Designation: ~~D1555M – 16~~ D1555M – 22

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

This standard is issued under the fixed designation D1555M; 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 This standard is for use in calculating the weight and volume of benzene, toluene, mixed xylenes, styrene, ortho-xylene, meta-xylene, para-xylene, cumene, ethylbenzene, 148.9 to ~~176.7°C~~176.7 °C and 176.7 to ~~204.4°C~~204.4 °C aromatic hydrocarbons, and cyclohexane. A method is given for calculating the volume at ~~15°C and 20°C~~a given temperature from an observed volume at an observed temperature, ~~t°C.~~ °C. Table 1 lists the density *in Vacuo* at ~~60°F~~ 15 °F and 20 °C for chemicals used to develop the relationship. Densities (or weights) "*in vacuo*" represent the true density (or weight) if measured in a vacuum without the buoyancy effect of air acting on the liquid. It is representative of the actual amount of product present. Densities (or weights) "*in air*" represent what would ~~actually~~ be measured on a scale. The difference is on the order of 0.13 %. Modern densitometers measure density *in vacuo* and the ASTM recommends the use of *in vacuo* densities (or weights).

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.2.1 A complete inch-pound unit companion standard has been developed in Test Method D1555.

1.3 *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~~ safety, health, and ~~health~~environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1217 Test Method for Density and Relative Density (Specific Gravity) of Liquids by Bingham Pycnometer
D1555 Test Method for Calculation of Volume and Weight of Industrial Aromatic Hydrocarbons and Cyclohexane
D3505 Test Method for Density or Relative Density of Pure Liquid Chemicals
D4052 Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter

2.2 *Other Documents:*

American Petroleum Society Research Project 44[3]
Patterson, J. B., and Morris, E. C., *Metrologia*, 31, 1994, pp. 277-288

[1] This test method is under the jurisdiction of ASTM Committee D16 on Aromatic, Industrial, Specialty 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] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] "Selected Values of Properties of Hydrocarbons and Related Compounds," prepared by American Petroleum Institute Research Project 44 at the Chemical Thermodynamics Center, Department of Chemistry, Texas A&M, College Station, TX.

***A Summary of Changes section appears at the end of this standard**

TABLE 1 Physical Properties

Product	Freezing Point °C	Boiling Point °C	Density *in Vacuo* at ~~15°C~~15 °C g/cc[A,B,C]	Density *in Air* at ~~15°C~~15 °C g/cc[D]	Density *in Vacuo* at ~~20°C~~20 °C g/cc[C,E,F]	Density *in Air* at ~~20°C~~20 °C g/cc[D]
Benzene	5.6	80.1	0.88431	0.88324	0.87908	0.87801
Cumene	-96.1	152.4	0.86586	0.86479	0.86160	0.86053
Cyclohexane	6.6	80.7	0.78317	0.78209	0.77849	0.77741
Ethylbenzene	-95.0	136.2	0.87126	0.87019	0.86685	0.86578
Styrene	-30.6	145.2	0.91028	0.90922	0.90586	0.90480
Toluene	-95.0	110.6	0.87147	0.87040	0.86686	0.86579
m-Xylene	-47.9	139.1	0.86831	0.86724	0.86408	0.86301
o-Xylene	-25.2	144.4	0.88387	0.88280	0.87968	0.87861
p-Xylene	13.3	138.3	0.86503	0.86396	0.86076	0.85969

[A] Obtained from Method D1555 – 04a by multiplying the chemical's ~~60°F~~60 °F density by the volume correction factor for ~~59°F~~59 °F.
[B] Specific Gravity at ~~15°C~~15 °C is not presented in this table as it is unnecessary to this standard. If needed, divide ~~15°C~~15 °C density in g/cc by 0.999102 g/cc. See Appendix X1.
[C] g/cc can be converted to kg/1000L or kg/m^3 by multiplying by 1000.
[D] Produced using the equation: Density g/mL$_{in\ air}$ = (1.000149926 × Density g/mL$_{in\ vacuo}$ – 0.001199407795) and rounding to 5 decimal places. See Appendix X2.
[E] Obtained from Method D1555~~–04a~~ – 04a by multiplying the chemical's ~~60°F~~60 °F density by the volume correction factor for ~~68°F~~68 °F.
[F] Specific Gravity at ~~20°C~~20 °C is not presented in this table as it is unnecessary to this standard. If needed, divide ~~20°C~~20 °C density in g/cc by 0.998206 g/cc. See Appendix X1.

