VAPOR-PRESSURE RELATIONS IN MIXTURES OF TWO LIQUIDS, III

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After obtaining the numerical results of my last paper, it is interesting to see what of theoretical interest they may contain.¹ We expect to find some relation between the composition of the vapor given off and the composition of the solution giving off such vapor. We also expect to find some relation between the partial pressure of acetone in the vapor and the percentage of acetone in the solution or between the partial pressure of the acetone and the pressure of pure acetone at that temperature. The most natural thing to do is to test the Law of Henry and the van 't Hoff-Raoult formula to see if they hold.²

The Law of Henry is formulated as follows:

$$\frac{p_1}{c_1} = \text{const.} \quad (\text{I.})$$

or

$$\frac{p_2}{c_2} = \text{const.} \quad (\text{II.})$$

In Equation I., p_1 is the partial pressure of the acetone in the vapor, and c_1 the corresponding concentration of the acetone in the solution. In Equation II., p_2 is the partial pressure of the water-vapor, and c_2 the concentration of the water in the solution. These equations hold at constant temperature. They are both formulations of the same law. In Equation I. acetone is the solvent and in Equation II. water. This simple formulation of Henry's law would hold only when in the solution the com-

¹ Jour. Phys. Chem. 4, 355 (1900).

² Margules; Wien. Ber. 104, 1243 (1895); Lehfeldt. Phil. Mag. [5] 46, 46 (1898), 48, 215 (1899).

pounds under consideration were monomolecular. That acetone exists as simple molecules in aqueous solutions, at least up to concentrations of 30 percent acetone, was shown by the freezing-point measurements of Waddell.¹

Equations III. and IV. represent the familiar van't Hoff-Raoult formula

$$\log_{\text{nat}} \frac{p_0}{p_1} = \frac{c_2}{c_1} = \frac{n}{N} \quad (\text{III.})$$

$$\log_{\text{nat}} \frac{p_0}{p_2} = \frac{c_1}{c_2} = \frac{N}{n} \quad (\text{IV.})$$

The letters p_1 , p_2 , c_1 , c_2 , have the same meaning as before. The vapor-pressure of pure acetone is indicated by p_1 and of pure water by p_2 . N and n represent the relative number of molecules of water and acetone in the solution. By transposing and changing to ordinary logarithms, we get expressions for p_2 and p_1 . These relations are more useful in the present consideration, and are given in Equations V. and VI.

$$\log_{10} p_0 - \left(0.4343 \frac{c_1}{c_2}\right) = \log p_2. \quad (\text{V.})$$

$$\log_{10} p_0 - \left(0.4343 \frac{c_2}{c_1}\right) = \log p_1. \quad (\text{VI.})$$

As before, the temperature is supposed to be constant, so a set of tables, Table II.-IX. have been made out at constant temperatures from 60°-25° to test Formula V. and Table X. for Formula VI. Table I. gives a set of general constants used throughout the other tables. In these tables the first column gives the gram percentage composition of acetone in the solution, the second the total pressure of the vapor given off, the third the molecular percentage composition of the vapor in acetone, the fourth the same calculated from the formula, the fifth the gram percentage composition of acetone in the solution, the sixth the same, calculated from column four, the seventh the partial pressure of the acetone, the eighth the partial pressure of the water, and the ninth the same calculated from the formula.

¹ Jour. Phys. Chem. 3, 160 (1899).

