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:*

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

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]

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