TRC Thermodynamic Tables—Hydrocarbons, NSRDS-NIST 75-121, Supplement No. 121, April 30, 2001[4]

3. Significance and Use

3.1 This test method is suitable for use in calculating weights and volumes of the products outlined in Section 1. The information presented in this method can be used for determining quantities of the above-stated aromatic hydrocarbons in tanks, shipping containers, etc.

4. Basic Data

4.1 Densities of materials should be determined by measurement (see Section 7). Densities of pure materials at ~~60°F~~60 °F may be estimated from densities furnished by NSRDS-NIST 75-121 (National Standard Reference Data Series—National Institute of Standards and Technology).

4.2 The VCF (Volume Correction Factor) equations provided below are derived from the Volume Correction implementation procedures presented in Method D1555.

4.3 The former VCF tables were based on data for compounds used in American Petroleum Institute Research Project 44 for which the purity is not clearly defined, but were reported to be usable for materials in the ranges indicated in Table 2. The data supporting this conclusion appears to be unavailable at the present time; however there is no reason to change this recommendation. If, depending on the composition of the impurities, there is reason to suspect that the VCF implementation procedures presented below do not apply to a particular impure product, a separate implementation procedure should be independently determined. This may be done by measuring the density of a representative sample at different temperatures throughout the expected working temperature range, regressing the data to obtain a temperature/density equation that best reproduces the observed data, and then dividing the constants of the temperature/density equation by the calculated density at ~~15°C and 20°C.~~a given temperature where the density is desired.

5. Volume Correction Factor Implementation Procedure

5.1 The following general equation is used to generate the Volume Correction Factors:

[4] Available from National Institute of Standards and Technology (NIST), 100 Bureau Dr., Stop 1070, Gaithersburg, MD 20899-1070, http://www.nist.gov.

TABLE 2 Application Range of Implementation Procedure

Impure Products	Range
~~Benzene~~	~~95 to 100%~~
Benzene	95 to 100 %
~~Cumene~~	~~95 to 100%~~
Cumene	95 to 100 %
~~Cyclohexane~~	~~90 to 100%~~
Cyclohexane	90 to 100 %
~~Ethylbenzene~~	~~95 to 100%~~
Ethylbenzene	95 to 100 %
~~Styrene~~	~~95 to 100%~~
Styrene	95 to 100 %
~~Toluene~~	~~95 to 100%~~
Toluene	95 to 100 %
Mixed Xylenes	All proportions
~~*m*-Xylene~~	~~95 to 100%~~
m-Xylene	95 to 100 %
~~*o*-Xylene~~	~~95 to 100%~~
o-Xylene	95 to 100 %
~~*p*-Xylene~~	~~94 to 100%~~
p-Xylene	94 to 100 %
~~148.9-176.7°C Aromatic Hydrocarbons~~	~~All proportions~~
148.9-176.7 °C Aromatic Hydrocarbons	All proportions
~~176.7-204.4°C Aromatic Hydrocarbons~~	~~All proportions~~
176.7-204.4 °C Aromatic Hydrocarbons	All proportions

$$VCF = \frac{}{a + b[1.8\,t\ + 32] + c(1.8\,t\ + 32)^2 + d\,(1.8\,t\ + 32)^3 + e\,(1.8\,t\ + 32)^4} \quad (1)$$

$$VCF^{XX} \quad (1)$$

$$VCF = \frac{[a + b \times t_{o,f} + c \times t_{o,f}^2 + d \times t_{o,f}^3 + e \times t_{o,f}^4]}{[a + b \times t_{b,f} + c \times t_{b,f}^2 + d \times t_{b,f}^3 + e \times t_{b,f}^4]} \quad (1)$$

$$t_{b,f} = 1.8 \times t_{b,c} + 32$$

$$t_{o,f} = 1.8 \times t_{o,c} + 32$$

where:

~~*t* = temperature in °C,~~
~~VCF^{XX} = $VCF^{59°F}$ or $VCF^{68°F}$~~

VCF = Volume correction factor to base temperature from observed temperature; constants a through e are specific to each compound (obtained from Method D1555 and presented in Table 3),
$t_{b,f}$ = Desired volume correction factor base temperature in °F,
$t_{b,c}$ = Desired volume correction factor base temperature in °C,
$t_{o,f}$ = Observed density temperature in °F, and
$t_{o,c}$ = Observed density temperature in °C.