In working out the partial pressures of the water and the acetone, it has been assumed that one simple molecular weight of water and one simple molecular weight of acetone both occupy the same volume in the gaseous form; and that in consequence, the partial pressure of each component is proportional to the molecular percentage composition of the vapor, and can be obtained by multiplying this percentage composition by the vapor-pressure of the solution. The columns labeled p_1 and p_2 were so calculated, that is by multiplying the figures in column two by those in three, the figures in column p_1 were obtained, and $p_s - p_1 = p_2$. The figures in p_2 calc, were obtained from the Formula V. and the percentage and molecular percentage composition of the vapor corresponding determined from them by the following simple formulae :

$$\frac{p_1}{p_s} = \text{acetone percentage mol. concentration of vapor.}$$

$$\left(1 - \frac{p_1}{p_s}\right) = \text{water percentage mol. concentration of vapor.}$$

$$18 \frac{p_1}{p_s} = D. \quad 58 \left(1 - \frac{p_1}{p_s}\right) = E.$$

$$\frac{D}{D + E} = \text{grams of acetone in 100 g. of solution.}$$

$$\frac{E}{D + E} = \text{grams of water in 100 g. of solution.}$$

It will be seen from the tables that the van't Hoff-Raoult equation in general predicts within one or two percent the composition of the vapor given off by any given acetone solution, and this was fully as accurately as I succeeded in determining the composition of the vapor given off. The pressure relations do not agree well, for they depend on the molecular concentration, and an error of one percent on the gram concentration of the vapor introduces an error several times as large in the molecular concentration. This is due to the fact that the molecular weights of water and acetone are so very different, viz., 18 and 58. Ninety percent acetone contains only seventy-six molecular weights of acetone to one hundred of solution, the

difference between the two being particularly great at the concentrations most used. An error of two percent in the composition of the vapor would introduce an error of nearly six percent in the vapor composition. When the vapor-pressure is 700 mm this would introduce an error of 42 mm in the partial pressure of the water or of the acetone. The partial pressure of the water is not more than 100 mm, so an immense percentage error is introduced.¹

It will be seen that there is seldom more than one percent variation between the calculated and the observed vapor decomposition up to sixty percent, after that a little more, and in the ninety percent about three percent difference. This is, I think, well beyond the possible experimental error. It can then well be said that the van't Hoff-Raoult formula predicts accurately the composition up to sixty percent or perhaps a little higher, and above that there is a tendency for less acetone to be given off than the formula would indicate. This is exactly what one would expect from the formula and where the water acts as solvent. The tables at the lower temperatures do not give quite as good results as the higher ones, as would be expected.

Table X. shows very clearly that Formula VI. does not hold at all, where the acetone is looked upon as solvent.

Tables XI.-XVIII. contain data with reference to Henry's law as expressed in Equations I. and II. The concentrations are all molecular concentrations except in Table XII. The headings of the columns make their meaning sufficiently evident without further explanation. At 55° in Table XII. the law is tested in a variety of ways. In the fourth column gram concentrations in the solution are used. When the partial pressure of the water is considered $\frac{p_2}{c_2}$ percent has a constantly rising value; if this is changed to molecular concentrations a reasonably good constant is obtained for the lower percentages, and by taking the square root of the concentrations for the higher concentrations. This was also carried on to the cube root and a constant nearly

¹ The apparent increase in the partial pressure of the water on dilution is further evidence of the experimental error.

as good obtained. On plotting the logarithmic curve, however, the points lie better on the square root curve.

The same methods were employed with p_1 the partial pressure of the acetone $\frac{p_1}{c_1}$ and $\frac{p_1}{\sqrt{c_1}}$ gives very little approach at a constant, but $\frac{p_1}{\sqrt[3]{c_1}}$ gives good values at the lower concentrations and $\frac{p_1}{\sqrt[4]{c_1}}$ at the higher concentrations.¹

The simple formula and the square root formula is used in all the other tables for the water; and the cube root and the fourth root formula for the acetone. The water formula does not hold well for the very highest concentration of acetone, nor the acetone formula for the lowest concentrations, as might be expected.

Not very great accuracy can be expected for this application of Henry's law for the partial pressures are not accurately known, especially those of the water. A more accurate knowledge of the vapor composition is needed before a satisfactory test of the law is made. It is especially unfortunate that the molecular weights of acetone and water are so different, this complicating this part of the work. The fact that the vapor from a rather dilute solution is so rich in acetone makes the accurate determination of the vapor composition almost impossible with any method yet devised. The present data would indicate however that Henry's Law does hold when complex molecules are assumed for both the water and the acetone in solution.

