LXXIII.—*Determinations of Vapour-pressures of Alcohols and Organic Acids, and the Relations existing between the Vapour-pressures of the Alcohols and Organic Acids.*

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Apparatus Used.—The vapour-pressures of the alcohols and acids were determined by means of the apparatus described by Drs. Ramsay and Young (*Chem. Soc. Trans.*, 1885, 42). The following alcohols and acids were examined :—

Methyl Alcohol, obtained from Kahlbaum as free from acetone, was distilled after standing 24 hours over calcium oxide, the last traces of water being then removed by treatment with small quantities of metallic sodium and subsequent distillation. It boiled at $65\cdot8^{\circ}$ at 760 mm.

Ethyl Alcohol.—A nearly pure specimen was provided by Dr. Ramsay, the last traces of water being removed by distillation after treatment with metallic sodium. It boiled at $78\cdot2^{\circ}$ at 760 mm.

Normal Propyl Alcohol (pure from Kahlbaum) was distilled after treatment with metallic sodium, as in the previous cases; the fraction which distilled over at $97\cdot2^{\circ}$ at 746·4 mm. was taken as pure.

Experimental Results.

The numbers representing the vapour-pressures of the alcohols and acids at different temperatures are given in the following tables; in all cases two series of experiments were made for each substance in order to check the results obtained.

Vapour-pressures.

Methyl alcohol.				Ethyl alcohol.			
1st experiment.		2nd experiment.		1st experiment.		2nd experiment.	
Temp. in C.°	Pressure in mm.	Temp. in C.°	Pressure in mm.	Temp. in C.°	Pressure in mm.	Temp. in C.°	Pressure in mm.
- 8·3	17·3	- 10·1	15·05	4·2	16·89	- 3·3	10·23
- 7·3	19·2	- 7·3	18·32	4·8	17·94	+ 7·3	22·39
- 3·3	24·33	- 6·3	19·09	8·8	23·31	13·6	30·67
- 2·3	25·23	- 6·3	19·44	9·8	24·51	19·8	45·22
+ 0·7	32·06	- 5·3	21·24	10·7	25·80	23·5	56·25
2·2	35·15	- 4·8	20·54	17·2	38·57	26·8	68·96
4·2	38·30	- 1·7	26·92	21·8	50·72	29·6	80·61
6·25	43·88	+ 0·2	28·67	22·6	51·96	30·7	83·86
8·5	48·97	4·7	36·89	23·1	54·86	32·8	95·10
11·2	55·82	7·7	48·87	25·3	62·48	34·8	104·81
12·0	59·84	12·2	58·48	27·3	71·11	37·3	119·97
16·7	77·99	14·7	68·72	30·7	81·86	42·2	155·59
22·7	108·96	20·7	94·03	35·3	107·22	43·8	165·41
27·3	133·55	23·7	112·19	36·6	114·59	46·5	189·56
30·2	155·34	25·7	124·85	40·1	138·41	50·05	226·99
33·3	183·77	31·7	158·07	43·1	162·96	52·8	257·52
39·2	235·13	36·2	202·83	47·2	199·18	55·50	258·49
43·7	289·84	46·6	332·37	49·6	222·87	59·80	349·02
49·2	370·26	54·7	459·22	53·7	269·83	65·80	451·48
56·7	500·20	58·7	552·47	57·3	320·87	68·80	513·76
59·9	584·24	66·45	754·9	61·0	370·12	71·10	569·64
65·7	753·05	—	—	—	—	73·80	642·98

Isobutyl Alcohol, supplied pure from Kahlbaum, was fractionated; after treatment with sodium the greater portion passed over at 107·7° at 755 mm.; this fraction was used.

Isoamyl Alcohol.—A sample, provided by Dr. Ramsay, was fractionated; after treatment with sodium that portion boiling constantly at 130·1° at 760 mm. was taken as pure (p. 764).

Glycerol.—A sample was taken, distilled in a vacuum, and the distillate collected when the boiling point was constant; this portion was considered free from water.

Formic Acid, obtained from Kahlbaum, was distilled, and the fraction which boiled constantly at 101.3° at 760 mm. was used.

Acetic Acid.—A pure specimen was provided by Dr. Ramsay. It boiled at 118.5° at 760 mm. (p. 765).

Propionic Acid.—A specimen obtained from Kahlbaum was fractionated, and the distillate which passed over at 140.3° at 760 mm. was taken as pure.