~~constants a through e and VCF^{XX} are specific to each compound (obtained from Method D1555 and presented in Table 3).~~

5.1.1 Temperature may be entered in tenths of a degree Celsius.

5.1.2 The calculated result is rounded to the appropriate significant figures if it is to be reported and not rounded if to be used in another calculation. No intermediate rounding or truncation should be done.

5.1.3 The equations are valid for liquid product up to ~~60°C (65.5°C~~60 °C (65.5 °C for *p*-xylene).

5.1.4 This implementation procedure replaces the printed tables of previous editions of this Method for determining VCFs. **The implementation procedure is the Standard, not the printed tables**. However, the printed tables are provided in ~~0.5°C~~0.5 °C increments for the user's convenience (Tables 4 and 5).

TABLE 3 VCF Constants

Product	a	b	c	d	e	VCF~~60F~~15 °C	VCF~~68F~~20 °C
Benzene	1.038382492	-6.2307×10^{-4}	-2.8505×10^{-7}	1.2692×10^{-10}	0	1.00066	0.99474
Cumene	1.032401114	-5.3445×10^{-4}	-9.5067×10^{-8}	3.6272×10^{-11}	0	1.00055	0.99563
Cyclohexane	1.039337296	-6.4728×10^{-4}	-1.4582×10^{-7}	1.03538×10^{-10}	0	1.00066	0.99468
Ethylbenzene	1.033346632	-5.5243×10^{-4}	8.37035×10^{-10}	-1.2692×10^{-9}	5.55061×10^{-12}	1.00056	0.99550
Styrene	1.032227515	-5.3444×10^{-4}	-4.4323×10^{-8}	0	0	1.00054	0.99568
Toluene	1.035323647	-5.8887×10^{-4}	2.46508×10^{-9}	-7.2802×10^{-12}	0	1.00059	0.99529
m-Xylene[A]	1.031887514	-5.2326×10^{-4}	-1.3253×10^{-7}	-7.35960×10^{-11}	0	1.00054	0.99567
o-Xylene	1.031436449	-5.2302×10^{-4}	-2.5217×10^{-9}	-2.13840×10^{-10}	0	1.00053	0.99579
p-Xylene	1.032307000	-5.2815×10^{-4}	-1.8416×10^{-7}	1.89256×10^{-10}	0	1.00054	0.99560
148.9-176.7°C	1.031118000	-5.1827×10^{-4}	-3.5109×10^{-9}	-1.98360×10^{-11}	0	1.00052	0.99585
176.7-204.4°C	1.029099000	-4.8287×10^{-4}	-3.7692×10^{-8}	3.78575×10^{-11}	0	1.00049	0.99610

[A] and Mixed Xylenes.

6. Use of the Implementation Procedure

6.1 *Convert Volume to ~~15°C or 20°C~~ Base Temperature*—Enter the appropriate equation with the temperature to the nearest 0.1 degree Celsius at which the bulk volume was measured (temperature *t*). Multiply the bulk volume measurement at temperature *t* by the VCF.

6.1.1 *Example 1*—What is the volume at ~~15°C~~15 °C and at ~~20°C~~20 °C of a tank car of *p*-xylene whose volume was measured to be ~~35,129 liters~~35 129 L at a mean temperature of ~~31.7°C?~~31.7 °C?

For ~~15°C,~~15 °C, enter Eq 1 with ~~31.7°C~~31.7 °C and the appropriate constants from Table 3 to calculate a VCF of 0.983411909349613. Multiply the volume at ~~31.7°C~~31.7 °C by the volume correction factor 0.983411909349613 to obtain the volume at ~~15°C.~~15 °C.

$$35129 \cdot 0.983411909349613 = 34{,}546.2769635425 \text{ or } 34546 \text{ liters}$$

If this value is to be reported, it may be rounded appropriately. The unrounded intermediate value should be used for additional calculations.

