ment of this surface equilibrium, the fact that the crystals are not of uniform composition when formed, as was mentioned above, introduces no difficulty. Indeed, even if the crystals were originally uniform, they would lose this uniformity during transition.

At low sulfate concentrations, transition may take place to either the hexahydrate or the tetrahydrate. It is of interest to consider which of these transitions will actually take place under given conditions. The hexahydrate is more stable than the tetrahydrate at any temperature below that at which the hexahydrate undergoes transition into the tetrahydrate. Consequently, if any hexahydrate is present, the transition is from decahydrate into hexahydrate, provided the concentration of sodium sulfate is not too high. In the absence of hexahydrate, the transition may be into the tetrahydrate, although this cannot readily be controlled. If any hexahydrate crystals have been in the room recently, it is almost impossible to prevent the hexahydrate from forming, as was mentioned in a different connection by Richards and Kelley.[4] Sometimes tetrahydrate forms first, and then changes spontaneously to the hexahydrate. To obtain transition to the tetrahydrate, it is necessary to exclude completely any hexahydrate nuclei from the atmosphere and to warm the system fairly rapidly past the temperature of transition into the hexahydrate. Under these conditions tetrahydrate may be obtained.

Summary

1. The transition of mixed crystals of sodium sulfate and sodium chromate decahydrate into hexahydrate, tetrahydrate or anhydrous crystals and solution has been investigated. The relation between temperature and the composition of the solution in equilibrium with decahydrate and another solid phase has been determined.

2. The existence of sodium sulfate hexahydrate in mixed crystals with sodium chromate hexahydrate has been established. Addition of sodium sulfate to sodium chromate hexahydrate lowers the temperature at which hexahydrate, tetrahydrate and solution are in equilibrium.

3. When the concentration of sodium sulfate is low, the solid formed from the decahydrate by transition is usually mixed crystals of sodium chromate and sodium sulfate hexahydrate. Under some conditions the transition product is mixed tetrahydrate crystals. When the sodium sulfate concentration is high, the transition product is anhydrous sodium sulfate.

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[CONTRIBUTION FROM THE SCHOOL OF CHEMISTRY AND PHYSICS OF THE PENNSYLVANIA STATE COLLEGE]

The Heat Capacity and Entropy, Heats of Fusion and Vaporization, and the Vapor Pressure of Dimethyl Ether. The Density of Gaseous Dimethyl Ether

BY R. M. KENNEDY, MALCOLM SAGENKAHN AND J. G. ASTON

The comparison of the gaseous heat capacity of dimethyl ether with that calculated from spectroscopic and molecular data has indicated a potential of 2500 cal. hindering the internal rotation of the methyl groups.[1] This paper presents the results of an investigation of the thermal properties of dimethyl ether from 14.13°K. to its normal boiling point which yields a value of 3100 ± 150 cal. for the hindering potential. This latter value is probably more nearly correct for reasons which will be presented presently.

Preparation and Purification of Dimethyl Ether.—Somewhat to our surprise, a preliminary and rather hasty preparation of dimethyl ether by dehydration of methyl alcohol over alumina gave a product which, for some reason unknown, could not be purified readily by fractional distillation. On the other hand, the reaction of methyl iodide with sodium methylate gave a product which was purified readily to yield the purest organic compound yet prepared in this Laboratory.

Four moles of methyl iodide was added to a solution of four moles of sodium in one liter of aldehyde-free alcohol, which had been distilled from magnesium, then from an equal atomic mixture of aluminum and zinc. The solution was contained in a 3-necked flask fitted with a mercury seal stirrer, a dropping funnel and a reflux condenser. The condenser outlet led to a carbon dioxide-snow trap through drying towers of calcium chloride and potassium hydroxide. The solution of sodium methylate was surrounded by a water-bath at 25° and the methyl iodide was added over a period of three hours. The bath was heated to 75–80° to obtain a reasonable rate of gas evolution. When the rate of gas evolution slowed down, the reaction was discontinued. The yield was approximately 180–190 g.

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[1] Kistiakowsky and Rice, *J. Chem. Phys.*, **8**, 618 (1940).

