Determination of Refractive Index of Glycerols By the Immersion Refractometer

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I. Introduction:

IN the comprehensive A.C.S. monograph, "Glycerol and the Glycols," by Lawrie, published in 1928, the author has assembled most of the available data on the physical properties of glycerol. The section on refractive index is surprisingly meager and consists chiefly of the refractive index tables of Lenz.[1] These tables were first published in 1880 and have been copied verbatim, discrepancies included, by many authors since that time. Lenz used, of course, the Abbé refractometer and conducted his experiments at the rather unusual temperature range of 12.5 to 12.8° C. Lenz determined the concentration of his pure glycerol (96.04%) by elementary analysis and checked the concentration of some of his diluted samples also by elementary analysis. His table which gives the refractive index of glycerine from 1% to 100% by 1% intervals, is shown in Table 1. The bulk of the values shown are, of course, extrapolated, Lenz having determined the refractive index of only ten diluted glycerols of known concentration. I have included in this table the differences in refractive index between each per cent.

Lenz states in his original article that by means of his table the concentration of glycerol may be determined from the refractive index, by the Abbé refractometer, with an accuracy of 0.5%. Thus, while convenient, rapid and applicable to only a few drops of material, the refractive index of glycerine as determined by the Abbé refractometer is distinctly less accurate as a method of determining the concentratoin of glycerol than is the specific gravity.

Lenz pointed out that it was possible to use the Abbé refractometer to determine the refractive index and consequently the concentration of glycerine without adjusting the sample and instrument to any special temperature provided that the refractive index of water was observed at the same temperature. The difference between the refractive index of the sample and the refractive index of water at the same temperature being a function of the concentration. Lenz's table of these differences is shown in Table 2. To this table, also, I have added the values for the difference between each successive percentage. There are some anomalies in this table of Lenz, especially noticeable at 64, 25, and 20% glycerol. The work which I have done with refractometers, and especially with the immersion refractometer which is at least ten times as sensitive to changes in refractive index as is the Abbé instrument, leads me to believe that some of these values given by Lenz are in error. Refractive index is not always a straight line function of concen-

TABLE No. 1

The Refractive Index, N_D at 12.5 to 12.8°, of Aqueous Solutions of Glycerol (Lenz). Z. anal. Chem. 19, 302 (1880)

Per Cent Anhydrous Glycerol	N_D	Difference	Per Cent Anhydrous Glycerol	N_D	Difference	Per Cent Anhydrous Glycerol	N_D	Difference
100	1.4758	....	66	1.4249	.0018	32	1.3745	.0013
99	1.4744	.0014	65	1.4231	.0018	31	1.3732	.0013
98	1,4729	.0015	64	1.4213	.0018	30	1.3719	.0013
97	1.4715	.0014	63	1.4195	.0018	29	1.3706	.0013
96	1.4700	.0015	62	1.4176	.0019	28	1.3692	.0014
95	1.4686	.0014	61	1.4158	.0018	27	1.3679	.0013
94	1.4671	.0015	60	1.4140	.0018	26	1.3666	.0013
93	1.4657	.0014	59	1.4126	.0014	25	1.3652	.0014
92	1.4642	.0015	58	1.4114	.0012	24	1.3639	.0013
91	1.4628	.0014	57	1.4102	.0012	23	1.3626	.0013
90	1.4613	.0015	56	1.4091	.0011	22	1.3612	.0014
89	1.4598	.0015	55	1.4079	.0012	21	1.3599	.0013
88	1.4584	.0014	54	1.4065	.0014	20	1.3585	.0014
87	1.4569	.0015	53	1.4051	.0014	19	1.3572	.0013
86	1.4555	.0014	52	1.4036	.0015	18	1.3559	.0013
85	1.4540	.0015	51	1.4022	.0014	17	1.3546	.0013
84	1.4525	.0015	50	1.4007	.0015	16	1.3533	.0013
83	1.4511	.0014	49	1.3993	.0014	15	1.3520	.0013
82	1.4496	.0015	48	1.3979	.0014	14	1.3507	.0013
81	1.4482	.0014	47	1.3964	.0015	13	1.3494	.0013
80	1.4467	.0015	46	1.3950	.0014	12	1.3480	.0014
79	1.4453	.0014	45	1.3935	.0015	11	1.3467	.0013
78	1.4438	.0015	44	1.3921	.0014	10	1.3454	.0013
77	1.4424	.0014	43	1.3906	.0015	9	1.3442	.0012
76	1.4409	.0015	42	1.3890	.0016	8	1.3430	.0012
75	1.4395	.0014	41	1.3875	.0015	7	1.3417	.0013
74	1.4380	.0015	40	1.3860	.0015	6	1.3405	.0012
73	1.4366	.0014	39	1.3844	.0016	5	1.3392	.0013
72	1.4352	.0015	38	1.3829	.0015	4	1.3380	.0012
71	1.4337	.0015	37	1.3813	.0016	3	1 3367	.0013
70	1.4321	.0016	36	1.3798	.0015	2	1.3355	.0012
69	1.4304	.0017	35	1.3785	.0013	1	1.3348	.0007
68	1.4286	.0018	34	1.3772	.0013	0	1.3330	.0018
67	1.4267	.0019	33	1.3758	.0014			