Isobutyric Acid was fractionated, and the portion which boiled constantly at 153° at 760 mm. was used (p. 766).

Isovaleric Acid.—An aqueous solution was distilled, and the fraction boiling above 150° was repeatedly shaken with phosphoric pentoxide; on again distilling, the greater portion passed over at 174.9° at 750 mm.; this fraction was taken as pure (p. 767).

Vapour-pressures—continued.

Normal propyl alcohol.				Isobutyl alcohol.			
1st experiment.		2nd experiment.		1st experiment.		2nd experiment.	
Temp. in $^{\circ}\text{C}$.	Pressure in mm.	Temp. in $^{\circ}\text{C}$.	Pressure in mm.	Temp. in $^{\circ}\text{C}$.	Pressure in mm.	Temp. in $^{\circ}\text{C}$.	Pressure in mm.
11.45	8.56	1.7	4.59	32.8	18.44	25.3	11.212
14.9	10.96	2.3	4.59	46.8	42.92	35.4	21.426
23.7	18.82	4.8	5.19	52.8	62.68	37.9	26.160
28.2	24.96	6.2	5.78	57.8	88.76	42.0	33.123
33.8	34.90	10.8	7.84	61.3	98.68	46.7	44.069
35.1	39.81	11.7	8.83	66.0	116.29	50.8	55.666
36.7	40.67	13.2	9.49	67.75	134.85	54.9	71.61
38.2	45.50	13.7	9.49	69.9	151.20	58.8	85.86
39.2	47.40	20.7	15.46	74.8	194.68	62.3	103.043
41.7	54.88	30.6	29.04	77.2	213.77	65.8	123.920
44.7	65.21	33.7	35.23	78.7	226.82	66.0	124.617
48.1	84.32	36.7	40.81	80.55	244.61	68.8	134.110
53.9	106.92	43.7	61.67	81.0	259.56	71.8	166.62
55.7	119.25	46.7	73.50	83.6	284.30	73.8	182.38
56.5	129.23	48.7	83.53	85.3	304.47	75.9	204.09
59.7	143.0	75.2	300.67	87.3	332.32	78.7	229.45
62.5	163.96	81.9	400.67	90.3	378.12	81.3	259.001
66.2	214.75	94.1	711.01	92.8	418.12	84.8	297.587
68.7	220.74	97.2	746.45	95.8	478.117	87.8	347.467
74.5	287.3	—	—	98.05	524.86	91.55	399.35
79.2	358.75	—	—	101.55	593.86	92.95	428.94
85.7	477.51	—	—	102.75	626.264	95.40	468.978
90.2	566.22	—	—	104.8	669.113	96.80	527.363
97.2	745.45	—	—	105.8	708.36	100.7	575.651
—	—	—	—	—	—	102.8	630.890
—	—	—	—	—	—	104.8	680.830
—	—	—	—	—	—	107.7	755.114

Vapour-pressures—continued.

Isoamyl alcohol.				Glycerol.			
1st experiment.		2nd experiment.		1st experiment.		2nd experiment.	
Temp. in C°.	Pressure in mm.	Temp. in C°.	Pressure in mm.	Temp. in C°.	Pressure in mm.	Temp. in C°.	Pressure in mm.
34·7	7·27	35·8	6·896	118·45	0·238	122·8	0·597
41·9	9·97	46·5	14·0	118·75	0·298	127·91	0·746
53·8	21·87	47·8	15·67	120·77	0·348	135·51	1·165
66·68	46·58	58·3	29·34	122·92	0·398	136·52	2·340
72·80	63·93	65·55	42·853	123·85	0·448	145·555	3·285
77·65	82·87	67·8	48·16	127·91	0·4978	152·34	4·659
84·40	116·60	70·3	56·56	130·8	1·891	163·36	7·417
90·55	150·98	73·0	65·46	134·8	1·941	169·70	12·059
91·90	164·93	74·25	69·613	137·025	2·00	175·52	15·683
92·30	167·92	76·8	79·06	138·39	2·191	183·40	20·512
95·65	193·08	78·05	85·66	139·04	2·338	192·0	30·62
96·80	196·07	81·55	100·04	141·04	2·588	199·8	41·81
103·80	276·15	82·05	102·548	141·04	2·387	205·8	52·767
104·0	279·04	84·9	107·18	143·645	3·046	211·55	68·703
107·0	314·72	85·8	113·609	147·06	3·385	217·3	86·725
107·70	319·71	88·95	143·0	151·99	4·083	224·3	115·25
109·30	345·96	89·55	145·5	161·25	6·527	227·0	130·535
111·50	387·0	90·6	155·56	162·45	8·115	229·8	144·87
111·80	388·67	93·7	175·87	171·05	12·694	237·1	183·503
112·80	399·80	95·65	190·41	172·80	12·745	246·4	239·95
115·80	452·20	99·20	220·60	183·25	20·461	248·5	258·627
118·80	524·21	101·80	253·59	195·30	34·369	245·3	266·85
120·80	536·81	103·7	273·52	200·8	44·865	257·3	347·092
123·50	598·40	106·8	304·74	201·3	45·61	—	—
124·80	628·92	108·8	334·42	211·5	65·61	—	—
128·55	681·46	110·9	370·44	220·3	100·813	—	—
—	—	114·3	417·7	229·5	137·95	—	—
—	—	121·1	524·36	241·80	201·225	—	—
—	—	123·6	591·75	250·3	231·872	—	—
—	—	—	—	260·4	385·326	—	—