The dimethyl ether was finally dried by passing the gas over activated alumina on glass wool in a tube 25 cm. long at the rate of one mole per hour. This operation was repeated after reactivating the alumina and the product finally distilled through the laboratory low temperature column (twelve theoretical plates). Two fractions of 30 and 40 g. were arbitrarily taken from the middle of a 100-g. portion boiling over a negligible range. The first of these samples together with about one-third of the second contained less than one part in 1,000,000 of solid-insoluble, liquid-soluble impurity as estimated from the freezing point curve and the premelting heat capacity.

The Heat Capacity Measurements.—The apparatus, method and temperature scale were as already described.[2,3] The heat capacity measurements are listed in Table I and plotted in Fig. 1. The temperature rises can be estimated from the intervals between points in a series. In Table II is listed the heat capacity at round values of the temperature. One defined calorie was taken equal to 4.1833 international joules. Corrections to the heat capacities for vaporization into the filling line were made using the density of the liquid given by Maass and Boomer.[4]

TABLE I

THE HEAT CAPACITY OF DIMETHYL ETHER

Mol. wt. 46.069; 0.68487 moles in calorimeter; 0°C. = 273.16°K.

Temp., °K.	C_p, cal./deg./mole
Series III	
13.70	0.777
15.99	1.164
18.69	1.714
21.15	2.257
24.27	2.903
28.20	3.679
32.36	4.563
36.18	5.302
39.49	5.929
43.02	6.496
47.98	7.311
53.88	8.159
60.00	8.967
Series I	
56.48	8.531
61.87	9.279
68.34	10.102
74.14	10.790
79.68	11.432
85.34	12.009
91.29	12.62
96.93	13.18
102.70	13.79
108.71	14.39
116.45	15.11
122.12	15.60
127.75	16.12
Series II	
137.18	23.45
142.70	23.48
148.75	23.50
155.04	23.56
173.98	23.52
180.03	23.51
185.89	23.51
191.62	23.52
202.89	23.65
212.79	23.83
217.96	23.93
223.29	24.01
228.73	24.12
234.33	24.15
240.28	24.54
245.48	24.65
Series IV	
148.57	23.49
167.86	23.53
196.99	23.63
207.58	23.69
Series V	
129.31	17.40
Series VI	
162.92	23.51
164.92	23.53
169.44	23.51
Series VII	
186.18	23.68
190.87	23.70
196.30	23.73
200.63	23.77
205.59	23.83
172.95	23.56
178.97	23.61
210.51	23.88

TABLE II

THE MOLAL HEAT CAPACITY OF DIMETHYL ETHER

T, °K.	C_p, cal./°K. Solid	T, °K.	C_p, cal./°K. Liquid
13	0.55	140	23.46
15	.95	150	23.52
17	1.34	160	23.52
20	1.96	170	23.50
25	3.05	180	23.50
30	4.08	190	23.55
35	5.06	200	23.62
40	5.95	210	23.75
50	7.57	220	23.93
60	9.04	230	24.15
70	10.31	240	24.45
80	11.45		
90	12.50		
100	13.52		
110	14.50		
120	15.41		
130	16.40		

The heat capacity measurements of Series VII were made by Dr. S. C. Schumann in the adiabatic calorimeter B on the entire sample introduced for measurements of the heat of vaporization. They are inherently of higher accuracy than the rest. They are on an average 0.3 per cent. higher than those of Series II.

The Melting Point, Heat of Fusion and Vapor Pressure Measurements.—The procedure was the same as described previously.[2,3] Tables III, IV, and V summarize the data according to

TABLE III

THE MELTING POINT OF DIMETHYL ETHER

0°C.· = 273.16°K.

