Designation: D 1555M – 00

METRIC

Standard Test Method for Calculation of Volume and Weight of Industrial Aromatic Hydrocarbons [Metric][1]

This standard is issued under the fixed designation D 1555M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 The tables in this test method cover calculating the weight and volume of benzene, toluene, mixed xylenes, styrene, *o*-xylene, *m*-xylene, *p*-xylene, cumene, ethylbenzene, 148.9 to 176.7°C (300 to 350°F) aromatic hydrocarbons, 176.7 to 204.4°C (350 to 400°F) aromatic hydrocarbons, and cyclohexane. A procedure is given for calculating the volume at 15.0°C from an observed volume at *t*°C. Table 1 lists the density in kilograms per litre at 15.0°C for high purity chemicals.

1.2 A procedure for the calculation of density in kilograms per litre at 15.0°C of materials of lower purity is provided.

NOTE 1—The purchaser and the seller should agree on a reasonable policy in regard to rounding of final numbers in all computations. Rounding the final weight or volume to not more than five significant digits is, in most cases, consistent with the experimental reliability of the data.

NOTE 2—An alternative test method is Test Method D 4052.

1.3 This test method is the SI companion of Test Method D 1555.

1.4 The following applies to all specified limits in this test method: for purpose of determining conformance with this test method, an observed value or calculated value shall be rounded off "to the nearest unit" in the last right-hand digit used on expressing the specification limit, in accordance with the rounding-off method of Practice E 29.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 941 Test Method for Density and Relative Density (Specific Gravity) of Liquids by Lipkin Bicapillary Pycnometer[2]

D 1217 Test Method for Density and Relative Density (Specific Gravity) of Liquids by Bingham Pycnometer[2]

D 1555 Test Method for Calculation of Volume and Weight of Industrial Aromatic Hydrocarbons[3]

D 3505 Test Method for Density or Relative Density of Pure Liquid Chemicals[3]

D 4052 Test Method for Density and Relative Density of Liquids by Digital Density Meter[4]

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[5]

E 201 Test Method for Calculation of Volume and Weight of Industrial Chemical Liquids[6]

E 380 Practice for Use of the International System of Units (SI) (the Modernized Metric System)[7]

TABLE 1 Density Data

Product	Density in Vacuum at 15.0°C, g/mL	Density in Air at 15°C, kg/L
Benzene	0.8842	0.8831
Cumene	0.8660	0.8649
Cyclohexane	0.7832	0.7821
Ethylbenzene	0.8714	0.8703
m-Xylene	0.8684	0.8673
o-Xylene	0.8843	0.8832
p-Xylene	0.8654	0.8643
Styrene	0.9106	0.9095
Toluene	0.8716	0.8705

3. Significance and Use

3.1 This test method is suitable for use in calculating weights and volumes of products outlined in Section 1. The information gained from this test method can be used for

[1] This test method is under the jurisdiction of ASTM Committee D16 on Aromatic Hydrocarbons and Related Chemicals and is the direct responsibility of Subcommittee D16.01 on Benzene, Toluene, Xylenes, Cyclohexane, and Their Derivatives.

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[2] *Annual Book of ASTM Standards*, Vol 05.01.

[3] *Annual Book of ASTM Standards*, Vol 06.04.

[4] *Annual Book of ASTM Standards*, Vol 05.02.

[5] *Annual Book of ASTM Standards*, Vol 14.02.

[6] *Annual Book of ASTM Standards*, Vol 15.05.

[7] Discontinued 1997. Replaced by IEEE/SI 10. Available from ASTM Headquarters.

determining quantities of stated aromatic hydrocarbons in tanks, shipping containers, etc.

TABLE 2 Application Range of Table 3

Commercial Product	%
Benzene	95 to 100
Toluene	95 to 100
Mixed xylenes	all proportions
Styrene	95 to 100
o-Xylene	95 to 100
m-Xylene	95 to 100
p-Xylene	94 to 100
Cyclohexane	90 to 100
148.9° to 176.7°C aromatic hydrocarbons	all proportions
176.7° to 204.4°C aromatic hydrocarbons	all proportions
Cumene	95 to 100
Ethylbenzene	95 to 100

4. Basic Data

4.1 This test method is a companion test method for Test Method D 1555 and is intended to be the metric equivalent of Test Method D 1555. All of the tables in this test method were derived from the tables in Test Method D 1555, with some information from other standards. When other standards or extended calculations were used, references are made in the appendix. Tables 5 and 6 in Test Method D 1555 were deleted from this test method as they were deemed unnecessary in countries where the metric system is used.

4.2 All calculations in Test Method D 1555 are derived from the densities furnished by the American Petroleum Institute Research Project 44.[8] The tables in Test Method D 1555 are based on data for compounds of the highest purity, but can be used for materials in the range indicated in Table 2.