Vapour-pressures—continued.

Formic Acid.				Acetic Acid.			
1st experiment.		2nd experiment.		1st experiment.		2nd experiment.	
Temp. in C°.	Pressure in mm.	Temp. in C°.	Pressure in mm.	Temp. in C°.	Pressure in mm.	Temp. in C°.	Pressure in mm.
55·9	151·9	18·5	28·657	2·72	4·0	5·59	4·9
61·1	185·39	22·7	34·588	7·06	5·25	6·11	5·0
68·7	245·2	29·7	47·844	10·60	6·50	6·87	5·10
76·2	318·72	39·1	73·262	15·5	9·10	7·62	5·50
82·7	391·23	44·45	82·97	20·1	12·00	8·27	5·90
87·7	467·47	57·3	156·89	31·3	21·80	9·70	6·20
91·2	529·03	64·9	207·423	36·1	28·30	10·7	6·75
92·7	562·17	68·6	238·22	40·1	34·30	14·72	8·50
96·6	648·89	71·7	276·90	48·5	51·70	17·00	9·75
97·9	677·76	75·2	310·088	57·4	78·70	25·60	15·95
100·45	728·43	—	—	59·6	87·60	—	—
101·7	762·52	—	—	68·5	127·50	—	—
3rd experiment.				69·1	131·90	—	—
				73·2	156·20	—	—
				81·65	215·20	—	—
				91·4	307·90	—	—
				100·6	425·20	—	—
				105·45	501·80	—	—
				110·4	587·10	—	—
				114·1	657·50	—	—
				117·15	717·90	—	—
				—	—	—	—
				—	—	—	—
				—	—	—	—
				—	—	—	—
				—	—	—	—
				—	—	—	—
		Temp. in C°.	Pressure in mm.				
		5·7	13·46				
		6·1	14·60				
		7·2	13·46				
		10·2	17·44				
		13·2	20·93				
		21·7	32·94				
		29·7	48·33				
		35·7	65·02				
		44·3	84·82				
		46·2	99·165				
		57·2	152·96				

Vapour-pressures—continued.

Propionic acid.				Isobutyric acid.			
1st experiment.		2nd experiment.		1st experiment.		2nd experiment.	
Temp. in C.°	Pressure in mm.	Temp. in C.°	Pressure in mm.	Temp. in C.°	Pressure in mm.	Temp. in C.°	Pressure in mm.
15·45	2·74	13·9	2·49	23·8	0·996	44·05	5·873
16·2	2·74	14·7	2·98	32·6	2·097	48·55	7·366
20·2	2·99	16·7	3·587	32·6	2·193	67·20	20·90
28·7	4·73	20·45	3·98	34·55	2·798	70·60	24·73
31·7	5·48	24·7	4·98	37·55	3·584	85·80	53·25
31·7	5·48	49·6	15·84	38·8	3·787	92·30	72·71
35·7	6·97	56·2	21·92	51·8	12·158	98·80	97·79
39·7	8·37	60·12	19·44	64·8	18·436	104·80	127·90
46·7	13·20	65·2	35·87	76·4	34·78	110·30	160·00
55·0	22·02	81·2	76·73	83·8	51·07	115·80	205·29
69·7	43·85	92·7	131·34	89·8	66·369	123·00	279·04
77·7	66·27	103·2	196·56	96·3	89·09	126·80	308·57
83·2	86·45	117·7	338·08	103·8	129·75	131·20	358·84
87·7	104·139	135·7	649·74	107·3	147·09	136·05	411·19
100·7	176·39	—	—	111·8	177·237	143·80	552·24
108·7	247·89	—	—	119·3	236·03	153·3	761·27
113·7	303·44	—	—	124·3	283·66	—	—
120·3	388·80	—	—	130·55	358·76	—	—
125·45	453·50	—	—	133·80	406·59	—	—
132·7	572·25	—	—	135·55	451·03	—	—
135·7	650·00	—	—	139·80	522·03	—	—
140·3	760·0	—	—	143·80	601·49	—	—