TABLE No. 2

Difference Between Refractive Indices of Aqueous Solutions of Glycerol and of Pure Water. (N_D Solution—N_D Water) (Lenz). Z. anal. Chem. 19, 305. (1880).

Per Cent Glycerol	Difference Glycerol-Water	Difference	Per Cent Glycerol	Difference Glycerol-Water	Difference	Per Cent Glycerol	Difference Glycerol-Water	Difference
100	0.1424	.0014	66	0.0915	.0018	33	0.0424	.0013
99	0.1410	.0015	65	0.0897	.0008	32	0.0411	.0013
98	0.1395	.0014	64	0.0889	.0028	31	0.0398	.0013
97	0.1381	.0015	63	0.0861	.0019	30	0.0385	.0013
96	0.1366	.0014	62	0.0842	.0018	29	0.0372	.0014
95	0.1352	.0015	61	0.0824	.0018	28	0.0358	.0013
94	0.1337	.0014	60	0.0806	.0014	27	0.0345	.0013
93	0.1323	.0015	59	0.0792	.0012	26	0.0332	.0014
92	0.1308	.0014	58	0.0780	.0012	25	0.0318	.0003
91	0.1294	.0015	57	0.0768	.0011	24	0.0315	.0013
90	0.1279	.0015	56	0.0757	.0012	23	0.0302	.0014
89	0.1264	.0014	55	0.0745	.0014	22	0.0288	.0013
88	0.1250	.0015	54	0.0731	.0014	21	0.0275	.0014
87	0.1235	.0014	53	0.0717	.0015	20	0.0261	.0028
86	0.1221	.0015	52	0.0702	.0014	19	0.0238	.0013
85	0.1206	.0015	51	0.0688	.0015	18	0.0225	.0013
84	0.1191	.0014	50	0.0663	.0014	17	0.0212	.0013
83	0.1177	.0015	49	0.0659	.0015	16	0.0199	.0013
82	0.1162	.0014	48	0.0645	.0015	15	0.0186	.0013
81	0.1148	.0015	47	0.0630	.0014	14	0.0173	.0013
80	0.1133	.0014	46	0.0616	.0015	13	0.0160	.0014
79	0.1119	.0015	45	0.0601	.0014	12	0.0146	.0013
78	0.1104	.0014	44	0.0587	.0015	11	0.0133	.0013
77	0.1090	.0015	43	0.0572	.0016	10	0.0120	.0012
76	0.1075	.0014	42	0.0556	.0015	9	0.0108	.0012
75	0.1061	.0015	41	0.0541	.0015	8	0.0096	.0013
74	0.1046	.0014	40	0.0526	.0016	7	0.0083	.0012
73	0.1032	.0014	39	0.0510	.0015	6	0.0071	.0013
72	0.1018	.0015	38	0.0495	.0016	5	0.0058	.0012
71	0.1003	.0016	37	0.0479	.0015	4	0.0046	.0013
70	0.0987	.0017	36	0.0464	.0013	3	0.0033	.0012
69	0.0970	.0018	35	0.0451	.0013	2	0.0021	.0013
68	0.0952	.0019	34	0.0438	.0014	1	0.0008	.0008
67	0.0933	.0018						

tration but it is highly questionable that refractive index is the erratic and fluctuating function of concentration that Lenz's tables would indicate. Lenz claimed that the coefficients of the refractive indices of glycerine and water were practically identical. While the differences in these coefficients are doubtless within the limits of error of the Abbé instrument, the available data shows that the coefficients are not identical.

