[CONTRIBUTION FROM CRYOGENIC LABORATORY, DEPARTMENT OF CHEMISTRY, THE OHIO STATE UNIVERSITY]

Thermal Conductivity of Condensed Gases. III. The Thermal Conductivity of Liquid Deuterium from 19 to 26 °K.

BY ROBERT W. POWERS, ROBERT W. MATTOX AND HERRICK L. JOHNSTON

RECEIVED JUNE 29, 1954

The thermal conductivities of liquid normal and liquid orthodeuterium measured over the temperature interval 19–26°K. were found to be the same within the limits of experimental error and can be expressed by the equation $K = (2.020 + 0.04965T) \times 10^{-4}$, cal. cm.$^{-1}$ sec.$^{-1}$ deg.$^{-1}$. The conductivity of liquid deuterium was found to be about 6% greater than that of liquid hydrogen.

Introduction

The thermal conductivities of liquid normal and liquid parahydrogen have been explained in a previous article from this Laboratory.[1] This paper gives the results of similar measurements on liquid deuterium. Measurements were made in a parallel plate type of conductivity cell described previously.[2] The correction for the heat flow through the cell wall and an estimate of experimental errors have been discussed in the article of hydrogen.[1] For deuterium, unlike hydrogen, the rate of heat evolution from the ortho–para reaction was inappreciable and could be neglected.

The purity of the deuterium used in this investigation was better than 99.9%, as checked by mass spectrometer analysis. The gas was passed through a coil immersed in liquid air before it was condensed in the cell. Normal deuterium was converted to the ortho-variety in the same converter as that used to convert normal to parahydrogen.

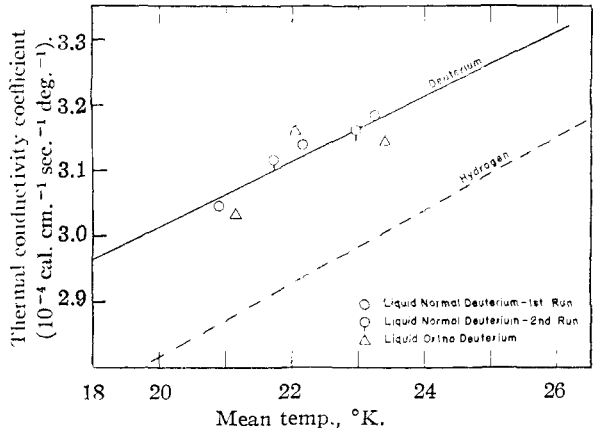

Fig. 1.—Thermal conductivity of liquid deuterium *vs.* temperature.

(1) R. W. Powers, R. W. Mattox and H. L. Johnston, THIS JOURNAL, **76**, 5968 (1954).

(2) R. W. Powers, R. W. Mattox and H. L. Johnston, *ibid.*, **76**, 5972 (1954).

Results

The results of our measurements are summarized in Table I and are shown graphically in Fig. 1.

TABLE I

THE THERMAL CONDUCTIVITY OF LIQUID DEUTERIUM AT SEVERAL TEMPERATURES

Run no.	Material	Mean temp., °K.	ΔT	$K \times 10^4$, cal. cm.$^{-1}$ sec.$^{-1}$ deg.$^{-1}$
1	Normal D_2	20.91	3.56	3.05
	Normal D_2	22.17	4.56	3.14
	Normal D_2	23.26	5.59	3.18
2	Normal D_2	21.73	4.18	3.12
	Normal D_2	22.96	4.88	3.16
3	Ortho-D_2	21.15	3.57	3.03
	Ortho-D_2	22.05	4.54	3.16
	Ortho-D_2	23.42	5.45	3.14

The conductivity of normal deuterium was measured with two different fillings of the conductivity cell. The points taken during a single filling constitute a run. Only one run was made on the orthodeuterium. It is apparent that the conductivity is independent of ortho–para composition within the limits of our experimental errors, which we believe to be less than 2.5%. The conductivity of deuterium is slightly greater than that of the lighter isotopic species (dashed line in Fig. 1); like hydrogen, however, deuterium has a positive temperature coefficient of thermal conductivity. The data were fitted to a straight line by the method of least squares. The equation

$$K = (2.020 + 0.04965T) \times 10^{-4}, \text{ cal. cm.}^{-1} \text{ sec.}^{-1} \text{ deg.}^{-1}$$

expresses our results with a r.m.s. deviation of 0.9%.

COLUMBUS, OHIO