



detailed description of the apparatus, method and results is to be published later; for the present it may be said that the test pieces were in the form of cylindrical rubber blocks  $\frac{7}{8}$  in. in diameter and  $\frac{7}{8}$  in. high, bonded at each end to steel screws by the conventional brass-plate method.

The property of an elastic material which is of paramount importance in determining its use as a vibration insulator is the dynamic modulus (in compression and/or shear). In order to compare the temperature variation of a wide range of materials from very soft to very hard, a plot may be made against temperature of relative modulus, that is, modulus at the stated temperature divided by modulus at some standard temperature (20°C. in the present case). Some early results are illustrated by the accompanying curves. The area enclosed by the full lines *A* and *B* shows the variation of the modulus-temperature effect in a comprehensive series of 'Neoprene *E*' (chloroprene polymer) compounds, the dotted lines *C* and *D* show the effect for a range of *GR-S* (butadiene-styrene co-polymer) compounds, and finally the broken lines *E* and *F* show the effect for a series of natural rubber compounds analogous to those in *GR-S*.

The purpose of this note is to direct attention to the following facts in connexion with rubber-like materials intended for use in anti-vibration devices.

- (1) The dynamic modulus has a considerable temperature coefficient.
- (2) Quite apart from temperature variations likely to be encountered in service, this fact is of importance in the quoting of dynamic results. The temperature of test should always be stated.
- (3) No sign of a temperature effect of this order is evident from static loading tests; in the present work these were carried out using a well-known torsion flexibility measurement.
- (4) In view of these facts, the practice of specifying the low-temperature requirements of such products as instrument mountings (anti-vibration) in terms of a static test is likely to lead to wastage of valuable raw materials and labour in the production of articles quite unsuitable for their intended purpose.

Similar results have been reported by previous

workers<sup>2</sup>, but it is felt that a considerably wider appreciation of such facts would be of general benefit in the present emergency.

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<sup>1</sup> Gehman, S. D., *J. Appl. Phys.*, **13**, 402 (1942).

<sup>2</sup> Lazurkin, Yu S., *J. Tech. Phys. U.S.S.R.*, **9**, 1261 (1939).

### Surface Flow of Liquid Helium II and Bose-Einstein Degeneracy

RECENTLY, London<sup>1</sup> has revived the theory of Bose-Einstein condensation and has discussed its application to explain some of the peculiar properties of liquid helium II. A most striking property of liquid helium II is the transport of the liquid over surfaces in the form of mobile films (thickness about 50 m $\mu$ ) and, as is well known, it is because of the surface transport that the rate of flow of liquid helium II in very narrow channels (less than 10<sup>-3</sup> cm.) is practically independent of the pressure head.

If *v* is the volume transferred per second per cm. width of surface, then the values of *v* for different temperatures, as observed by Daunt and Mendelssohn<sup>2</sup>, are given below.

$$T_0 = \lambda\text{-point} = 2.19^\circ \text{K.} \quad C = \frac{v}{1 - (T/T_0)^{3/2}}$$

<i>T</i> ° K.	1	1.5	1.7	1.9	2.1	2.16
<i>v</i> × 10 <sup>6</sup> (c.c. per sec.)	7.4	7.5	6.3	4.0	1.2	0
<i>C</i> × 10 <sup>6</sup>	10.7	17.3	19.9	20.9	19.7	0

It is interesting to observe that for a Bose-Einstein degenerate gas, a flow independent of pressure is realizable, this being due to the flow of the particles constituting the condensed phase (non-energetic particles). The number of particles per unit volume in the condensed phase at temperature *T*° K. is given by

$$n^* = n [1 - (T/T_0)^{3/2}], \dots (1)$$

where *n* is the total number of particles per unit volume and *T*<sub>0</sub> is the λ-point (= 2.19° K.).

If *l* denotes the thickness of the surface film, then the velocity of the particles in the condensed phase will be *u* ~  $h/2ml$ , *m* being the mass of the atom. The volume rate of flow per unit width of the film will therefore be given by

$$v \sim \frac{n^* ul}{4} = \frac{h}{8m} [1 - (T/T_0)^{3/2}] \dots (2)$$

As the accompanying table shows, this relation, so far as the temperature dependence is concerned, agrees reasonably well with observation (the discrepancy is rather serious for the value at 1° K.). Further, the mean observed value of *C* is about 18, which may be compared with the theoretical value of 12.5 given by equation 2. This agreement appears to be indeed remarkable but, considering the crude nature of the theory, it is to be regarded as more or less accidental.

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<sup>1</sup> *Phys. Rev.*, **54**, 947 (1938).

<sup>2</sup> *Reports on Progress in Physics*, **6**, 286 (1939).