4.3 The basic data and conversion factors used are given in the appendix of Committee D16's *1963 Annual Report*.[9] Densities listed in Table 1 are given in *ASTM Data Series Publications*.[10]

5. Tables

5.1 Table 3 contains twelve columns as follows:

5.1.1 *Column 1*—Observed temperature in degrees centigrade, and

5.1.2 *Columns 2 through 12, Inclusive*— Multiplying factors for the reduction to 15.0°C, specifically the ratio of the volume at 15.0°C to the volume at *t*°C.

6. Procedure

6.1 *Volume Reduction to 15.0°C*— Enter the appropriate column of Table 3, selecting that temperature to the nearest 0.5°C at which the bulk volume was measured (temperature *t*), and select the corresponding volume reduction factor (ratio) in Columns 2 through 12. Multiply the bulk volume measurement at temperature, *t*, by the factor selected from the table (see Note 1).

6.1.1 *Example 1*—What is the volume at 15.0°C of a tank car of para-xylene whose volume was measured to be 35 130 L at a mean temperature of 31.4°C? Enter Table 3, Column 7, at 31.5°C and note that the "volume ratio" is 0.9836. The volume at 15.0°C is 35 130 × 0.9836 = 34 554 L.

6.2 *Converting Volume to Weight for Chemicals Other Than Mixed Xylenes Listed in* Table 1—Multiple the volume in litres at 15.0°C (five digits) by the density in air in kilograms per litre at 15.0°C (see Table 1).

6.2.1 *Example 2*—What is the weight of para-xylene whose volume is 35 130 L at 31.4°C? See Example 1. The weight is 34 554 × 0.8643 = 29 865 kg.

6.3 *Converting Volume to Weight for Mixed Xylenes*—Correct the measured bulk volume to 15.0°C as described in 6.1. Determine the density (all weights in vacuum) at 15.0°C in grams per millitre as described in Section 7. Obtain the value for kilograms per litre in standard air at 15.0°C by means of the following equation, and round to five digits:

$$a = (b - A) \quad (1)$$

where:

a = kilograms per litre in standard air at 15.0°C,
b = grams per millilitre (also kg/L) in vacuum at 15.0°C,
A = correction factor as given in Table 4.

6.3.1 Multiply the corrected volume by the calculated kilograms per litre at 15.0°C value in order to obtain the weight in kilograms in air (see Note 1).

6.3.1.1 *Example 3*—What is the weight (in air) of the contents of a tank car of mixed xylenes having a calculated density (see Section 7) of 0.87638 g/mL (in vacuum), whose volume was measured to be 35 130 L at a mean temperature of 31.4°C? Enter Table 3 at 31.5°C and note the "factor for reducing volume to 15.0°C" is 0.9840. The volume at 15.0°C is 35 130 × 0.9840 = 34 568 L. From Eq 1: 0.87368 − 0.001090 = 0.87529 kg/L. The weight of mixed xylenes in the tank car is then 34 568 × 0.87529 = 30 257 kg.

7. Calculation

7.1 Density determination may be carried out by any procedure known to be reliable to four digits. Test Methods D 941, D 4052 and D 1217 are suitable and are written to give density completely in vacuum (corrected) that is required for the computation described herein.

7.2 If the methods described in Test Method D 3505 are used, the density in grams per millilitre in vacuum at 20.0°C should be determined.

7.3 Convert density in vacuum at *t* degrees to density at 15.0°C using the multipliers given in Table 4 on interpolated values.

7.3.1 *Example 4*—The density in vacuum of a mixed xylenes sample was determined at 25°C and found to be 0.87095. The coefficient from the table is 1.00986. The density in vacuum at 15.0°C is 0.87095 × 1.00986 = 0.87954.

7.4 Convert the density at 15.0°C in vacuum to density in air at 15.0°C by use of Table 5.

[8] "Selected Values of Properties of Hydrocarbons and Related Compounds," prepared by American Petroleum Institute Research Project 44 at the Chemical Thermodynamic Center, Department of Chemistry, Agriculture and Mechanical, College Station, TX.

[9] *Proceedings*, ASTM, Vol 63, 1963.

[10] "Physical Constants of Hydrocarbons C_1 to C_{10}." *ASTM Data Service Publication DS4A*, ASTM, 1971.

7.5 Calculate kilograms per litre in air in accordance with 6.3.

8. Precision and Bias

8.1 Since this is a calculation method, no precision and bias statement is required.

9. Keywords

9.1 aromatic hydrocarbons; benzene; calculation; conversion; cumene; cyclohexane; density; ethylbenzene; industrial aromatic hydrocarbons; *m*-xylene; mixed xylene; *o*-xylene; *p*-xylene; specific gravity; styrene; toluene; volume; weight