Melted, %	Total time Hr.	Total time Min.	T, °K. Res. Th.	T, °K. Thermocouple S-4	T, °K. Thermocouple S-7
8.7	2		131.662	131.658	131.676
21.7	3	40	131.665	131.658	131.667
34.6	6	15	131.665	131.658	131.667
50.9	8	35	131.665	131.658	131.667
63.8	11	15	131.664	131.645	131.658
80.0	13		131.666	131.645	131.658
95.1	14	40	131.665	131.645	131.658
			131.665	131.652	131.664
Melting point of pure dimethyl ether					131.66 ± 0.05°K.
Mole per cent. impurity					.00

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(2) Aston and Messerly, THIS JOURNAL, **58**, 2354 (1936).

(3) Messerly and Aston, *ibid.*, **62**, 886 (1940).

(4) Maass and Boomer, *ibid.*, **44**, 1709 (1922).

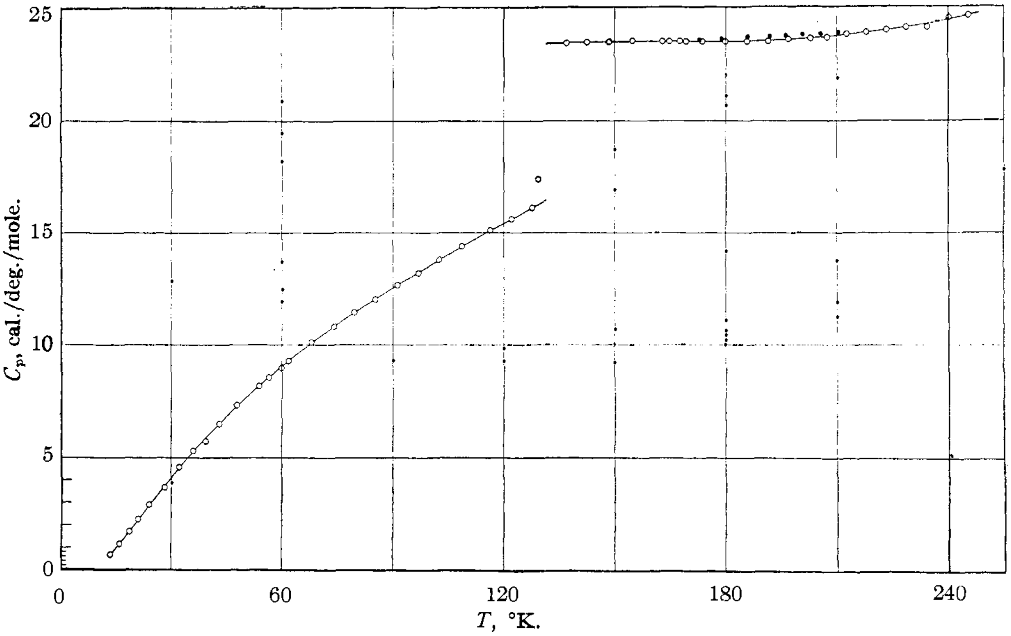

Fig. 1.—The molal heat capacity of dimethyl ether.

our usual method of tabulation.[2,3] The impurity estimated from pre-melting heat capacity was 1.28×10^{-4} mole per cent. The only other value for the melting point found in the literature was 135.2°K. (− 138.0°C.).[4]

TABLE IV

MOLAL HEAT OF FUSION OF DIMETHYL ETHER

Mol. wt. = 46.069; 0.68487 mole; melting point, 131.66 ± 0.05°K.; 0°C. = 273.16°K.

Temp. interval, °K.	Corrected heat input, cal./mole	$\int C_p dT$, cal./mole	ΔH fusion, cal./mole
129.532–133.565	1294.1	113.1	1181.0
131.094–134.581	1285.8	106.9	1178.9
129.222–133.299	1291.9	112.2	1179.7
		Mean	1179.8 ± 0.9

In the range from approximately 170 to 195°K. the vapor pressures were best fitted by equation (1)

$$\text{Log } P_{\text{mm.}} = (4245.203/T) + 120.49313 \log T - 0.122596T - 272.24932 \quad (1)$$

From 195°K. to the boiling point, equation (2) gave the best fit.

$$\text{Log } P_{\text{mm.}} = (-1691.8056/T) - 6.04560 \log T + 0.00195754\, T + 23.686185 \quad (2)$$

The latter was used in calculating the heat of vaporization at 200°K. and at the normal boiling point. From equation (2) the normal boiling point is 248.34 ± 0.05°K. The only other value given in the literature is 248.3°K. (− 24.9°C.).[4]

TABLE V

THE VAPOR PRESSURE OF DIMETHYL ETHER

0°C. = 273.16°K.; boiling point, 248.34 ± 0.05°K.; g for State College, 980.124 (I. C. T.)