Vapour-pressures—continued.

Isovaleric acid.					
1st experiment.		2nd experiment.		3rd experiment.	
Temp. in C.°	Pressure in mm.	Temp. in C.°	Pressure in mm.	Temp. in C.°	Pressure in mm.
51·3	2·588	51·79	2·741	55·4	3·388
59·4	3·635	56·25	3·335	73·51	10·714
60·8	4·678	58·74	3·932	88·85	23·99
69·9	8·212	62·725	4·977	96·10	34·88
88·2	22·891	65·45	5·725	106·22	58·149
92·9	28·468	73·51	9·955	111·36	62·588
102·4	46·982	84·12	18·914	115·42	80·727
107·8	56·225	89·35	24·291	123·85	122·595
111·8	74·354	92·51	28·372	130·0	154·785
120·55	104·96	93·32	29·867	133·01	174·01
124·4	125·71	93·82	31·087	135·02	185·552
128·8	155·873	96·81	35·977	138·04	218·262
130·9	186·929	101·38	42·45	142·25	253·443
136·4	212·014	106·275	55·891	146·36	292·310
140·0	264·05	112·09	63·805	151·29	349·716
145·8	299·31	112·62	72·273	155·01	399·95
151·8	370·674	114·65	81·482	155·11	398·611
155·8	436·72	116·70	88·799	157·20	434·53
157·6	479·06	124·05	122·298	158·26	440·91
161·3	557·0	133·0	175·159	163·45	526·52
173·3	645·19	138·25	218·114	171·15	673·23
—	—	143·05	256·192	174·93	744·99
—	—	148·67	312·085	—	—
—	—	150·3	368·386	—	—
—	—	153·1	369·531	—	—
—	—	158·27	434·039	—	—
—	—	162·4	492·774	—	—
—	—	165·625	551·877	—	—
—	—	171·25	673·252	—	—
—	—	176·0	745·587	—	—

From the construction of the apparatus used for making the vapour-pressure determinations, it is obvious that errors arising from the vapour becoming superheated are entirely avoided, for even if the vapours should become superheated, the liquid in contact with the thermometer bulb must be at the true boiling point, since it has a free surface of evaporation; that the temperature was sufficiently high was insured by keeping the temperature of the bath at least 30° higher than that of the evaporating liquid. The numbers given also represent the true vapour-pressures of the substances experimented on, for it has been shown by Regnault and others that the statical and

dynamical methods of measuring vapour-pressures give identical results; as, however, this identity has been denied by Kahlbaum (*Siedetemperatur und Druck*, Leipzig, 1885), the vapour-pressures of methyl and ethyl alcohol as obtained by the two methods are compared in the following table:—

Mm.	Methyl alcohol.		Ethyl alcohol.	
	Regnault.	Richardson.	Regnault.	Richardson.
50.....	10° C.	9° C.	22·2° C.	21·8° C.
100.....	22·45	21·8	34·8	34·0
150.....	30·2	30·0	42·2	41·8
200.....	36·0	35·9	48·0	47·4
250.....	40·9	40·5	52·6	52·2
300.....	44·7	54·4	56·6	56·0
350.....	48·0	47·9	60·0	59·5
400.....	51·1	51·0	62·7	62·5
450.....	54·0	54·4	65·9	65·5
500.....	56·8	56·5	68·5	68·3
550.....	58·8	58·5	70·3	70·0

The vapour-pressures of some of the acids of the acetic series have been determined by Landolt (*Annalen*, Sup. 6, 129), but I believe his results are untrustworthy for the following reasons:—

(1.) In the case of the higher acids, the observed boiling points do not agree with those calculated from his formulæ; for example: Butyric acid; observed boiling point 163° at 765·3 mm.; calculated 160·8° at 760 mm. Valeric acid; observed boiling point 175·6° to 176·1° at 766·2 mm.; calculated 173·7° at 760 mm.