The immersion refractometer was developed just prior to 1900 by the firm of Carl Zeiss at Jena. This instrument, with a single fixed prism, had a limited range but was extremely sensitive. The scale of 110° from —5° to 105° by 1° intervals corresponds to a spread of refractive index from 1.32736 to 1.36674. The instrument is equipped with a vernier reading to 0.1° and it is thus easily possible to observe differences in refractive index of the order of magnitude of 0.00004. By 1907 a considerable literature had developed on the uses of this valuable instrument and the available data was published in book form as Wagner's "Immersion Refractometer Tables," containing nearly 80 tables for the quantitative estimation of organic and inorganic substances. Figure 3 is a reproduction of Wagner's[3] table of the refractive index of dilute glycerol solutions, a refinement and extension of a similar table published by Henkel and Roth[2] in 1905. It will be observed that within the range of the single prism instrument it is possible, by Wagner's table, to determine the concentration of a pure dilute glycerine solution with an accuracy of 0.03%. Wagner's data when plotted gives a curve which is a nearly perfect straight line, and refutes the erratic curve given by Lenz's data over the corresponding range of concentration. Insofar as the author is aware the data by Wagner appears not to be generally known. It is not mentioned by Lawrie or others.

The change of the refractive index of pure water per 1° C. is not a constant, and the change of refractive index of glycerine solutions per 1° C. varies with the concentration and is numerically much larger at high concentrations than the coefficient for water as shown by the following data, Table 4 [4], [5].

II. Experimental Work:

Since 1927 a new immersion refractometer has been available with six replaceable prisms, thus providing an extremely accurate and sensitive method of determining refractive index over the extensive range from 1.32539 to 1.54581. No investigation of the refractive index of glycerol with the aid of this multiple prism immersion refractometer has been reported in the literature.

Through the courtesy of the Bausch and Lomb Optical Co., one of these fine instruments was placed at the author's disposal and a preliminary study has been made of the refractive index of various glycerols, particularly at higher concentrations.

Mr. J. T. R. Andrews of The Proctor and Gamble Co., Chairman of the Glycerine Analysis Committee of the American Oil Chemists' Society, very kindly furnished the author a supply of glycerol of unusual purity and high concentration. This glycerol was prepared in the Research Laboratory of The Proctor and Gamble Co. by fractional distillation of a double-distilled C.P. Glycerol through a 48″ Vigreux column under 5-7 mm. pressure. The sample used represents the middle portion only of the distillate which exhibited a very constant

TABLE No. 3

Refractive Index vs. Concentration of Dilute Glycerol Solutions by the Zeiss Immersion Refractometer at 17.5° C. Wagner's Immersion Refractometer Tables 1907 ed. p. 46 Table 70 Glycerol

Scale Reading °Z	Refractive Index	Per Cent Glycerol Gms. per 100 cc.	Scale Reading °Z	Refractive Index	Per Cent Glycerol Gms. per 100 cc.	Scale Reading °Z	Refractive Index	Per Cent Glycerol Gms. per 100 cc.
15	1.333200	0.00	46	....	10.01	76	....	19.48
16	....	0.33	47	....	10.33	77	....	19.79
17	....	0.66	48	....	10.65	78	....	20.10
18	....	0.99	49	....	10.96	79	....	20.41
19	....	1.32	50	1.346500	11.28	80	1.357500	20.72
20	1.335168	1.64	51	....	11.59	81	....	21.03
21	....	1.97	52	....	11.91	82	....	21.34
22	....	2.29	53	....	12.22	83	....	21.65
23	....	2.62	54	....	12.54	84	....	21.96
24	....	2.94	55	1.348360	12.86	85	1.359300	22.27
25	1.337050	3.27	56	....	13.17	86	....	22.58
26	....	3.59	57	....	13.49	87	....	22.89
27	....	3.92	58	....	13.81	88	....	23.20
28	....	4.24	59	....	14.12	89	....	23.50
29	....	4 56	60	1.350210	14.44	90	1.361090	23.81
30	1.338960	4.88	61	....	14.75	91	....	24.12
31	....	5.21	62	....	15.07	92	....	24.43
32	....	5.53	63	....	15.38	93	....	24.73
33	....	5.85	64	....	15.70	94	....	25.04
34	....	6.17	65	1.352050	16.02	95	1.362870	25.35
35	1.340860	6.49	66	....	16.33	96	....	25.66
36	....	6.81	67	....	16.65	97	....	25.96
37	....	7.13	68	....	16.96	98	....	26.26
38	....	7.45	69	....	17.28	99	....	26.57
39	....	7.77	70	1.353880	17.59	100	1.364640	26.88
40	1.342750	8.09	71	....	17.91	101	....	27.18
41	....	8.41	72	....	18.22	102	....	27.49
42	....	8.73	73	....	18.54	103	....	27.80
43	....	9.05	74	....	18.85	104	....	28.11
44	....	9.37	75	1.355690	19.16	105	1.366740	28.41
45	1.344630	9.69				106	....	28.72

boiling point. This glycerol had a Sp. Gr. of 1.2616 (25°/25° C.) corresponding to a purity of 99.84%.