This paper, then, would seem to indicate that:

The van 't Hoff-Raoult formula, when water is the solvent, predicts, within the limits of experimental error, the composition of the vapor given off from all but the highest concentrations of acetone; and that Henry's law holds only when complex molecular structure is assumed for water and acetone in solution.

¹ Strictly speaking, the values of c_1 should be recalculated since they are based on the assumption of identity between formula weight and molecular weight; but it seemed hardly worth while to do this with the present data which are in no sense final.

TABLE I

% Ac.	C ₁	Log C ₁	C ₂	Log C ₂	$\frac{C_1}{C_2}$	$\frac{C_2}{C_1}$	$(0.4343 \frac{C_1}{C_2})$	$(0.4343 \frac{C_2}{C_1})$
0	0.	—	100	2.0000	—	—	—	—
10	3.3	0.5185	96.7	1.9854	0.0341	29.3	0.0148	12.73
20	7.2	0.8573	92.8	1.9675	0.0775	12.9	0.0337	5.598
30	11.7	1.0682	88.3	1.9460	0.132	7.55	0.0575	3.278
40	17.1	1.2330	82.9	1.9186	0.206	4.85	0.0896	2.106
50	23.7	1.3747	76.3	1.8825	0.310	3.22	0.1349	1.398
60	31.8	1.5024	68.2	1.8338	0.466	2.14	0.2025	0.9316
70	42.0	1.6232	58.0	1.7634	0.724	1.38	0.3145	0.5958
80	55.4	1.7435	44.6	1.6493	1.24	0.805	0.5395	0.3496
90	73.6	1.8669	26.4	1.4216	2.79	0.359	1.211	0.1558
100	100	2.0000	0.0					

TABLE II

60°

log 149 = 2.1732

% Ac.	p_s mm.	Mols. Ac vapor	Ibid. calc.	% Ac. vapor	Ibid. calc.	p_1 mm.	p_2 mm.	p_2 calc. mm.
0	149	0	0	0	0	0	149	149
10	339	56.0	57.5	80.8	81.5	190	149	144
20	485	70.5	71.5	88.5	89	342	143	138
30	577	76.8	77.5	91.5	91.8	443	134	131
40	640	77.3	81	91.8	93.3	495	145	121
50	682	81.2	84	93.3	94.5	553	129	109
60	714	82.3	87	93.8	95.5	588	126	93.5
70	740	84.3	90.3	94.5	96.8	624	116	72
80	774	86.8	94.5	95.5	98	672	102	43
90	808	88.0	99	96	99.5	711	97	9.2
100	860	100	100	100	100	860	0	0

TABLE III

55°

log 117.5 = 2.0700

% Ac.	p_s mm.	Mols Ac. vapor	Ibid. calc.	% Ac. vapor	Ibid. calc.	p_1 mm.	p_2 mm.	p_2 calc. mm.
0	117.5	0	0	0	0	0	117.5	117.5
10	275	57	58.7	81	82.2	157	118	113.5
20	399	71.5	72.8	89.0	89.5	283.5	115.5	109
30	478	77.3	78.5	91.8	92.3	370.5	107.5	103
40	534	78.7	82	92.3	93.8	420	114	95.5
50	572	82.5	85	93.8	94.8	472	100	86
60	598	83	87.7	94	95.8	496.5	101.5	73.7
70	621	85	90.8	94.8	97	528	93	57.0
80	645	87.5	94.8	95.8	98.3	566.5	78.5	34.0
90	680	89	99	96.3	99.5	602	78	7.2
100	721	100	100	100	100	721	0	0