T obsd., °K.	P obsd., Int. mm. Hg.	P obsd., − P calcd., mm.[a]	T calcd. − T obsd., °K.
171.63	4.97	−0.01	−0.023
177.71	8.46	− .01	− .014
178.21	8.82	− .01	− .013
183.41	13.80	+ .02	+ .017

[a] $\text{Log } P_{\text{mm.}} = 4245.203/T + 120.4931 \log T - 0.1225960\, T - 272.249320$.

T obsd., °K.	P obsd., Int. mm. Hg.	P obsd. − P calcd. mm.[b]	T calcd. − T obsd., °K.
194.93	35.13	0	0
202.49	60.91	+0.01	+0.003
207.90	87.80	+ .02	+ .003
213.12	122.37	+ .01	+ .001
218.01	164.34	0	0
223.25	221.71	− .04	− .003
228.05	287.53	− .07	− .004
233.13	373.61	− .02	− .001
238.05	475.55	− .01	− .001
241.97	571.59	− .11	− .004
245.48	670.27	+ .12	+ .004
248.24	756.42	− .01	− .001

[b] $\text{Log } P_{\text{mm.}} = -1691.806/T - 6.045600 \log T + 0.001957540T + 23.6861850$.

The Heat of Vaporization and Density.—The heat of vaporization was measured using the adiabatic calorimeter[5] (laboratory designation B) in conjunction with an apparatus for collecting the vapor similar to that described by Giauque

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(5) Aston and Eidinoff, *ibid.*, **61**, 1533 (1939).

and Johnston.[6] The volume of the thermostated bulb was 3148.52 ± 0.05 cc. It was calibrated by weight with both water and mercury.

The measurements were taken on a sample obtained from the second 40 g. fraction obtained in the original fractionation. About one quarter of the sample on which the melting point was determined consisted of this fraction. Thus the impurity must be less than 4 parts per million. The first and second samples vaporized were returned to the calorimeter after their volume had been measured. The third and fourth samples after their volume had been measured were condensed into weighed glass sample bulbs and each weighed independently by two persons. These provided the state data necessary to calculate the amount vaporized in each case. For each sample vaporized, volume measurements were taken at three different pressures, read on a Société Génévoise cathetometer with two telescopes equipped with micrometer eyepieces accurate to a few thousandths of a millimeter.

Table VI summarizes the density data. The last column gives the density and the third column gives the values of the second virial coefficient calculated therefrom. These are to be compared with the value calculated from the modified Berthelot equation and given in the note to the table. The comparison indicates that the values of B from the Berthelot equation are too small in absolute value by 4.8 per cent. State data on dimethyl ether have been obtained by Cawood and Patterson,[7] Batuecas,[8] and Baumé.[9] The only independent values for the density which can be obtained are those calculated from the data of Baumé,[9] and Batuecas.[8] These values are included in Table VI. In view of the uncertain purity of the samples used in these earlier investigations, these density values are not of comparable accuracy with the one given here. Since none of the state data extend below 0°, no attempt has been made to use them in calculating heats of vaporization from the vapor pressures.

TABLE VI

THE VAPOR DENSITY OF DIMETHYL ETHER

Sample, g.	Pressure, atm.	B^a l./mole	Density, g./l. 298.16°K., 1 atm.
5.6958	0.92351	−0.44561	1.91850
5.6958	.92349	− .44472	1.91851
5.6958	.92341	− .44518	1.91847
5.8162	.94317	− .44574	1.91852
5.8162	.94337	− .44577	1.91852
5.8162	.94317	− .44933	1.91881
	Mean	− .4461 ± 0.0015	1.91855 ± 0.00012
From the data of Baume[9]			1.91836
From the data of Batuecas[8]			1.91753

[a] B is the second virial coefficient, given by $PV = RT[1 + B/V]$. The value obtained from the modified Berthelot equation with $T_c = 399.4$°K., $P_c = 53$ atm. is $B = 9/128\ PV/P_c(1–6T_c^2/T^2) = -0.4248$.