(2.) In no case does Landolt appear to have boiled the mercury in his barometer tube; unless this is done it is impossible to insure absence of air in the tubes filled by such a method as he adopted. Landolt believed that errors due to this cause were eliminated by filling both the barometer and the experimental tubes in precisely the same way; it is extremely probable, however, that air adhering to the glass in the experimental tube would be carried up by the liquid as it rose through the mercury on being introduced from below, whereas in the barometer tube the air would remain for the most part adhering to the sides of the tube.

(3.) If Landolt's results for valeric acid are closely examined it will be seen—

(a.) That the boiling points of the two samples which he employed were almost identical.

(b.) That the vapour-pressures of the two samples at 40° were

respectively 18.9 mm. and 12 mm., corresponding to a temperature difference of about 14°.

(c.) That the vapour-pressures at 178.2° (slightly above the boiling point) differed in the two samples by 49.5 mm., equivalent to a difference in temperature of about 2°.

Now it has been proved that vapour-pressure determinations by the dynamical and statical methods are identical when the substance under examination is pure, and the fact that the boiling points of Landolt's two samples were almost identical whilst the vapour-pressures at the boiling points were widely different, can only be explained in one of two ways, either the substances were impure, or the determinations of the vapour-pressures were inaccurate (this remark applies to 1).

(4.) It has been shown with more than 50 substances that, when compared with water, the value C in the equation $R' = R + C(t' - t)$ is a constant through wide limits of pressure; the only observed exceptions are mercury, as determined by Regnault, and acetic, propionic, butyric, and valeric acids, as determined by Landolt; owing to this apparent anomaly in the case of mercury and to the unsatisfactory nature of Regnault's experiments with this substance, the vapour-pressures of mercury have been redetermined by Ramsay and Young, who find that mercury does not really form an exception to the above law. If the vapour-pressures of the acids given in this paper are correct, then these substances also conform to the law, whereas if Landolt's results are correct they are the only known exceptions to it.

Observed Relations between the Vapour-pressures of the Alcohols and Acids.

These substances were compared amongst themselves in order to ascertain whether a relation existed between them similar to that observed by Ramsay and Young (*Phil. Mag.*, Dec., 1885) between chlorobenzene and bromobenzene and between chloride and bromide of ethyl and other nearly allied compounds, where it was shown that the ratios of the absolute temperatures corresponding to equal vapour-pressures remain constant for very wide ranges of vapour-pressure. The acids and alcohols were also considered with reference to the further relation which exists between compounds not necessarily allied in properties and composition, for Ramsay and Young have shown that the ratios of the absolute temperatures of any two substances corresponding to an equal vapour-pressure are either constant for all vapour-pressures, or else the ratios increase or decrease with rise in temperature by an amount which is directly proportional to the rise in temperature.

In the subjoined table, the ratios of the absolute temperature of the

alcohols and acids are given for vapour-pressures between 50 mm. and 750 mm. It will be seen that in the case of methyl and ethyl alcohol, the ratio of the absolute temperature at 50 mm. is 1:1.045, diminishing with increased vapour-pressure to 1:1.035 at 700 mm.; a decrease is observed in the value of the ratios between ethyl and propyl alcohol from 1:1.062 to 1:1.051. In the case of propyl and isobutyl alcohol, however, the variation is much smaller, the ratio at 50 mm. being 1:1.027, at 700 mm. 1:1.029, whilst the value of the ratio of isobutyl and isoamyl alcohol is practically a constant for all vapour-pressures between 50 mm. and 750 mm.

Similarly the ratios of the absolute temperatures of formic acid and acetic acid vary considerably, being at low vapour-pressures 1:1.059, falling as the pressure rises to 1:1.049; so also with acetic and propionic acids, a fall in ratio from 1:1.071 to 1:1.054, accompanies the rise in vapour-pressure. On ascending the series, propionic and isobutyric acids are much more nearly constant in the values of their ratios at different vapour-pressures, being at 50 mm. 1:1.030, and at 750 mm. 1:1.037, the value of the ratios approaching a constant for all vapour-pressures between 50 mm. and 750 mm., in the case of isobutyric and isovaleric acids.