TABLE IV

50°

log 92 = 1.9638

% Ac.	p_s mm.	Mols Ac. vapor	Ibid. calc.	% Ac. vapor	Ibid. calc.	p_1 mm.	p_2 mm.	p_2 calc. mm.
0	92	0	0	0	0	0	92	92
10	221	57	59.8	81	82.8	126	95	89
20	324	71.8	73.7	89.3	90	232.5	91.5	85
30	393	78	79.5	92	92.5	306.5	86.5	80.5
40	442	79.3	83	92.5	94	350.5	91.5	75
50	472	83	85.7	94	95	392	80	67.5
60	499	83	88.5	94	96	414	85	58
70	517.5	85.5	91.3	95	97	442.5	75	44.5
80	536	89	95	96.3	98.5	477	59	26.5
90	566.5	89.8	99	96.5	99.8	509	57.5	5.7
100	607	100	100	100	100	607	0	0

TABLE V
 45°
 $\log 71.5 = 1.8543$

% Ac.	p_s mm.	Mols. Ac vapor	Ibid. calc.	% Ac. vapor	Ibid. calc.	p_1 mm.	p_2 mm.	p_2 calc. mm.
0	71.5	0	0	0	0	0	71.5	71.5
10	177	57	61	81	83.5	101	76	69
20	262	72.5	74.8	89.5	90.5	192.5	69.5	66
30	319	79.3	81.3	92.5	93.3	253	66	62.5
40	364	80.5	84	93	94.3	293	71	58
50	391	84.3	86.5	94.5	95.5	329.5	61.5	52.5
60	414	83.7	89.2	94.3	96.3	346.5	67.5	45
70	428	86.3	92	95.5	97.3	369	59	34.5
80	447	89.5	95.5	96.5	98.5	400	47	20.5
90	469	90.3	99	96.8	99.7	423.5	45.5	4.4
100	505	100	100	100	100	505	0	0

TABLE VI
 40°
 $\log 55 = 1.7404$

% Ac.	p_s mm.	Mols. Ac vapor	Ibid. calc.	% Ac. vapor	Ibid. calc.	p_1 mm.	p_2 mm.	p_2 calc. mm.
0	55	0	0	0	0	0	55	55
10	139	57.5	61.8	81.3	84	80	59	53
20	209	73	76.7	89.8	91.5	152.5	56.5	51
30	258	79.8	81.3	92.8	93.3	206	52	48
40	298.5	81.2	84.7	93.3	94.7	242.5	55.5	46
50	319	85	87.3	94.8	95.7	271	48	40.5
60	340	84.3	89.8	94.5	96.5	286.5	53.5	34.5
70	352	86.8	92.5	95.5	97.5	305	47	26.5
80	368	90.3	95.7	96.8	98.7	332.5	35.5	16
90	387.5	90.3	99.2	96.8	99.7	350	37.5	3.5
100	416	100	100	100	100	416	0	0

TABLE VII
35°
log 42 = 1.6232

% Ac.	p_s mm.	Mols. Ac vapor	Ibid. calc.	% Ac. vapor	Ibid. calc.	p_1 mm.	p_2 mm.	p_2 calc. mm.
0	42	0	0	0	0	0	42	42
10	107	57.8	62	81.5	84	62	45	40.5
20	165	73.8	76.5	90	91.3	122	43	39
30	206	80.5	82.5	93	93.7	166	40	37
40	239	82.3	85.7	93.8	95	196.5	42.5	34
50	260	86.3	88.2	95.3	96	224.5	35.5	31
60	277	84.3	90.5	94.5	96.8	233.5	43.5	26.5
70	290	87.5	93.0	95.8	97.7	254	36	20.5
80	301	91.7	96	97.3	98.8	276	25	12
90	318	91.7	99.2	97.3	99.8	292	26	2.5
100	343	100	100	100	100	343	0	0