From this glycerol were prepared by weighing on an analytical balance eleven diluted glycerols ranging in concentration from 25% to 98.7% glycerol. Most of these samples were in the higher bracket of 80 to 98% concentration. The samples were thoroughly mixed before any observations were made and were kept in tightly stoppered containers.

The refractive index of these diluted glycerols and of other samples of high concentration glycerols including C.P., dynamite, and crude glycerols was determined with the Bausch and Lomb immersion refractometer at 20° C. The temperature of the water bath used with the instrument was maintained within ± .02° C. of 20°. To avoid changes of concentration of these glycerols while under observation, as could easily occur if the samples of this hygroscopic material were examined in open beakers suspended in the water bath (the usual procedure), the metal cup which screws tightly onto the instrument was used in every case. In this way the sample could be kept in the water bath for hours if necessary without fear of change in concentration. It was found that an appreciable time interval was sometimes required before the refractive index became constant. In the case of glycerols of 95% or higher concentration this time interval might amount to two hours or more before equilibrium was reached, even though the water bath, instrument and sample were all at the same temperature of 20° C. at the start of the test. The initial reading tends to be lower and may be as much as two whole degrees below the reading at equilibrium. Groups of ten readings were taken at intervals of one-half hour, until the averages of successive readings agreed within .05°. The results are shown in Table No. 5.

Note: In samples of glycerol of higher than 90% concentration some difficulty is encountered in making readings at 20° C. because of the indistinctness of the line as viewed through the instrument. This difficulty is increased with increasing temperature but appears to disappear if the temperature is lowered sufficiently. Thus even pure glycerol, 99.8%, gives a clear sharp line at 10° C.

If the refractive index of pure glycerol is plotted versus concentration, the data (of Part I, Table No. 5) will be found to give a smooth curve which deviates only slightly from a straight line. If the data for the refractive index of the high concentrations of glycerol, from 80 to 100%, is plotted on a much larger scale the results fall very close to a straight line.

Part II Table No. 5 shows the refractive index of 4 samples of C.P. glycerol of high purity and different origin. These glycerols are the samples sent out in 1930 to members of the Glycerin Analysis Committee of the American Oil Chemists' Society. The values given in Table No. 5 for the per cent moisture and per cent glycerol (by sp. gr.) are accepted values resulting from the work of eleven collaborators on these samples and have the very small probable errors of ± 0.02% for the glycerol values and of ± .03-.06% for the moisture values. The refractive indices of these samples when plotted fall close to, but slightly above, the curve obtained from the Part I Table No. 5 values.

The refractive index of dynamite glycerol and the crude glycerols shown in Part III of Table No. 5 is

TABLE No. 4

°Zeiss, Refractive Index of Distilled Water Between 10°-30° C.
Wagner, "Immersion Refractometer Tables," p. IX

° C.	° Zeiss	Refractive Index	Difference, per 1° C.	
30	11.8	1.33196	......	
29	12.1	1.33208	.000120	
28	12.4	1.332195	.000115	
27	12.7	1.33231	.000115	
26	13.0	1.33242	.000110	
25	13.25	1.332525	.000105	
24	13.5	1.332625	.000100	
23	13.75	1.33272	.000095	
22	14.0	1.33281	.000090	
21	14.25	1.33290	.000090	
20	14.5	1.33299	.000090	
19	14.7	1.333075	.000085	
18	14.9	1.33316	.000085	
17.5	15.0	1.33320	.000040	.000080
17	15.1	1.33324	.000040	
16	15.3	1.333315	.000075	
15	15.5	1.33339	.000075	
14	15.7	1.33346	.000070	
13	15.85	1.333525	.000065	
12	16.0	1.33359	.000065	
11	16.15	1.33365	.000060	
10	16.3	1.333705	.000055	

Coefficient of Refractive Index of Glycerol

Lewkowitsch "Oils, Fats and Waxes," 5th ed. Vol. III, 387
Data of Van der Willigen, Fortschritte der Physik 1869, p. 288

Specific Gravity	Variation of N_D per 1° C.	Approx. Per Cent Glycerol
1.25350	0.00032	96.
1.24049	0.00025	91.
1.19286	0.00023	73.5
1.16270	0.00022	62.5
1.11463	0.00021	56.5

Much more recent—although confirming the above very old values—is the data reported by Wolff (5) who found a change in refractive index of very pure 86% glycerol of .00028 over the temperature range of 12.5-17.5° C.