It would appear, therefore—

(1.) That the ratios of the absolute temperatures of the lower alcohols and acids diminish with increased vapour-pressure.

(2.) That among the higher alcohols and acids in the series the value of the ratios tends to become a constant number for vapour-pressures between 50 mm. and 750 mm.

Comparison of the Ratio of the Absolute Temperature of Alcohols and Acids for Vapour-pressures between 50 and 750 mm.

Mm.	Alcohols.						Acids.	
	CH ₃ ·OH to C ₂ H ₅ ·OH.		C ₂ H ₅ ·OH to C ₃ H ₇ ·OH.		Normal C ₃ H ₇ ·OH to C ₄ H ₉ ·OH		Iso C ₄ H ₉ ·OH to C ₃ H ₁₁ ·OH.	
	1	1·045	1	1·062	1	1·027	1	1·059
50.....	..	1·042	..	1·060	..	1·028	..	1·058
100.....	..	1·042	..	1·060	..	1·027	..	1·059
150.....	..	1·037	..	1·059	..	1·026	..	1·060
200.....	..	1·037	..	1·059	..	1·026	..	1·059
250.....	..	1·036	..	1·059	..	1·027	..	1·059
300.....	..	1·036	..	1·058	..	1·028	..	1·057
350.....	..	1·035	..	1·058	..	1·028	..	1·059
400.....	..	1·035	..	1·056	..	1·028	..	1·059
450.....	..	1·036	..	1·056	..	1·028	..	1·059
500.....	..	1·036	..	1·054	..	1·028	..	1·059
550.....	..	1·036	..	1·054	..	1·029	..	1·059
600.....	..	1·035	..	1·053	..	1·029	..	1·059
650.....	..	1·035	..	1·053	..	1·029	..	1·059
700.....	..	1·036	..	1·051	..	1·029	..	1·059
750.....	..	1·036	..	1·051	..	1·029	..	1·059

Acids—continued.

Mm.	CH ₃ ·COOH to C ₂ H ₅ ·COOH.		C ₂ H ₅ ·COOH to C ₃ H ₇ ·COOH.		C ₃ H ₇ ·COOH to C ₄ H ₉ ·COOH.	
50.....	1	1·071	1	1·037	1	1·053
100.....	..	1·072	..	1·035	..	1·054
150.....	..	1·069	..	1·031	..	1·056
200.....	..	1·069	..	1·030	..	1·056
250.....	..	1·067	..	1·031	..	1·053
300.....	..	1·062	..	1·033	..	1·053
350.....	..	1·061	..	1·033	..	1·052
400.....	..	1·068	..	1·033	..	1·054
450.....	..	1·061	..	1·032	..	1·051
500.....	..	1·060	..	1·031	..	1·051
550.....	..	1·059	..	1·031	..	1·051
600.....	..	1·059	..	1·031	..	1·051
650.....	..	1·057	..	1·032	..	1·051
700.....	..	1·056	..	1·032	..	1·052
750.....	..	1·054	..	1·031	..	1·053

Additional proof of the truth of the second relation is afforded by comparing the vapour-pressures of these compounds with those of water, that substance being taken as the standard, since the determinations of the vapour-pressures of water between 0° and 100° (*i.e.*, up to one atmosphere) are more trustworthy than those of any other substance. In the following table, in which the ratios of the absolute temperatures of the alcohols and acids to those of water are given, it is seen that the coefficient (C) of increase or decrease of the ratio per unit rise of temperature of the standard substance (water) is a constant.

The true values of C having been obtained graphically, the ratios found were corrected and the absolute temperatures of the acids and alcohols at the required pressures were calculated by multiplying those of water by the corrected ratios, the absolute temperatures were then reduced to degrees Centigrade and compared with the observed results.

It will be seen by referring to the annexed tables, that, with one or two exceptions, the two sets of numbers agree well. Obviously this is a simple method for smoothing the observed results of vapour-pressure determinations.

Ratio of the Absolute Temperatures of Alcohols and Acids to Water at Vapour-pressures between 50 mm. and 750 mm.