TABLE VIII
30°
log 31.5 = 1.4983

% Ac	p_s mm.	Mols. Ac vapor	Ibid. calc.	% Ac. vapor	Ibid. calc.	p_1 mm.	p_2 mm.	p_2 calc. mm.
0	31.5	0	0	0	0	0	31.5	31.5
10	82	57.8	62.8	81.5	84.5	47.5	34.5	30.5
20	130	73.8	77.5	90	91.8	96	34	29
30	164.5	81.3	83.3	93.3	94	134	30.5	27.5
40	191.5	82.3	86.5	93.8	95.5	157.5	34	25.5
50	211	86.3	89	95.3	96.3	182	29	23
60	224	84.3	91.3	94.5	97	189	35	20
70	235	87.5	93.5	95.8	97.8	205	29.5	15
80	245	91.7	96.3	97.3	98.7	225	20	9
90	258	91.7	99.3	97.3	99.8	236.5	21.5	2
100	281	100	100	100	100	281	0	0

TABLE IX

25°

$$\log 23.5 = 1.3711$$

% Ac	p mm.	Mols. Ac vapor	Ibid. calc.	% Ac. vapor	Ibid. calc.	p_1 mm.	p_2 mm.	p_2 calc. mm.
0	23.5	0	0	0	0	0	23.5	23.5
10	65	58	65	81.8	85.8	38	27	22.7
20	104	74	79	90.3	92.5	77	27	21.7
30	130	81.3	84.3	93.3	94.5	105	25	20.5
40	151	83	87.3	94	95.8	125.5	24.5	19
50	168	86.8	89.8	95.5	96.5	146	22	17
60	180	84.2	91.8	94.5	97.3	152	28	15
70	188	87.5	94	95.8	98	164.5	23.5	11.5
80	198	91.8	96.5	97.3	98.8	182	16	6.8
90	209	91.8	99.3	97.3	99.8	192	17	1.5
100	229	100	100	100	100	229	0	0

TABLE X

55°

% Ac.	p_s	Mols. Ac. vapor	Ibid. calc.	% Ac. vapor	Ibid. calc.
0	117.5	0	—	0	—
10	275	57	—	81	—
20	399	71.5	0.03455	89	—
30	478	77.3	0.0379	91.8	—
40	534	78.7	1.0	92.3	—
50	572	82.5	5.0	93.8	—
60	598	83	14.0	94	34.5
70	621	85	29.2	94.8	57.2
80	645	87.5	50	95.8	76.3
90	680	89	74	96.3	90.3
100	721	100	100	100	100

TABLE XI

60°

% Ac.	c_1	c_2	p_1 mm.	p_2 mm.	$\frac{p_1}{\sqrt[3]{c_1}}$	$\frac{p_1}{\sqrt[4]{c_1}}$	$\frac{p_2}{c_2}$	$\frac{p_2}{\sqrt{c_2}}$
0	0	100	0	149	—	—	1.49	14.9
10	3.3	96.7	190	149	103.5	141	1.54	15.2
20	7.2	92.8	342	143	177	209	1.54	14.8
30	11.7	88.3	443	134	195	240	1.52	14.3
40	17.1	82.9	495	145	192	243	1.77	15.9
50	23.7	76.3	553	129	192	250	1.69	14.8
60	31.8	68.2	588	126	185	247	1.85	15.3
70	42.0	58.0	624	116	179	245	2.00	15.2
80	55.4	44.6	672	102	176	246	2.29	15.3
90	73.6	26.4	711	97	170	243	3.67	18.9
100	100	0	860	0	185	272	—	—