Table VII summarizes the data on the heat of vaporization. Table VII also compares the measured heat of vaporization with that calculated from equation (2) and thermodynamics using the modified Berthelot equation of state with the critical constants given in the table. It is almost unnecessary to state that the measured heat of vaporization is the correct value. The comparison indicates that the Berthelot correction, and also B, is too small by 15.8% (at the boiling point). A value of the heat of vaporization calculated from equation (2) at 200°K. in the same manner is also given.

This is used in calculating the entropy of the ideal gas at 200°K.

TABLE VII

MOLAL HEAT OF VAPORIZATION OF DIMETHYL ETHER AT THE NORMAL BOILING POINT

Mol. wt. = 46.069; boiling point = 248.34 ± 0.05°K.

Moles vaporized	Mean temp. of vapn., °K.	Total input, cal./mole	$\int C_p dT$, cal./mole	ΔH at 248.36°K., cal./mole
0.128734	248.17	5192.9	47.8	5142.8
.126580	248.12	5190.6	48.0	5139.7
.121016	248.23	5225.6	82.1	5141.9
.123579	248.34	5177.4	37.3	5139.8
			Mean	5141.0 ± 5.0
Calculated from equation (2) and critical data of Maass and Winkler,[10] (T_c = 399.4°K., P_c = 53 atm. Berthelot correction = 168.44 cal.)				5118.7 ± 5.0
Calculated from equation (2) and same critical data at 200°K. (Berthelot correction = 20.6 cal.)				5673.7 ± 5

Comparison of the Entropy from Thermal Data with the Entropy from Molecular Data.—Table VIII summarizes the calculation of the entropy from calorimetric data at the normal boiling point. Table IX summarizes the calculation from molecular data at 200°K. and at the normal boiling point.

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[6] (a) Giauque and Johnston, THIS JOURNAL, **51**, 2300 (1929); (b) This apparatus was built by Dr. S. C. Schumann and will be described in a forthcoming publication. We are indebted to him for making this and the calorimeter available, and for invaluable help in the measurements.

[7] Cawood and Patterson, *J. Chem. Soc.*, 619–24 (1933).

[8] Batuecas, *J. chim. phys.*, **22**, 111 (1925).

[9] Baumé, *ibid.*, 1, 89 (1908).

[10] Maass and Winkler, *Can. J. Research*, **6**, 458 (1932).

At 200°K., the vibrational contribution to the entropy is one-half that at 248.34°K. The Berthelot correction in calculating the heat of vaporization from the vapor pressure equation is 0.4% of the heat of vaporization as compared to 3.3% at 248.34°K. Thus any uncertainty in the frequency assignment is reduced and no corresponding error is introduced from the heat of vaporization.

TABLE VIII

MOLAL ENTROPY OF DIMETHYL ETHER FROM THERMAL DATA

Mol. wt. = 46.069; 0°C. = 273.16°K.

	E. u.	
0 to 14.13°K., Debye extrapolation, (6 degrees of freedom, θ = 148.0)	0.265	
14.13 to 131.66°K., graphical	15.974	
Fusion, 1179.8/131.66	8.960	
131.66 to 200.00°K., graphical	9.825	
Entropy of liquid at 200.00 °K.	35.03 ± 0.07	35.03 ± 0.07
Vaporization 5673.7/200.00		28.37
Entropy real gas at 0.06710 atm.		63.40
Gas imperfection correction[a]		0.004
Entropy ideal gas at 0.06710 atm.		63.404
ΔS for ideal gas from 0.06710 to 1 atm.		−5.37
Entropy ideal gas at 200.00 °K., 1 atm.		58.03 ± 0.10
200 to 248.34°K., graphical	5.215	
Vaporization, 5141.0/248.34	20.700	
Entropy real gas at N. B. P.	60.95	
Gas imperfection[a]	0.06	
Entropy ideal gas at N. B. P.	61.01 ± 0.15	
Entropy ideal gas at 298.16 °K., 1 atm.	63.72 ± 0.20	
Entropy liquid at 298.16°K.	44.98 ± 0.40	

[a] $S_{\text{ideal}} - S_{\text{real}} = 27RT_c{}^3P/32T^3P_c$; P_c = 53 atm.; T_c = 399.4°K.

