflon' cylinder, the friction being measured by means of strain gauges attached to the flexible rider holder[1].

The first of the experimental results serves to illustrate the important effects which surface preparation and conditioning may have on friction. It has been found, for example, that clean, newly prepared surfaces in sliding contact at low speed (1·1 cm./sec.) exhibit low friction for at least 4,100 traversals over the same track. On the other hand, if the same surfaces are subjected to sliding at high speed (189 cm./sec.), the friction increases ($\mu_k = 0{\cdot}36$) and the condition of the track becomes irreversibly changed. Subsequent sliding at low speed is then accompanied by a two- to three-fold increase in the friction coefficient over the original low-speed value.

These observations do not contradict previous work in other laboratories on the friction of 'Teflon' on 'Teflon' but rather supplement it[2,3]. Previous workers have presumably used new surfaces and have measured either static coefficients or kinetic coefficients at sliding speeds of the order of 0·01 cm./sec. Bowers, Clinton and Zisman[3] studied the friction of steel rubbing on 'Teflon' and found that both μ_s and μ_k increased slightly after thirty passes (the steel rider being cleaned after each pass) and after a hundred passes μ_s had increased to 0·13 and μ_k to 0·08. To the best of our knowledge, there is no previous mention in the literature of the effect of continuous sliding on the friction of 'Teflon' on 'Teflon'.

The second result of particular importance is the relationship between friction and temperature for 'Teflon' on 'Teflon'. By varying the temperature of the cylinder within the range 12°–30° C., it has been found that a sharp increase in friction (about two-fold) takes place as the temperature is raised through 17° C. In view of the fact that the bulk temperature of the rider is above that of the cylinder, and that localized heating effects may also be present, there can be little doubt but that the rise in friction is related to the phase transition in 'Teflon' which takes place[4] at 20° C. This change in friction is reversible, as apart from the irreversible change produced by high-speed sliding.

A more complete discussion of these and other frictional properties of 'Teflon' will be published at a later date. It is important, for the present, to emphasize the close relationship between the frictional and structural changes which take place in this polymer.

One of us (D. G. F.) wishes to acknowledge helpful discussions with Dr. J. D. Hoffman, who first directed our attention to the phase transition at room temperature in 'Teflon'.

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Rotations, Orientations and Collisions of Suspended Particles in Velocity Gradients

PARTICLES suspended in a liquid subjected to a velocity gradient undergo rotational and translational movements. For fluid velocities u, v, w, along the x-, y- and z-axes given by $u = Gy$, and $v,w = 0$, Jeffery[1] has shown that a prolate spheroid of axial ratio r, in the absence of Brownian motion and interaction with other particles, rotates with a period

$$T = 2\pi (r + 1/r)/G \qquad (1)$$

in a fixed spherical elliptical orbit described[2] by

$$\tan \lambda = Cr \sin 2\pi t/T \qquad (2)$$

where λ is the angle between the z-axis and the x–z projection of the main particle axis and C is the orbit constant. The particle, when viewed as its projection on the shear planes, should therefore appear to oscillate between $\pm \lambda_{max.} = \tan^{-1} Cr$.

Measurements[2] on single rods have shown excellent agreement with equation 2. Values of T, however, were less than given by equation 1; this effect has been attributed to the cylindrical, rather than ellipsoidal, shape. It could not be established definitely that C remained constant with time.

The interaction of equal-sized glass spheres, brought into collision by translational motion as proposed by v. Smoluchowski[3], was also studied in some detail[4]. Absolute collision frequencies, persistence times and rotational velocities of the transitory doublets were found to be in excellent agreement with calculated values; but conclusive proof of true physical contact between the spheres was lacking.

We have extended these observations using various particles suspended in corn syrup of viscosity 50 p. at values of G up to 2·5 sec.$^{-1}$.