TABLE XII

55°

% Ac.	p_1 mm.	p_2 mm.	$\frac{p_2}{c_2}$ %	$\frac{p_2}{c_2}$ mol.	$\frac{p_2}{\sqrt{c_2}}$	$\frac{p_2}{\sqrt[3]{c_2}}$	$\frac{p_1}{c_1}$	$\frac{p_1}{\sqrt{c_1}}$	$\frac{p_1}{\sqrt[4]{c_1}}$	$\frac{p_1}{\sqrt[5]{c_1}}$
0	0	117.5	1.175	1.175	11.75	25.3	—	—	—	—
10	157	118	1.31	1.22	12.0	25.7	47.6	86.4	109	105.5
20	283.5	115.5	1.44	1.25	12.0	25.5	39.4	106	177	146.5
30	370.5	107.5	1.53	1.22	11.45	24.15	31.6	108	200	163
40	420	114	1.90	1.38	12.5	26.15	24.5	102	206.5	163
50	472	100	2.00	1.31	11.45	23.6	19.9	97	214	164.5
60	496.5	101.5	2.54	1.49	12.3	24.85	15.6	88	209	157
70	528	93	3.10	1.60	12.2	24.0	12.6	81.5	207.5	152
80	566.5	78.5	3.92	1.76	11.75	22.15	10.2	76	207.5	148.5
90	602	78	7.8	2.95	15.2	26.2	8.18	70	205.5	143.5
100	721	0	0	—	—	—	7.2	72	228	155.5

TABLE XIII

50°

% Ac.	c_1	c_2	p_1 mm.	p_2 mm.	$\frac{p_1}{\sqrt[3]{c_1}}$	$\frac{p_1}{\sqrt[4]{c_1}}$	$\frac{p_2}{c_2}$	$\frac{p_2}{\sqrt{c_2}}$
0	0	100	0	92	—	—	0.920	9.20
10	3.3	96.7	126	95	84.6	93.5	0.982	9.66
20	7.2	92.8	232.5	91.5	120	142	0.986	9.50
30	11.7	88.3	306.5	86.5	135	166	0.975	9.20
40	17.1	82.9	350.5	91.5	136	172	1.10	10.05
50	23.7	76.3	392	80	136	178	1.05	9.16
60	31.8	68.2	414	85	131	174	1.25	10.3
70	42.0	58.0	442.5	75	127	174	1.29	9.85
80	55.4	44.6	477	59	125	175	1.32	8.84
90	73.6	26.4	509	57.5	121	174	2.18	11.2
100	100	0	607	0	131	192	—	—

TABLE XIV

45°

% Ac.	c_1	c_2	p_1 mm.	p_2 mm.	$\frac{p_1}{\sqrt[3]{c_1}}$	$\frac{p_1}{\sqrt[4]{c_1}}$	$\frac{p_2}{c_2}$	$\frac{p_2}{\sqrt{c_2}}$
0	0	100	0	71.5	—	—	0.715	7.15
10	3.3	96.7	101	76	67.7	74.7	0.786	7.15
20	7.2	92.8	192.5	69.5	99.7	118	0.749	7.73
30	11.7	88.3	253	66	111.5	137	0.747	7.22
40	17.1	82.9	293	71	114	144	0.856	7.02
50	23.7	76.3	329.5	61.5	115	149	0.806	7.80
60	31.8	68.2	346.5	67.5	109	146	0.990	7.04
70	42.0	58.0	369	59	106	145	1.04	8.17
80	55.4	44.6	400	47	105	147	1.05	7.75
90	73.6	26.4	423.5	45.5	101	145	1.72	7.04
100	100	0	505	0	109	160	—	8.86

TABLE XV

40°

% Ac.	c_1	c_2	p_1 mm.	p_2 mm.	$\frac{p_1}{\sqrt[3]{c_1}}$	$\frac{p_1}{\sqrt[4]{c_1}}$	$\frac{p_2}{c_2}$	$\frac{p_2}{\sqrt{c_2}}$
0	0	100	0	55	—	—	0.550	5.50
10	3.3	96.7	80	59	53.7	59.3	0.610	6.00
20	7.2	92.8	152.5	56.5	79.0	93.1	0.609	5.87
30	11.7	88.3	206	52	90.7	111	0.589	5.53
40	17.1	82.9	242.5	55.5	94.1	119	0.669	6.16
50	23.7	76.3	271	48	94.4	123	0.629	5.50
60	31.8	68.2	286.5	53.5	90.5	121	0.784	6.48
70	42.0	58.0	305	47	87.9	120	0.810	6.17
80	55.4	44.6	332.5	35.5	87.2	122	0.795	5.32
90	73.6	26.4	350	37.5	83.5	120	1.42	7.30
100	100	0	416	0	89.6	131	—	—