TABLE No. 5

Refractive Index of Glycerols by Immersion Refractometer
Temperature 20.0° C. ± 0.02°

I. Pure Glycerol, of Unusual Purity and High Concentration, Diluted to Various Known Concentrations

	Per Cent Water	Per Cent Glycerol	Prism Used	Refractive Index	
				Scale Reading	Average N_D
1.	0.16	99.84	D	98.59 98.59	1.473461
2.	1.20	98.80	D	93.04 93.07	1.471552
3.	2.62	97.38	D	86.49 86.54	1.469325
4.	4.74	95.26	D	78.01 77.99	1.466380
5.	7.90	92.10	D	64.41 64.39	1.461610
6.	10.03	89.97	D	55.19 55.20	1.458340
7.	14.87	85.13	D	35.49 35.51	1.451245
8.	20.38	79.62	D	12.17 12.18	1.442647
9.	30.69	69.31	C	72.44 72.42	1.427030
10.	40.46	59.54	C	31.53 31.48	1.412297
11.	50.25	49.75	B	81.11 81.12	1.397411
12.	74.96	25.04	A	97.60 97.70	1.364134

II. Group of C. P. Glycerols. A. O. C. S. Glycerol Committee 1930 Collaborative Samples. Note: All Readings with Prism D, at 20.00° C.

	Moisture			Refractive Index	
Sample	Direct Det. %	Calc. from Curve %	% Glycerol by Spec. Gr.	Scale Reading	Average N_D
A ...	4.60	4.40	95.30	79.32 79.26 79.30	1.466830
B ...	4.73	4.30	95.26	79.94 79.95	1.467051
C ...	4.75	4.48	95.10	79.09 79.09	1.466761
D ...	4.83	4.48	95.09	79.08 79.13 79.11	1.466766

III. Miscellaneous Glycerols. Note: All Readings with Prism D, at 20.00° C.

Variety of Glycerol	Moisture by Direct Det.	% Glycerol		% Ash	Refractive Index Scale Reading	N_D
1. Dynamite Glycerol, Larkin Co., Inc........	0.33	99.66	(by difference)	None	98.26 98.24	1.473345
2. Soap Lye Crude Glycerol—A. O. C. S. 1929 Standard Sample	4.99	83.33	(by acetin)	8.76	96.02	1.472586
3. Soap Lye Crude, with high salt...	6.20	79.53	(by acetin)	13.62	96.36	1.472702
4: Saponification Crude	7.26	89.89	(by acetin)	2.55	76.52	1.465862

interesting. Dynamite glycerol which contains no detectable amount of ash and whose amber color is due to traces of organic impurities gives a refractive index which falls practically on the curve for pure glycerol at the proper point, as would be expected. In the case of the soap lye crude glycerols which contain an appreciable amount of salt, i.e., sodium chloride, the refractive index is, of course, quite meaningless, which is also exactly what would be expected. The presence of high and variable amounts of salt in soap lye crude make it impossible to determine the per cent of true glycerol in such samples either by specific gravity or refractive index tables. Chemical analysis must be resorted to. In the case of saponification crude glycerol the amount of inorganic salts present is much less but is still sufficient to give a refractive index which does not indicate the true amount of glycerol present.

III. Summary and Conclusions.

The refractive index of glycerol of high purity has been determined at 20.0° C. by the Immersion Refractometer for 12 samples having a range of glycerol content from 25% to 99.8%. These values of refractive index when plotted versus concentration give a smooth curve which deviates slightly from a straight line.

In the case of solutions of pure glycerol ranging from low concentrations up to about 80%, the refractive index may be very quickly and accurately determined. At higher concentrations, especially above 95%, some difficulty is encountered in obtaining constant readings since it may require two hours before a constant reading is obtained on such samples. It is unfortunate that the bulk of glycerols to which this method might be applied are the C.P. and dynamite glycerols having a concentration of 95% or more glycerol. In these cases time could be saved by accurately diluting the sample under investigation with a known weight of water to a concentration of 80% or less and taking the refractive index of the diluted sample.