TABLE IX

THE ENTROPY OF DIMETHYL ETHER IN THE IDEAL GAS STATE FROM MOLECULAR AND SPECTROSCOPIC DATA

	Entropy, cal./deg./mole T = 200.00°K.	Entropy, cal./deg./mole T = 248.34°K.
Translation + external rotation of rigid molecule	54.91	56.63
Vibrational	0.47	0.84
Total	55.38 ± 0.10	57.47 ± 0.10
Calorimetric	58.03 ± 0.10	61.01 ± 0.15
$s_{rr} \times 2$	2.65	3.54
$S_f \times 2$ ($I_{me} = 4.86 \times 10^{-40}$)	6.22	6.65
$(S_f - S) \times 2$ (Exptl.)	3.57	3.11
$(S_f - S) \times 2$ (V = 3100, $I_{me} = 4.86 \times 10^{-40}$)	3.57	3.15

In calculating the entropy from molecular data, the following molecular dimensions were used:[11] C–H, 1.09 Å.; C–O, 1.42 Å.; C–O–C angle, 111°; H–C–H angle, 109°28′. The values obtained for the principal external moments are: $A = 83.42 \times 10^{-40}$, $B = 21.65 \times 10^{-40}$, $C = 94.46 \times 10^{-40}$, all in g. cm.^{2}. The reduced moment of the methyl group is 4.86×10^{-40} g. cm.^{2}. The symmetry number for the rigid molecule is 2, whence

$$S_{\text{rigid rotation}} = 3/2R \ln T + 3.698 \qquad (3)$$

The translational entropy is

$$S_{\text{trans.}} = 5/2\, R \ln T + 9.102 \qquad (4)$$

The following values of the necessary constants were used:[12] $N = 6.0227 \times 10^{-23}$; $h = 6.62365 \times 10^{-27}$ erg. sec.; $k = 1.38052 \times 10^{-16}$ erg./deg.; R = 1.98688 cal./deg. The frequency assignment was that of Crawford and Joyce.[13] The frequencies used, in cm.$^{-1}$, were: carbon–oxygen skeleton: ν (σ), 1122; ν (π) 940; δ, 412. CH_3 (internal): ${}^6\nu$, 2900; ${}^4\delta$ (π), ${}^2\delta$ (σ), 1466. Hydrogen (external) ${}^4\delta$, 1180.

Discussion

The value of 3100 ± 150 cal. for the potential hindering each methyl group in dimethyl ether is derived from the data at 200°K. The chief error possible is that in the vibrational assignment. However, the total contribution to the entropy of the vibrational degrees of freedom is only 0.47 e. u. so that any error from this source seems unlikely, especially in view of the close check of entropy calculated using this potential at 248.34°K. where the vibration contribution is 0.84 e. u.

The same cannot be said of the value of 2500 cal. obtained from the heat capacity measurements of Kistiakowsky and Rice.[1] In this case the vibrational contribution is an important part of the heat capacity and hence any error in the frequency assignment has a serious effect on the potential. Assuming 3100 cal. as the correct value and that the gaseous heat capacity measurements are correct, it follows that the vibra-

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(11) Pauling and Brockway, THIS JOURNAL, **67**, 2684 (1935).

(12) Birge, Aug. 1939. Private communication through Professor H. S. Taylor. These constants are slightly different from those used in previous papers from this Laboratory, silicon tetramethyl excepted.

(13) Crawford and Joyce, *J. Chem. Phys.*, **7**, 307 (1939).

tional assignment used was not correct. Since the same assignment is used in this paper the values of the vibrational entropy must also be in some error but the absolute value of this error must be small for the reason given above.