TABLE XVI

35°

% Ac.	c_1	c_2	p_1 mm.	p_2 mm.	$\frac{p_1}{\sqrt[3]{c_1}}$	$\frac{p_1}{\sqrt[4]{c_1}}$	$\frac{p_2}{c_2}$	$\frac{p_2}{\sqrt{c_2}}$
0	0	100	0	42	—	—	0.42	4.2
10	3.3	96.7	62	45	41.5	45.8	0.465	4.58
20	7.2	92.8	122	43	63.1	74.3	0.463	4.46
30	11.7	88.3	166	40	73.0	89.7	0.453	4.26
40	17.1	82.9	196.5	42.5	76.3	96.8	0.513	4.67
50	23.7	76.3	224.5	35.5	78.1	102	0.465	4.06
60	31.8	68.2	233.5	43.5	73.7	98.3	0.638	5.27
70	42.0	58.0	254	36	73.0	99.6	0.620	4.73
80	55.4	44.6	276	25	72.4	101	0.560	3.74
90	73.6	26.4	292	26	69.6	99.6	0.985	5.06
100	100	0	343	0	73.9	108	—	—

TABLE XVII

30°

% Ac.	c_1	c_2	p_1 mm.	p_2 mm.	$\frac{p_1}{\sqrt[3]{c_1}}$	$\frac{p_1}{\sqrt[4]{c_1}}$	$\frac{p_2}{c_2}$	$\frac{p_2}{\sqrt{c_2}}$
0	0	100	0	31.5	—	—	0.315	3.15
10	3.3	96.7	47.5	34.5	31.8	35.2	0.357	3.51
20	7.2	92.8	96	34	49.7	58.6	0.366	3.53
30	11.7	88.3	134	30.5	58.9	72.3	0.345	3.25
40	17.1	82.9	157.5	34	61.2	77.5	0.410	3.73
50	23.7	76.3	182	29	63.4	82.5	0.380	3.32
60	31.8	68.2	189	35	70.7	94.3	0.513	4.24
70	42.0	58.0	205	29.5	59.2	80.8	0.509	3.87
80	55.4	44.6	225	20	58.9	82.4	0.448	2.99
90	73.6	26.4	236.5	21.5	56.5	80.8	0.814	4.18
100	100	0	281	0	60.6	88.9	—	—

TABLE XVIII

25°

% Ac.	c_1	c_2	p_1 mm.	p_2 mm.	$\frac{p_1}{\sqrt[3]{c_1}}$	$\frac{p_1}{\sqrt[4]{c_1}}$	$\frac{p_2}{c_2}$	$\frac{p_2}{\sqrt{c_2}}$
0	0	100	0	23.5	—	—	0.235	2.35
10	3.3	96.7	38	27	25.3	28.0	0.279	2.75
20	7.2	92.8	77	27	39.8	47.0	0.291	2.80
30	11.7	88.3	105	25	46.4	57.0	0.283	2.66
40	17.1	82.9	125.5	24.5	48.7	61.6	0.296	2.69
50	23.7	76.3	146	22	50.8	66.1	0.288	2.52
60	31.8	68.2	152	28	47.9	63.9	0.411	3.39
70	42.0	58.0	164.5	23.5	47.3	64.6	0.405	3.09
80	55.4	44.6	182	16	47.7	66.6	0.370	2.47
90	73.6	26.4	192	17	45.8	65.5	0.663	3.33
100	100	0	229	0	49.3	72.4	—	—