TABLE 3 Volume Corrections to 15°C

Temperature °C	Benzene	Toluene	*m*-Xylene and Mixed Xylenes	Styrene	*o*-Xylene	*p*-Xylene	Cyclo-hexane	Ethyl-benzene	Cumene	148.9 to 176.7°C Aromatic Hydro-carbons	176.7 to 204.4°C Aromatic Hydro-carbons
−20.5	...	1.0376	...	...	...	...	...	...	...	...	...
−20.0	...	1.0371	...	...	...	...	...	...	...	...	...
−19.5	...	1.0366	...	...	...	...	...	...	...	...	...
−19.0	...	1.0361	...	...	...	...	...	...	...	...	...
−18.5	...	1.0355	...	...	...	...	...	...	...	...	...
−18.0	...	1.0350	...	...	...	...	...	...	...	...	...
−17.5	...	1.0345	...	...	...	...	...	...	...	...	...
−17.0	...	1.0339	...	...	...	...	...	...	...	...	...
−16.5	...	1.0334	...	...	...	...	...	...	...	...	...
−16.0	...	1.0329	...	...	...	...	...	...	...	...	...
−15.5	...	1.0323	...	...	...	...	...	...	...	...	...
−15.0	...	1.0318	1.0289	...	1.0285	...	...	1.0300	1.0293	1.0278	1.0262
−14.5	...	1.0313	1.0284	...	1.0280	...	...	1.0295	1.0288	1.0274	1.0258
−14.0	...	1.0308	1.0280	...	1.0275	...	...	1.0290	1.0283	1.0269	1.0253
−13.5	...	1.0302	1.0275	...	1.0270	...	...	1.0285	1.0278	1.0265	1.0249
−13.0	...	1.0297	1.0270	...	1.0266	...	...	1.0280	1.0274	1.0260	1.0245
−12.5	...	1.0292	1.0265	...	1.0261	...	...	1.0275	1.0269	1.0255	1.0240
−12.0	...	1.0286	1.0260	...	1.0256	...	...	1.0270	1.0264	1.0251	1.0236
−11.5	...	1.0281	1.0256	...	1.0251	...	...	1.0265	1.0259	1.0246	1.0232
−11.0	...	1.0276	1.0251	...	1.0247	...	...	1.0260	1.0254	1.0241	1.0227
−10.5	...	1.0270	1.0246	...	1.0242	...	...	1.0255	1.0249	1.0237	1.0223
−10.0	...	1.0265	1.0241	...	1.0237	...	...	1.0250	1.0244	1.0232	1.0218
−9.5	...	1.0260	1.0236	1.0237	1.0232	...	...	1.0245	1.0240	1.0228	1.0214
−9.0	...	1.0254	1.0232	1.0232	1.0228	...	...	1.0240	1.0235	1.0223	1.0210
−8.5	...	1.0249	1.0227	1.0227	1.0223	...	...	1.0235	1.0230	1.0218	1.0205
−8.0	...	1.0244	1.0222	1.0222	1.0218	...	...	1.0230	1.0225	1.0214	1.0201
−7.5	...	1.0239	1.0217	1.0217	1.0214	...	...	1.0225	1.0220	1.0209	1.0197
−7.0	...	1.0233	1.0213	1.0212	1.0209	...	...	1.0220	1.0215	1.0204	1.0192
−6.5	...	1.0228	1.0208	1.0208	1.0204	...	...	1.0216	1.0210	1.0200	1.0188
−6.0	...	1.0223	1.0203	1.0203	1.0199	...	...	1.0211	1.0205	1.0195	1.0184
−5.5	...	1.0217	1.0198	1.0198	1.0195	...	...	1.0206	1.0201	1.0191	1.0179
−5.0	...	1.0212	1.0193	1.0193	1.0190	...	...	1.0201	1.0196	1.0186	1.0175
−4.5	...	1.0207	1.0188	1.0188	1.0185	...	...	1.0196	1.0191	1.0181	1.0171
−4.0	...	1.0201	1.0184	1.0184	1.0180	...	...	1.0191	1.0186	1.0177	1.0166
−3.5	...	1.0196	1.0179	1.0179	1.0176	...	...	1.0186	1.0181	1.0172	1.0162
−3.0	...	1.0191	1.0174	1.0174	1.0171	...	...	1.0181	1.0176	1.0167	1.0157
−2.5	...	1.0186	1.0169	1.0169	1.0166	...	...	1.0176	1.0171	1.0163	1.0153
−2.0	...	1.0180	1.0164	1.0164	1.0161	...	...	1.0171	1.0166	1.0158	1.0149
−1.5	...	1.0175	1.0160	1.0159	1.0157	...	...	1.0166	1.0162	1.0153	1.0144
−1.0	...	1.0170	1.0155	1.0155	1.0152	...	...	1.0161	1.0157	1.0149	1.0140
−0.5	...	1.0164	1.0150	1.0150	1.0147	...	...	1.0156	1.0152	1.0144	1.0136
0.0	...	1.0159	1.0145	1.0145	1.0142	...	...	1.0151	1.0147	1.0140	1.0131
0.5	...	1.0154	1.0140	1.0140	1.0138	...	...	1.0146	1.0142	1.0135	1.0127
1.0	...	1.0148	1.0136	1.0135	1.0133	...	...	1.0141	1.0137	1.0130	1.0123
1.5	...	1.0143	1.0131	1.0131	1.0128	...	...	1.0136	1.0132	1.0126	1.0118
2.0	...	1.0138	1.0126	1.0126	1.0123	...	...	1.0131	1.0127	1.0121	1.0114
2.5	...	1.0133	1.0121	1.0121	1.0119	...	...	1.0126	1.0122	1.0116	1.0109
3.0	...	1.0127	1.0116	1.0116	1.0114	...	...	1.0121	1.0118	1.0112	1.0105
3.5	...	1.0122	1.0111	1.0111	1.0109	...	...	1.0116	1.0113	1.0107	1.0101
4.0	...	1.0117	1.0107	1.0106	1.0104	...	...	1.0111	1.0108	1.0102	1.0096
4.5	1.0123	1.0111	1.0102	1.0102	1.0100	...	1.0126	1.0106	1.0103	1.0098	1.0092
5.0	1.0118	1.0106	1.0097	1.0097	1.0095	...	1.0120	1.0101	1.0098	1.0093	1.0088
5.5	1.0112	1.0101	1.0092	1.0092	1.0090	...	1.0114	1.0096	1.0093	1.0088	1.0083
6.0	1.0106	1.0095	1.0087	1.0087	1.0085	...	1.0108	1.0091	1.0088	1.0084	1.0079
6.5	1.0100	1.0090	1.0082	1.0082	1.0081	...	1.0102	1.0086	1.0083	1.0079	1.0074
7.0	1.0094	1.0085	1.0078	1.0077	1.0076	...	1.0096	1.0081	1.0078	1.0074	1.0070
7.5	1.0088	1.0080	1.0073	1.0073	1.0071	...	1.0090	1.0076	1.0074	1.0070	1.0066
8.0	1.0083	1.0074	1.0068	1.0068	1.0066	...	1.0084	1.0071	1.0069	1.0065	1.0061
8.5	1.0077	1.0069	1.0063	1.0063	1.0062	...	1.0078	1.0066	1.0064	1.0061	1.0057
9.0	1.0071	1.0064	1.0058	1.0058	1.0057	...	1.0072	1.0061	1.0059	1.0056	1.0053