Mm.	H ₂ O.	Alcohols.											
		CH ₃ .OH.		C ₂ H ₅ .OH.		C ₃ H ₇ .OH.		C ₄ H ₉ .OH.		C ₅ H ₁₁ .OH.			
		Observed.	Calculated. C = 0·0007.	Observed.	Calculated. C = 0·0009.	Observed.	Calculated. C = 0·0025.	Observed.	Calculated. C = 0·0022.	Observed.	Calculated. C = 0·0025.		
50.....	1	0·9059	0·9066	0·9474	0·9474	1·0064	1·0064	1·0344	1·0344	1·0964	1·0950		
100.....	..	0·9079	0·9076	0·9455	0·9460	1·0021	1·0030	1·0311	1·0310	1·0918	1·0918		
150.....	..	0·9076	0·9080	0·9451	0·9454	1·0018	1·0010	1·0292	1·0291	1·0911	1·0898		
200.....	..	0·9096	0·9055	0·9435	0·9440	0·9997	0·9997	1·0262	1·0278	1·0890	1·0882		
250.....	..	0·9094	0·9090	0·9439	0·9444	1·0000	0·9984	1·0264	1·0267	1·0874	1·0870		
300.....	..	0·9090	0·9091	0·9429	0·9440	0·9983	0·9972	1·0261	1·0255	1·0860	1·0859		
350.....	..	0·9095	0·9095	0·9430	0·9438	0·9977	0·9963	1·0261	1·0250	1·0849	1·0850		
400.....	..	0·9101	0·9099	0·9424	0·9434	0·9966	0·9955	1·0247	1·0240	1·0830	1·0841		
450.....	..	0·9101	0·9102	0·9431	0·9431	0·9953	0·9949	1·0237	1·0233	1·0837	1·0834		
500.....	..	0·9110	0·9103	0·9434	0·9430	0·9958	0·9941	1·0225	1·0225	1·0824	1·0827		
550.....	..	0·9100	0·9105	0·9427	0·9427	0·9926	0·9935	1·0225	1·0221	1·0818	1·0820		
600.....	..	0·9099	0·9107	0·9414	0·9425	0·9911	0·9930	1·0215	1·0217	1·0810	1·0815		
650.....	..	0·9097	0·9108	0·9418	0·9424	0·9911	0·9925	1·0206	1·0212	1·0805	1·0810		
700.....	..	0·9093	0·9109	0·9418	0·9421	0·9903	0·9920	1·0205	1·0209	1·0804	1·0809		
750.....	..	0·9100	0·9110	0·9425	0·9420	0·9909	0·9915	1·0204	1·0204	1·0810	1·0800		

Acids.

Mm.	H ₂ O.	H ₂ .COOH.		CH ₃ .COOH.		C ₂ H ₅ .COOH.		C ₃ H ₇ .COOH.		C ₄ H ₉ .COOH.	
		Observed.	Calculated. C=0·0047.	Observed.	Calculated. C=0·0040.	Observed.	Calculated. C=0·0001.	Observed.	Calculated. C=0·0002.	Observed.	Calculated. C=0·0013.
50	1	0·9766	0·9774	1·0314	1·0271	1·1083	1·1083	1·1494	1·1450	1·2111	1·2100
100	..	0·9852	0·9838	1·0333	1·0321	1·1078	1·1086	1·1463	1·1448	1·2082	1·2082
150	..	0·9880	0·9878	1·0366	1·0356	1·1090	1·1087	1·1432	1·1447	1·2083	1·2073
200	..	0·9897	0·9906	1·0380	1·0380	1·1087	1·1087	1·1411	1·1445	1·2054	1·2066
250	..	0·9930	0·9929	1·0401	1·0401	1·1089	1·1087	1·1434	1·1440	1·2051	1·2060
300	..	0·9945	0·9946	1·0434	1·0420	1·1072	1·1088	1·1433	1·1443	1·2049	1·2054
350	..	0·9970	0·9963	1·0440	1·0430	1·1081	1·1088	1·1441	1·1442	1·2030	1·2049
400	..	0·9994	0·9980	1·0447	1·0447	1·1082	1·1088	1·1446	1·1441	1·2039	1·2044
450	..	1·0017	0·9990	1·0457	1·0458	1·1098	1·1088	1·1452	1·1440	1·2039	1·2040
500	..	1·0022	1·0040	1·0462	1·0469	1·1098	1·1088	1·1447	1·1440	1·2037	1·2038
550	..	1·0015	1·0017	1·0470	1·0470	1·1096	1·1089	1·1444	1·1440	1·2037	1·2038
600	..	1·0027	1·0028	1·0483	1·0489	1·1089	1·1089	1·1435	1·1439	1·2032	1·2030
650	..	1·0027	1·0038	1·0491	1·0498	1·1082	1·1089	1·1438	1·1439	1·2026	1·2038
700	..	1·0033	1·0046	1·0507	1·0507	1·1079	1·1089	1·1433	1·1439	1·2032	1·2025
750	..	1·0043	1·0055	1·0526	1·0514	1·1091	1·1089	1·1439	1·1439	1·2050	1·2023

Observed and Corrected Vapour-pressures compared.

