

TEMPERATURE AND PRESSURE
VARIATION OF HEAT
CONDUCTIVITY OF LIQUIDS
ON OSIDA'S THEORY

ARGUING from a model of liquid structure similar to that proposed by Andrade¹ in his theory of viscosity of liquids, Osida² deduced,

$$K = 4k \nu / \sigma \quad (i)$$

in which K is the coefficient of heat conductivity of the liquid, k the molecular gas constant, ν the vibration frequency of the liquid molecules, and σ the mean inter-molecular distance.

Temperature increases σ . From Einstein's well-known expression³ for ν , viz.,

$$\nu = C \times 0.77 \times 10^{12} \sqrt{\Gamma_m / MV}^{2/3} \quad (ii)$$

where C is a constant, T_m the melting-point on the absolute scale, M the molecular weight, and V the molecular volume $N\sigma^3$, it follows that

$$\nu \propto 1/\sigma;$$

that is, an increase in σ (as a result of temperature rise) is accompanied by decrease of ν . Such a conclusion was arrived at by Macleod⁴ from considerations of free space in liquids. A negative temperature coefficient for K is therefore to be anticipated. This result, obtained from theory, is in agreement with the findings of Bridgman⁵ in the case of all liquids, except water, which has a positive temperature coefficient. The behaviour of liquid metals also falls in line with the above deduction.⁶

Bridgman⁵ has shown that K increases with pressure, the effect being greater for more compressible liquids, and at 75° than at 30° C. Further, the temperature coefficient of all liquids at pressures above 3,000 kg./cm.² is positive. The effect of pressure is to reduce σ causing thereby an increase in ν . The increased conductivity of liquids under pressure is thus explained with more compressible liquids, and at high temperatures, the reduction in σ due to a certain pressure will be more marked than with less compressible liquids and at low temperatures.

The high conductivity of water is due to its associated nature. In associated liquids, apart from the propagation of heat by collisions as postulated by Osida,¹ an additional factor is the following: When an associated complex arrives at the hotter part of the liquid as a consequence of irregular heat movements, it partially dissociates into smaller units; conversely, when these smaller units come into the colder parts they partially reunite. Since dissociation is accompanied by heat absorption and reformation of complexes by generation of heat, this process would enhance the thermal conductivity. An additional factor is the greater vibration frequency of the smaller units formed in the process. Due to the formation of such smaller units with greater ν at higher temperatures, water has a positive temperature coefficient of conductivity. The positive coefficient of all other liquids, above 3,000 kg./cm.², investigated by Bridgman⁵ might be due to the formation of complexes at such high pressures.

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THE VISUAL SHAPE OF THE
OVERCAST SKY

THE problem of the apparent shape of the cloudy sky is one of much interest in meteorological optics. This was partially investigated by Miller and Neuberger¹ in the case of skies covered with 90 per cent. or more of clouds based below 10,000 feet. Their results lead to the surprising conclusion that the half-arc angle² decreases with increasing cloud-height; in other words, the sky appears to become flatter with increasing cloud-height. No explanation has so far been suggested for this anomaly. It was felt desirable to examine whether this conclusion holds for overcast skies, whose ceiling lies above 10,000 feet. In view of the uncertain influence on the half-arc angle of differential illumination of the clouds when they are cumuliform,³ measurements were made by the author only when the skies were totally overcast with the stratiform type of medium and high clouds based above 10,000 ft. In this note are reported the results of those measurements. An attempt has also been made to offer a possible explanation for the observed anomaly.

The method of determination of the half-arc angle is the same as described in a previous communication.⁴ In order to obviate the effect of partial illumination and differing visibility on the half-arc angle, all measurements were made at about noon-time when the sun was near the zenith and under conditions of good and nearly identical visibility of 20-25 miles. Eight measurements were made at a time in four different directions free from orographic elevations and their mean was adopted as the representative value.

The results reproduced in Table I are the means of a number of representative values for skies overcast with stratified clouds of

TABLE I

| Kind of cloud | Average height of base in ft. | Half-arc angle in deg. | Ratio OII/OZ |
|---------------------|-------------------------------|------------------------|--------------|
| Thick Altostratus | 10 000 | 27.1 | 2.73 |
| Thin Altostratus | 13,000 | 26.6 | 2.80 |
| Thick Cirro stratus | 17,000 | 26.2 | 2.85 |
| Thin Cirro stratus | 22,000 | 25.4 | 2.97 |