TABLE 3 *Continued*

Temperature °C	Benzene	Toluene	*m*-Xylene and Mixed Xylenes	Styrene	*o*-Xylene	*p*-Xylene	Cyclo-hexane	Ethyl-benzene	Cumene	148.9 to 176.7°C Aromatic Hydro-carbons	176.7 to 204.4°C Aromatic Hydro-carbons
9.5	1.0065	1.0058	1.0053	1.0053	1.0052	...	1.0066	1.0056	1.0054	1.0051	1.0048
10.0	1.0059	1.0053	1.0049	1.0048	1.0047	...	1.0060	1.0050	1.0049	1.0047	1.0044
10.5	1.0053	1.0048	1.0044	1.0044	1.0043	...	1.0054	1.0045	1.0044	1.0042	1.0039
11.0	1.0047	1.0042	1.0039	1.0039	1.0038	...	1.0048	1.0040	1.0039	1.0037	1.0035
11.5	1.0041	1.0037	1.0034	1.0034	1.0033	...	1.0042	1.0035	1.0034	1.0033	1.0031
12.0	1.0036	1.0032	1.0029	1.0029	1.0028	...	1.0036	1.0030	1.0029	1.0028	1.0026
12.5	1.0030	1.0027	1.0024	1.0024	1.0024	1.0025	1.0030	1.0025	1.0025	1.0023	1.0022
13.0	1.0024	1.0021	1.0019	1.0019	1.0019	1.0020	1.0024	1.0020	1.0020	1.0019	1.0018
13.5	1.0018	1.0016	1.0015	1.0015	1.0014	1.0015	1.0018	1.0015	1.0015	1.0014	1.0013
14.0	1.0012	1.0011	1.0010	1.0010	1.0009	1.0010	1.0012	1.0010	1.0010	1.0009	1.0009
14.5	1.0006	1.0005	1.0005	1.0005	1.0005	1.0005	1.0006	1.0005	1.0005	1.0005	1.0004
15.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
15.5	0.9994	0.9995	0.9995	0.9995	0.9995	0.9995	0.9994	0.9995	0.9995	0.9995	0.9996
16.0	0.9988	0.9989	0.9990	0.9990	0.9991	0.9990	0.9988	0.9990	0.9990	0.9991	0.9991
16.5	0.9982	0.9984	0.9985	0.9985	0.9986	0.9985	0.9982	0.9985	0.9985	0.9986	0.9987
17.0	0.9977	0.9979	0.9981	0.9981	0.9981	0.9980	0.9976	0.9980	0.9980	0.9981	0.9982
17.5	0.9971	0.9973	0.9976	0.9976	0.9976	0.9975	0.9970	0.9975	0.9975	0.9977	0.9978
18.0	0.9965	0.9968	0.9971	0.9971	0.9972	0.9970	0.9964	0.9970	0.9971	0.9972	0.9974
18.5	0.9959	0.9963	0.9966	0.9966	0.9967	0.9965	0.9958	0.9965	0.9966	0.9967	0.9969
19.0	0.9953	0.9958	0.9961	0.9961	0.9962	0.9961	0.9952	0.9959	0.9961	0.9963	0.9965
19.5	0.9947	0.9952	0.9956	0.9956	0.9957	0.9956	0.9946	0.9954	0.9956	0.9958	0.9961
20.0	0.9941	0.9947	0.9951	0.9952	0.9953	0.9951	0.9940	0.9949	0.9951	0.9953	0.9956
20.5	0.9935	0.9942	0.9946	0.9947	0.9948	0.9946	0.9934	0.9944	0.9946	0.9949	0.9952
21.0	0.9929	0.9936	0.9942	0.9942	0.9943	0.9941	0.9928	0.9939	0.9941	0.9944	0.9947
21.5	0.9923	0.9931	0.9937	0.9937	0.9938	0.9936	0.9922	0.9934	0.9936	0.9939	0.9943
22.0	0.9917	0.9926	0.9932	0.9932	0.9934	0.9931	0.9916	0.9929	0.9931	0.9935	0.9939
22.5	0.9911	0.9920	0.9927	0.9927	0.9929	0.9926	0.9910	0.9924	0.9926	0.9930	0.9934
23.0	0.9905	0.9915	0.9922	0.9922	0.9924	0.9921	0.9904	0.9919	0.9921	0.9925	0.9930
23.5	0.9899	0.9910	0.9917	0.9918	0.9919	0.9916	0.9898	0.9914	0.9916	0.9921	0.9925
24.0	0.9893	0.9905	0.9912	0.9913	0.9915	0.9911	0.9892	0.9909	0.9912	0.9916	0.9921
24.5	0.9887	0.9899	0.9907	0.9908	0.9910	0.9906	0.9886	0.9904	0.9907	0.9911	0.9917
25.0	0.9881	0.9894	0.9902	0.9903	0.9905	0.9901	0.9880	0.9898	0.9902	0.9907	0.9912
25.5	0.9875	0.9889	0.9898	0.9898	0.9900	0.9896	0.9874	0.9893	0.9897	0.9902	0.9908
26.0	0.9869	0.9883	0.9893	0.9893	0.9896	0.9891	0.9868	0.9888	0.9892	0.9897	0.9903
