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 Andrade[1] in his theory of viscosity of liquids, Osida[2] deduced,

$$K = 4k\,\nu/\sigma \qquad \text{(i)}$$

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 expression[3] for ν, *viz.*,

$$\nu = C \times 0{\cdot}77 \times 10^{12}\sqrt{T_m/MV^{2/3}} \qquad \text{(ii)}$$

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 Macleod[4] 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 Bridgman[5] 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]

Bridgman[5] 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 addtional 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 renuite. 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 Bridgman[5] 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 Neuberger[1] 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 angle[2] 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 OH/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

approximately the same height of base. In the fourth column of this table are given the ratios of the apparent distances of the horizon and the zenith from the place of observation (CH/OZ), calculated on the assumption of a circular profile for the meridional section of the sky.

The half-arc angles reported by Miller and Neuberger for cloudy skies with average base at 1,200, 3,900 and 8,900 feet respectively are 29°·2, 28°·0 and 27°·2. These values fit in very well with those in the above table, which show a steady diminution with increasing cloud-height. The observed inverse relationship between the half-arc angle and the cloud-height cannot be explained on a geometrical basis, on which, there should indeed be a positive correlation between the two.

The true explanation for the observed anomaly appears to consist in the subjective perception of depth, which varies according to the kind and colour of the cloud. As the author has recently pointed out while discussing the apparent enlargement of the sun and the moon near the horizon,[5] a darker object tends to impress the eye as being more distant and bigger than a brighter one at the same distance, all other conditions remaining equal. The thicker and darker the cloud, the more convex would the overcast sky therefore appear. Amongst the cloudy skies referred to in the above table, the maximum convexity would seem to be associated with the thick and greyish altostratus cloud, which is practically impervious to direct sunlight; and the minimum convexity with the high and whitish cirrostratus cloud, through which the sunlight easily penetrates. In the case of low clouds, the thicker and darker the ceiling, the higher does it look.

One fact of practical interest that emerges from this investigation is that subjective impression considerably influences the visual estimation of the heights of base of clouds. There is a general tendency to under-estimate the heights of medium and high clouds. This tendency is more pronounced, the brighter and thinner the clouds are. The heights of low clouds are overestimated and this the more so, the thicker they appear. It may, therefore, be laid down as a safe rule to follow in utilising data of estimated cloud heights in meteorological work, that the actual heights are higher in the case of medium and high clouds and lower in the case of low clouds than the estimated ones.

In conclusion, the author wishes to express his grateful thanks to Mr. B. N. Sreenivasaiah, Regional Director, Regional Meteorological Centre, Madras, for his kind encouragement during the course of this work.

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ZARATITE IN THE NUASAHI CHROME ORE

The presence of Zaratite, a carbonate of nickel, in chrome ore has not so far been recorded from any of the chromite deposits of India, viz., the Singhbhum, the Baluchistan, the Mysore and the Madras deposits. The chromite deposit recently discovered at Nuasahi (21° 17', 86° 20') in Keonjhar State has revealed its presence.

It is grass green in colour and earthy in appearance. Seen under the microscope, it is highly pleochroic from green to yellow and has a high refractive index and a high birefringence. It is uniaxial, negative.

The mineral occurs in the inter spaces between the chromite grains. Further it not only fills in the cracks in the chromite grains but rarely shows some sort of a graphic texture with it. Occasionally it is entirely enclosed in chromite.

The chemical formula for the mineral, according to Dana, is $NiCO_3.2Ni(OH)_2.4H_2O$ (?). The Indian mineral has not been quantitatively analysed but chrome ore, containing the mineral alone analysed 0·3 per cent nickel and 0·6 per cent cobalt and 1·8 per cent water (including moisture). Nickel seems to have been partly replaced by cobalt in the present mineral.

Phillips[1] had ascribed the presence of zaratite in the Shetland chrome-ore to the weathering of traces of nickel originally present in the chromite itself or in a nickeliferous olivine.

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1. *Q. J. G. S.*, **83**, 615.

MALE FERNS OF KASHMIR

MALE-FERN is one of the oldest anthelmintic drugs known and was used by the ancient physicians, Pliny and Galen. It is administered in the form of extract filixmas for eradicating tape-worm infection in man and livestock.

The British Pharmacopœial Drug is derived from the rhizomes and frond bases of *Dryopteris filixmas* (Linn.) Schott, a fern indigenous to Great Britain. It should be used within one year of the date of its collection. In America *D. marginalis* A. Gray, which is found in Eastern and Central United States and North to Prince Edward Island forms the source of American Male-fern.

D. filixmas and *D. marginalis* are not indigenous to India but the other ferns belonging to the *Dryopteris* (*Lastrea*) *filixmas* complex grow wild in the Himalayas in general and in the mountainous ranges of Kashmir in particular. These ferns are

Dryopteris rusthorni (Diels) C. Chr.; *D. blandfordii* (Hope) C. Chr.; *D. odontoloma* (Moore) C. Chr.; *D. ramosa* (Hope) C. Chr.; and *D. marginata* (Wall.) Christ.

Considerable quantities of the male-fern extract are annually imported into India for medicinal purposes. In order to study if the