The corresponding potential of 2000 cal. for dimethyl sulfide[14] seems somewhat high in view of the fact that the potential hindering internal rotation of the methyl groups in the case of tetramethylmethane is 5000 cal.[15] while that in the case of silicon tetramethyl[16] is only 1300 cal.

Acknowledgment.—We wish to thank Dr. R. B. Greenburg for the preparation of the extremely pure sample of dimethyl ether, and also Dr. S. C. Schumann for making the liquid hydrogen and measurements with the adiabatic calorimeter. The Grants-in-Aid of the National Research Council with which much of the apparatus was purchased made this work possible.

Summary

1. Pure dimethyl ether has been prepared with impurity of the order of 1 part per million.

2. The normal boiling point of dimethyl ether is 248.34 ± 0.05°K. (− 24.82°C.). The vapor pressure of the liquid from 170 to 190°K. can be represented by the equation

$$\log P_{\text{mm.}} = (4245.203/T) + 120.4931 \log T - 0.1225960T - 272.249320$$

and from 190 to 249°K. by the equation

$$\log P_{\text{mm.}} = (-1691.806/T) - 6.045600 \log T + 0.001957540T + 23.6861850$$

3. The melting point of dimethyl ether is 131.66 ± 0.05°K. (− 141.50°C.).

4. The heat capacity of solid and liquid dimethyl ether has been measured from 13.2 to 248.3°K.

5. The heat of fusion of dimethyl ether has been found to be 1179.8 ± 0.9 cal. per mole.

6. The heat of vaporization determined calorimetrically is 5141 ± 5 cal. per mole.

7. The second virial coefficient of dimethyl ether as determined from the density is − 0.4461 ± 0.0015 liter per mole at 298°K.

8. The molal entropy of the ideal gas calculated from the experimental data at the normal boiling point and 1 atmosphere is 61.01 ± 0.15 cal./deg. mole. At 200°K. and 1 atmosphere it is 58.03 ± 0.10 cal./deg. mole.

9. To bring the values of the entropy calculated from molecular data into agreement with the values from the calorimetric data requires the assumption of three equal potential energy maxima of 3100 ± 150 cal. hindering the internal rotation of the methyl groups. These are shown probably to be due to repulsive forces.

10. The entropies of the ideal gas and the superheated liquid at 298.16°K. are 63.72 ± 0.20 and 44.98 ± 0.40 cal./deg. mole, respectively.

STATE COLLEGE, PENNA. RECEIVED MAY 19, 1941

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[14] Osborne, Doescher and Yost, *J. Chem. Phys.*, **8**, 506 (1940).

[15] Aston, *Chem. Rev.*, **27**, 59 (1940).

[16] Aston and Kennedy, THIS JOURNAL, **62**, 2567 (1940).

NOTES

An Investigation of the Oil from *Amaranthus retroflexus* Seeds

BY BERT E. CHRISTENSEN AND LEWIS S. MILLER

The purpose of this investigation is to determine the nature of the oil present in the seeds of the *Amaranthus retroflexus* L. of the family *amaranthaceae* (red root pig weed plant). Although the plant is very common and yields a considerable crop of a small seed, little information is available regarding the nature of the fatty oils which might be obtained from this source.[1] The seeds in this study were collected in Oregon, in October, 1940. The hulls were removed and the ground seed was extracted in a soxhlet apparatus. The *Amaranthus retroflexus* seed was found to contain 7% of an ether-extractable oil, the physical and chemical characteristics of which are given in Table I. Due to the limited amount of oil available semimicro methods were used throughout the investigation.[2,3]

Experimental

To meet the demands of this problem it was necessary to

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[1] A. D. Furshaev and N. S. Nozarova, *Trans. Soratov Univ.*, **11**, No. 1, 25–45 (1934).

[2] E. Chargaff, *Z. physiol Chem.*, **199**, 221–224 (1931).

[3] Jamieson, "Vegetable Fats and Oils," American Chemical Society Monograph Series, The Chemical Catalog Co., Inc., New York, N. Y.