26.5	0.9863	0.9878	0.9888	0.9888	0.9891	0.9886	0.9862	0.9883	0.9887	0.9893	0.9899
27.0	0.9857	0.9873	0.9883	0.9884	0.9886	0.9881	0.9856	0.9878	0.9882	0.9888	0.9895
27.5	0.9851	0.9867	0.9878	0.9879	0.9881	0.9876	0.9850	0.9873	0.9877	0.9883	0.9890
28.0	0.9845	0.9862	0.9873	0.9874	0.9877	0.9871	0.9844	0.9868	0.9872	0.9879	0.9886
28.5	0.9839	0.9857	0.9868	0.9869	0.9872	0.9866	0.9838	0.9863	0.9867	0.9874	0.9881
29.0	0.9833	0.9852	0.9863	0.9864	0.9867	0.9861	0.9832	0.9858	0.9862	0.9869	0.9877
29.5	0.9827	0.9846	0.9858	0.9859	0.9862	0.9856	0.9826	0.9852	0.9857	0.9865	0.9873
30.0	0.9821	0.9841	0.9854	0.9854	0.9858	0.9851	0.9820	0.9847	0.9853	0.9860	0.9868
30.5	0.9815	0.9836	0.9849	0.9850	0.9853	0.9846	0.9814	0.9842	0.9848	0.9855	0.9864
31.0	0.9809	0.9830	0.9844	0.9845	0.9848	0.9841	0.9808	0.9837	0.9843	0.9851	0.9859
31.5	0.9803	0.9825	0.9839	0.9840	0.9843	0.9836	0.9802	0.9832	0.9838	0.9846	0.9855
32.0	0.9797	0.9820	0.9834	0.9835	0.9839	0.9831	0.9796	0.9827	0.9833	0.9841	0.9851
32.5	0.9791	0.9814	0.9829	0.9830	0.9834	0.9826	0.9790	0.9822	0.9828	0.9837	0.9846
33.0	0.9785	0.9809	0.9824	0.9825	0.9829	0.9821	0.9784	0.9817	0.9823	0.9832	0.9842
33.5	0.9779	0.9804	0.9819	0.9820	0.9824	0.9816	0.9778	0.9811	0.9818	0.9827	0.9837
34.0	0.9773	0.9799	0.9814	0.9815	0.9820	0.9811	0.9772	0.9806	0.9813	0.9822	0.9833
34.5	0.9767	0.9793	0.9809	0.9811	0.9815	0.9806	0.9766	0.9801	0.9808	0.9818	0.9828
35.0	0.9761	0.9788	0.9804	0.9806	0.9810	0.9801	0.9760	0.9796	0.9803	0.9813	0.9824
35.5	0.9755	0.9783	0.9799	0.9801	0.9805	0.9796	0.9754	0.9791	0.9798	0.9808	0.9820
36.0	0.9749	0.9777	0.9795	0.9796	0.9801	0.9791	0.9748	0.9786	0.9793	0.9804	0.9815
36.5	0.9743	0.9772	0.9790	0.9791	0.9796	0.9786	0.9742	0.9780	0.9788	0.9799	0.9811
37.0	0.9737	0.9767	0.9785	0.9786	0.9791	0.9781	0.9736	0.9775	0.9783	0.9794	0.9806
37.5	0.9731	0.9761	0.9780	0.9781	0.9786	0.9776	0.9730	0.9770	0.9779	0.9790	0.9802
38.0	0.9724	0.9756	0.9775	0.9776	0.9782	0.9771	0.9724	0.9765	0.9774	0.9785	0.9798
38.5	0.9718	0.9751	0.9770	0.9772	0.9777	0.9766	0.9717	0.9760	0.9769	0.9780	0.9793
39.0	0.9712	0.9746	0.9765	0.9767	0.9772	0.9761	0.9711	0.9755	0.9764	0.9776	0.9789
39.5	0.9706	0.9740	0.9760	0.9762	0.9768	0.9756	0.9705	0.9750	0.9759	0.9771	0.9784
40.0	0.9700	0.9735	0.9755	0.9757	0.9763	0.9751	0.9699	0.9744	0.9754	0.9766	0.9780
40.5	0.9694	0.9730	0.9750	0.9752	0.9758	0.9746	0.9693	0.9739	0.9749	0.9762	0.9776
41.0	0.9688	0.9724	0.9745	0.9747	0.9753	0.9741	0.9687	0.9734	0.9744	0.9757	0.9771
41.5	0.9682	0.9719	0.9740	0.9742	0.9749	0.9736	0.9681	0.9729	0.9739	0.9752	0.9767
42.0	0.9676	0.9714	0.9735	0.9737	0.9744	0.9731	0.9675	0.9724	0.9734	0.9747	0.9762
42.5	0.9670	0.9708	0.9730	0.9733	0.9739	0.9726	0.9669	0.9719	0.9729	0.9743	0.9758
43.0	0.9663	0.9703	0.9726	0.9728	0.9734	0.9721	0.9663	0.9713	0.9724	0.9738	0.9753
43.5	0.9657	0.9698	0.9721	0.9723	0.9730	0.9716	0.9657	0.9708	0.9719	0.9733	0.9749
44.0	0.9651	0.9692	0.9716	0.9718	0.9725	0.9711	0.9651	0.9703	0.9714	0.9729	0.9745