It is estimated that with care the concentration of pure aqueous solutions of glycerols, including dynamite and C.P., may be determined by refractive index, using the immersion refractometer, with an accuracy of about 0.10%.

The refractive index of crude glycerols is so strongly affected as to be meaningless by the highly variable amounts of inorganic salts contained in such samples.

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Evaluation of Activated Carbons

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WHEN activated carbons are to be evaluated, one naturally thinks in terms of the question, "What carbon will be most economical for removing color from our product?" It is in this way that one often fails to realize that results other than decolorization may be obtained by the proper selection of an activated carbon. We will, therefore, take up as thoroughly as possible, all the various factors which might be accomplished.

Tastes in products for human consumption are becoming very vital factors in the minds of the public. The salesman is able to break down resistance if he can prove that his material is more palatable than his competitor's product. I once had the opportunity of seeing a very clever soap salesman succeed in selling five cases of soap to a little corner grocery store-keeper on the fact that his soap tasted better. The salesman palmed the samples he was supposed to be tasting, but the storekeeper was not so clever, and at last ordered five cases in order to save himself from taking any more of the bitter medicine. As a result of this I have always been very hesitant about tasting any materials which under ordinary conditions, have a taste far from pleasing to my palate. However, an occasion arose when it was necessary that I taste some vegetable shortening or possibly incur the ill-will of the plant superintendent. After considerable hesitation, I finally consented to taste the supposedly obnoxious material and, much to my surprise, I had to report that the shortening had no taste whatever. The manufacturer attributed his success almost wholly to the type of activated carbon which he was using. Since that time I have not been quite so hesitant about tasting materials treated with activated carbons and consequently have noticed immense improvements in the palatability of such materials as sugars, syrups, water, oils, gelatines, fruit juices, cordials and even wines and liquors. Tests have shown that not all activated carbons are suitable for improving the flavor of a definite solution, or compound. It is, therefore, necessary to carry on tests in order to determine the type of activated carbon best suited for this purpose. In carrying on such tests it is well to remember that the tastes among various individuals may vary considerably. It is, therefore, advisable to have at least five persons taste the various samples and select the carbon which receives the approval of the majority. In the edible oil industry it has been found that activated carbon will correct off-flavored oils, and also will correct the "earthy" flavor imparted by a fullers earth. In some cases the use of a preservative will impart an "earthy" taste and this has also been corrected with an activated carbon.

Odor is very closely allied to flavor, and in general it can be said that an improvement in flavor is usually accompanied by an improvement in odor. (Some psychologists hold that taste is merely a secondary reaction of the olfactory organs.) Edible fish oils and lard are very good examples. However, certain cases arise where odor improvement is an important factor and taste improvement is not essential. Dry cleaners solvent is a good example. Where activated carbons are not properly used it is very difficult to remove the last traces of odor from a garment, and the cleaner is bound to receive complaints. In this case the carbon acts to remove the last traces of free fatty acids and soap and anything of a rancid nature. The presence of any of these materials in a solvent may result in a sour or gasoline odor in the clothes.

Activated carbons are beginning to find application in removing odors from air. The most notable example of this is in the ice-box or refrigerator. The carbon will absorb such odors as those emanating from onions, and vegetables in general, fish, fruits, etc., and prevent these from penetrating into such materials as butter, milk or eggs which have a strong adsorptive power of their own. It seems that since activated carbon is a more powerful adsorbing agent, the odors are preferentially taken up by it.

The natural question comes up as to whether the most efficient decolorizing carbon is also the most efficient for improving taste and odor. It is impossible to make any general statement which would answer this question. It has been found that one type of activated carbon is usually the most efficient for improving the taste and odor. The type referred to is manufactured in several different grades, according to their efficiency in decolorizing. Tests indicate that there is very little, if any, difference in the efficiency of these various grades for correcting taste or odor. It would therefore appear that the most important factor for making a good deodorizing carbon is the proper selection of a raw material.

The value of a carbon for correcting the odor or flavor of a solution is largely dependent upon the particular material being treated, and the clientele served. Let us take for example the treatment of water with activated carbon. Here is a case where taste and odor are of prime importance and decolorization with activated carbon is very seldom a matter of any consideration. It has been remarked previously that the tastes of various individuals will vary considerably. This is especially true in the case of water. It has been my experience to go into a community and find the water supply to have a very perceptible off-taste. Upon inquiry I have been

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