Pres. in mm.	Methyl alcohol.		Ethyl alcohol.		Propyl alcohol.		Isobutyl alcohol.		Isoamyl alcohol.	
	Observed.	Calculated.	Observed.	Calculated.	Observed.	Calculated.	Observed.	Calculated.	Observed.	Calculated.
50	9.0	9.34	21.8	21.76	40.3	40.29	49.0	49.04	68.3	67.93
100	21.8	21.76	34.0	34.17	52.4	52.67	61.8	61.76	81.5	81.57
150	29.0	29.58	41.8	41.81	60.7	60.50	69.8	69.79	90.2	90.07
200	35.9	35.60	47.4	47.83	66.5	66.5	75.5	76.07	96.8	96.64
250	40.5	40.8	52.1	52.14	71.4	70.88	80.5	80.65	101.5	101.46
300	44.4	44.29	56.0	56.36	75.3	75.06	85.0	84.85	105.9	105.98
350	47.9	47.70	59.5	59.71	78.8	78.44	88.8	88.38	109.5	109.68
400	51.0	50.93	62.5	62.81	81.8	81.51	91.8	91.55	112.8	112.8
450	54.0	53.90	65.5	65.47	84.2	84.14	94.4	94.26	115.9	116.0
500	56.5	56.17	68.3	68.04	86.9	86.70	97.0	96.90	118.5	118.71
550	58.5	58.50	70.5	70.33	89.0	88.97	99.4	99.17	121.0	121.16
600	60.5	60.66	72.5	72.35	90.8	91.00	101.4	101.36	123.2	123.54
650	62.4	62.42	74.1	74.43	92.5	93.00	103.3	103.44	125.4	125.60
700	64.1	64.63	76.1	76.23	94.1	94.77	105.3	105.3	127.7	127.61
750	65.9	66.21	78.0	77.8	96.0	96.45	107.0	106.96	129.6	129.30

Observed and Corrected Vapour-pressures compared—continued.

Pres. in Mm.	Formic acid.		Acetic acid.		Propionic acid.		Isobutyric acid.		Isovaleric acid.	
	Observed.	Calculated.	Observed.	Calculated.	Observed.	Calculated.	Observed.	Calculated.	Observed.	Calculated.
50	31	31.44	48.1	46.70	72.0	72.0	84.8	83.43	104.0	104.91
100	46.9	46.40	62.5	62.20	86.7	86.86	99.2	98.71	119.3	119.53
150	56.1	56.10	72.3	71.90	96.4	96.4	107.8	108.30	129.5	129.28
200	63.1	63.37	79.5	79.53	103.5	103.44	114.5	115.6	136.5	136.89
250	69.0	68.92	85.5	85.17	108.9	108.76	120.8	121.10	142.0	142.41
300	74.1	73.98	90.7	90.45	113.3	113.79	125.9	126.21	147.4	147.66
350	78.8	78.33	95.1	94.83	117.7	117.89	130.4	130.43	151.5	151.92
400	82.8	82.30	98.9	98.91	121.5	121.70	134.5	134.49	155.5	155.87
450	86.5	85.61	102.2	102.40	125.3	124.95	138.0	137.58	159.0	159.18
500	89.5	88.75	105.4	105.70	128.4	128.06	141.0	140.77	162.2	162.28
550	92.0	91.77	108.3	108.68	131.1	130.85	143.8	143.63	165.0	165.30
600	94.5	94.41	111.2	111.38	133.4	133.39	146.1	146.27	167.8	167.8
650	96.7	96.97	113.8	113.95	135.6	135.83	148.7	148.77	170.4	170.54
700	98.9	99.41	116.5	116.50	137.7	138.07	150.8	151.08	173.0	172.95
750	101.0	101.45	119.0	119.43	140.0	139.96	153.0	153.0	175.8	174.78