TABLE 3 *Continued*

Temperature °C	Benzene	Toluene	*m*-Xylene and Mixed Xylenes	Styrene	*o*-Xylene	*p*-Xylene	Cyclo-hexane	Ethyl-benzene	Cumene	148.9 to 176.7°C Aromatic Hydro-carbons	176.7 to 204.4°C Aromatic Hydro-carbons
44.5	0.9645	0.9687	0.9711	0.9713	0.9720	0.9706	0.9645	0.9698	0.9709	...	...
45.0	0.9639	0.9682	0.9706	0.9708	0.9715	0.9701	0.9639	0.9693	0.9704	...	...
45.5	0.9633	0.9677	0.9701	0.9703	0.9711	0.9696	0.9633	0.9687	0.9699	...	...
46.0	0.9627	0.9671	0.9696	0.9698	0.9706	0.9691	0.9627	0.9682	0.9694	...	...
46.5	0.9620	0.9666	0.9691	0.9693	0.9701	0.9686	0.9621	0.9677	0.9690	...	...
47.0	0.9614	0.9661	0.9686	0.9689	0.9696	0.9681	0.9615	0.9672	0.9685	...	...
47.5	0.9608	0.9655	0.9681	0.9684	0.9692	0.9676	0.9609	0.9667	0.9680	...	...
48.0	0.9602	0.9650	0.9676	0.9679	0.9687	0.9670	0.9603	0.9661	0.9675	...	...
48.5	0.9596	0.9645	0.9671	0.9674	0.9682	0.9665	0.9597	0.9656	0.9670	...	...
49.0	0.9590	0.9639	0.9666	0.9669	0.9677	0.9660	0.9591	0.9651	0.9665	...	...
49.5	0.9583	0.9634	0.9661	0.9664	0.9673	0.9655	0.9585	0.9646	0.9660	...	...
50.0	...	...	...	...	...	0.9650	...	...	...	...	...
50.5	...	...	...	...	...	0.9645	...	...	...	...	...
51.0	...	...	...	...	...	0.9640	...	...	...	...	...
51.5	...	...	...	...	...	0.9635	...	...	...	...	...
52.0	...	...	...	...	...	0.9630	...	...	...	...	...
52.5	...	...	...	...	...	0.9625	...	...	...	...	...
53.0	...	...	...	...	...	0.9620	...	...	...	...	...
53.5	...	...	...	...	...	0.9615	...	...	...	...	...
54.0	...	...	...	...	...	0.9610	...	...	...	...	...
54.5	...	...	...	...	...	0.9604	...	...	...	...	...
55.0	...	...	...	...	...	0.9599	...	...	...	...	...
55.5	...	...	...	...	...	0.9594	...	...	...	...	...
56.0	...	...	...	...	...	0.9589	...	...	...	...	...
56.5	...	...	...	...	...	0.9584	...	...	...	...	...
57.0	...	...	...	...	...	0.9579	...	...	...	...	...
57.5	...	...	...	...	...	0.9574	...	...	...	...	...
58.0	...	...	...	...	...	0.9569	...	...	...	...	...
58.5	...	...	...	...	...	0.9564	...	...	...	...	...
59.0	...	...	...	...	...	0.9559	...	...	...	...	...
59.5	...	...	...	...	...	0.9553	...	...	...	...	...
60.0	...	...	...	...	...	0.9548	...	...	...	...	...
60.5	...	...	...	...	...	0.9543	...	...	...	...	...
61.0	...	...	...	...	...	0.9538	...	...	...	...	...
61.5	...	...	...	...	...	0.9533	...	...	...	...	...
62.0	...	...	...	...	...	0.9528	...	...	...	...	...
62.5	...	...	...	...	...	0.9523	...	...	...	...	...
63.0	...	...	...	...	...	0.9518	...	...	...	...	...
63.5	...	...	...	...	...	0.9512	...	...	...	...	...
64.0	...	...	...	...	...	0.9507	...	...	...	...	...
64.5	...	...	...	...	...	0.9502	...	...	...	...	...
65.0	...	...	...	...	...	0.9497	...	...	...	...	...
65.5	...	...	...	...	...	0.9492	...	...	...	...	...

TABLE 4 Multipliers to Convert From Density in Vacuum at *t* Degrees to Density at 15.0°C in Vacuum

Product	Multiplier for Temperature		
	20°C	25°C	30°C
Benzene	1.00595	1.01203	1.01820
Toluene	1.00532	1.01071	1.01614
Mixed xylenes	1.00489	1.00986	1.01490
Styrene	1.00488	1.00982	1.01481
m-Xyelene	1.00489	1.00986	1.01490
o-Xylene	1.00775	1.01655	1.02658
p-Xylene	1.00498	1.01003	1.01515
Cyclohexane	1.00593	1.01199	1.01816
Cumene	1.00489	1.00986	1.01490
Ethylbenzene	1.00489	1.00986	1.01490

TABLE 5 Converting to Densities in Standard Air

Density at 15.0°C, in Vacuum, g/mL	Correction Factor, *A*, g/mL
0.82	0.001098
0.83	0.001097
0.84	0.001095
0.85	0.001094
0.86	0.001092
0.87	0.001091
0.88	0.001090
0.89	0.001088
0.90	0.001087

APPENDIX

(Nonmandatory Information)

X1. TABLE DATA DERIVATION DETAILS

X1.1 Introduction

X1.1.1 Test Method D 1555 is widely used in commerce. Products are generally bought and sold by weight or volume at a specified temperature. In the United States the normal reference temperature has been 60°F. Recent movement to the metric system required for international trade was accomplished by simply changing to 15.56°C as the reference. This temperature is not convenient to use in many cases and a new standard at a more meaningful temperature was desired. For simplicity 15.0°C was chosen as the reference temperature for this test method. The conversions done to Test Method D 1555 tables were simple algebraic in nature and resulted in differences no greater than 0.0002 in any case. Hence, they are considered to be equivalent. The general algebraic equations used in the conversions are as follows from Tables 1 and 3 of Test Method D 1555:

$$D_{p60} = W \div V_{60} \quad \text{and} \quad V_{60} = [V_{15(59)}] \times [F_{15(59)}] \qquad \text{(X1.1)}$$

and W remains constant:

$$\begin{aligned} D_{p15(59)} &= W \div V_{15(59)} \\ &= W \div [V_{60} + F_{15(59)}] \\ &= [W \div V_{60}] \times F_{15(59)} \\ &= D_{p60} \times F_{15(59)} \end{aligned} \qquad \text{(X1.2)}$$

where:

$D_{p\,60}$ = density of product at 60°F (15.56°C), Table 1,
W = weight or mass of product,
V_{60} = volume of product at 60°F (15.56°C),
$V_{15(59)}$ = volume of product at 15.0°C (59°F), and
$F_{15(59)}$ = multiplying factor for product at 59°F, from Table 3.

X1.2 Table 1 of Test Method D 1555 Conversion to Table 1 of This Test Method

X1.2.1 Column 1, the product names remained unchanged.

X1.2.2 Column 2, relative density was not required in countries where the metric system is used and was replaced with density in vacuum. Calculation of the data was done by adding 0.0011 to the data in Column 3 (see X1.2.3 and Table 5).

X1.2.3 Column 3, lb/gal at 60°F to kg/L at 15.0°C (see Eq X1.2 and Practice E 380):

$$(\text{lb/gal } 60°\text{F}) \times F_{15(59)} = \text{lb/gal } 15.0°\text{C} \qquad \text{(X1.3)}$$

$$\text{kg/L} = \text{lb/gal} \times 0.4535924 \text{ kg/lb} \times 0.2641729 \text{ gal/L}$$

X1.3 Table 2 of Test Method D 1555 Conversion to Table 2 of This Test Method

X1.3.1 Table contained no reference to temperature and was left unchanged.

X1.4 Table 3 of Test Method D 1555 Conversion to Table 3 of This Test Method

X1.4.1 Column 1, 1°F increments changed to 0.5°C.

X1.4.2 *Columns 2 Through 10, Inclusive*—Table 3 contains multiplying factors that are ratios of one volume to another (or one density to another). As explained in the research report for Test Method E 201 this volume versus temperature curve can be represented by different equations. It was found that the quadratic equation would fit well. The conversion to degrees Celsius was done by getting three densities (using density at 60°F from Table 1 in Test Method D 1555, and the multiplying factors from Table 1 of Test Method D 1555). Then one would use those three densities to calculate constants for the quadratic equation, and then for calculating the ratios. This procedure would also be suitable for determining a curve for any product that three densities could be analyzed. More detail of the steps are as follows:

X1.4.2.1 Pick three temperatures ($t1$, $t2$, and $t3$) so that $t1 > t2 > t3$ and $t1 - t2 = t2 - t3$. It is important that the three temperatures represent the range of temperatures to be encountered with a product. Then calculate three densities at $t1$, $t2$, $t3$ by $D_t = D_{p60} \times F_t$ (see Eq X1.2). The density at any temperature, by the quadratic equation, is $D_t = D_{tc} + a\ (t - tc) + b\ (t - tc)^2$(from the research report for Test Method E 201), by substituting $t1$, $t2$, $t3$ in two equations a and b can be solved for, $a = (D_{t1} - D_{t3})/[2(t1 - t2)]$ *and* $b = (D_{t1} - 2D_{t2} + D_{t3})/[2(t1 - t2)^2]$, *then the multiplying factor for any product for* *any temperature t equals D_t/D_{15}. The density at 15°C was calculated by Eq X1.2 and Table 1 of Test Method D 1555. Values used for the calculation were:*

	*t*1	*t*2	*t*3	*a*	*b*
Benzene	5	25	45	−0.0010650	−0.000000700
Toluene	−5	15	35	−0.0009250	−0.000000000
m-Xylene	−5	15	35	−0.0008450	−0.000000250
Styrene	−5	15	35	−0.0008825	−0.000000125
o-Xylene	−5	15	35	−0.0008400	−0.000000000
p-Xylene	15	35	55	−0.0008675	−0.000000375
Cyclohexane	5	25	45	−0.0009425	−0.000000125
Ethylbenzene	−5	15	35	−0.0008825	−0.000000375
Cumene	−5	15	35	−0.0008700	−0.000000125

X1.4.3 *Columns 11 and 12*—Columns 2 through 10 were done by using an equation to represent the change in density with temperature and the densities came from Table 1 in Test Method D 1555. There is no fixed density for aromatic hydrocarbons, so an alternate method was used. Algebraically, working through the calculations with $D_{p60} \times F_t$ instead of D_t, the density will eventually drop out of the equation and a quadratic formula can be generated with the multiplying factors only. This worked well and equivalent curves were produced. Values used in the calculation are:

	*t*1	*t*2	*t*3	*a*	*b*
159-177 AH	−5	15	35	−0.0009325	−0.000000125
177-204 AH	−5	15	35	−0.0008775	−0.000000125

X1.5 Table 4 of Test Method D 1555 Conversion to Table 4 of This Test Method

X1.5.1 The reference temperature changed to 15.0°C. Calculations were done to correct the values listed in Column 2. These resulted in changes in the eighth decimal place. Hence (when rounded off to six places), the values appear to be unchanged, but are the corrected data.

X1.6 Table 5 and 6 Deletion of Test Method D 1555

X1.6.1 Relative density and apparent density were not of interest to countries where the metric system is used and were deleted from this standard.

X1.7 Table 7 of Test Method D 1555 Conversion to Table 5 of This Test Method

X1.7.1 Reference temperature in title was changed to 15.0°C. Column 2 was deleted as meaningless. Columns 3 through 5 were calculated by the following:

density 60°F = density $t \times$ multiplier for t,
density 15°C $\times$ multiplier for 15°C = density 60°F,
density 15°C = density 60°F $\div$ multiplier for 15°C,
density 15°C = (density $t \times$ multiplier for t) $\div$ multiplier for 15°C,
density 15°C = density $t \times$ (multiplier for $t \div$ multiplier for 15°C), and
multiplier for $t \div$ multiplier for 15°C = the new multiplier listed.