For ~~20°C,~~20 °C, enter Eq 1 with ~~31.7°C~~31.7 °C and the appropriate constants for Table 3 to calculate a VCF of 0.98829143409066. Multiply the volume at ~~31.7°C~~31.7 °C by the volume correction factor 0.98829143409066 to obtain the volume at ~~15°C.~~15 °C.

$$35129 \cdot 0.98829143409066 = 34{,}717.6897881708 \text{ or } 34{,}718 \text{ liters}$$

6.2 *Converting Volume to Weight for Chemicals Listed in* Table 1—Convert the measured bulk to liters at ~~15°C or 20°C~~ base temperature as described in 6.1. Determine the density (all weights *in vacuo*) at ~~15°C or 20°C~~ base temperature in grams per milliliter (equivalent to grams per cubic centimeter and kilograms per liter) as described in Section 7. To obtain the density *in air* at ~~15°C or 20°C,~~ base temperature, use the equation described in footnote D of Table 1 or refer to Appendix X2:

$$D\ g/mL_{in\ air} = [1.00014926 \cdot D\ \ g/mL_{in\ vacuo} - 0.00119940779543]$$

To obtain the weight multiply the density by the volume to obtain the weight *in vacuo* or *in air*.

6.2.1 *Example 2*—The density of the *p*-xylene in Example 1 has been determined to be 0.8646 g/mL (*in vacuo*) at ~~15°C,~~15 °C, the desnity *in air* is:

$$D_{in\ air} = [1.00014926 \cdot 0.8646 - 0.00119940779543] = 0.86352964240057\ g/mL$$

The weight of the net volume is thus:

$$34{,}546.2769635425 \text{ liters} * 0.8646 = 298687110.626788 \text{ kg } in\ \ vacuo$$

$$34{,}546.2769635425 \text{ liters} * 0.86352964240057 = 29831.7341925989 \text{ kg } in\ air$$

If this value is to be reported, the value can be rounded as needed by the user. The unrounded intermediate value should be used for additional calculations.

A similar procedure would be followed for a reference density of ~~20°C.~~20 °C.

7. Density Determination

7.1 Density determinations may be carried out by any procedure known to be reliable to at least 4 digits. Test Methods D1217,

TABLE 4 Volume Correction Factors

Volume Correction to ~~15°C~~15 °C											
Temperature °C	Benzene	Cumene	Cyclohexane	Ethyl Benzene	Styrene	Toluene	*m*-Xylene and Mixed Xylenes	*o*-Xylene	*p*-Xylene	148.9 to ~~176.7°C~~176.7 °C Aromatic Hydrocarbons	176.7 to ~~204.4°C~~204.4 °C Aromatic Hydrocarbons
-20.5	...	...	...	...	...	...	...	...	...	...	...
-20.0	...	...	...	...	...	1.03707	...	...	...	...	...
-19.5	...	...	...	...	...	1.03654	...	...	...	...	...
-19.0	...	...	...	...	...	1.03601	...	...	...	...	...
-18.5	...	...	...	...	...	1.03548	...	...	...	...	...
-18.0	...	...	...	...	...	1.03495	...	...	...	...	...
-17.5	...	...	...	...	...	1.03442	...	...	...	...	...
-17.0	...	...	...	...	...	1.03389	...	...	...	...	...
-16.5	...	...	...	...	...	1.03336	...	...	...	...	...
-16.0	...	...	...	...	...	1.03283	...	...	...	...	...
-15.5	...	...	...	...	...	1.03230	...	...	...	...	...
-15.0	...	1.02916	...	1.03001	...	1.03177	1.02871	1.02828	...	1.02799	1.02618
-14.5	...	1.02868	...	1.02951	...	1.03124	1.02824	1.02781	...	1.02753	1.02575
-14.0	...	1.02820	...	1.02901	...	1.03071	1.02777	1.02734	...	1.02706	1.02531
-13.5	...	1.02771	...	1.02852	...	1.03018	1.02730	1.02686	...	1.02659	1.02488
-13.0	...	1.02723	...	1.02802	...	1.02965	1.02682	1.02639	...	1.02613	1.02444
-12.5	...	1.02675	...	1.02752	...	1.02912	1.02635	1.02592	...	1.02566	1.02401
-12.0	...	1.02627	...	1.02702	...	1.02859	1.02588	1.02545	...	1.02519	1.02357
-11.5	...	1.02579	...	1.02653	...	1.02806	1.02540	1.02498	...	1.02473	1.02314
-11.0	...	1.02530	...	1.02603	...	1.02753	1.02493	1.02451	...	1.02426	1.02270
-10.5	...	1.02482	...	1.02553	...	1.02700	1.02446	1.02404	...	1.02380	1.02227
-10.0	...	1.02434	...	1.02504	...	1.02647	1.02398	1.02357	...	1.02333	1.02183
-9.5	...	1.02385	...	1.02454	...	1.02594	1.02351	1.02310	...	1.02286	1.02140
-9.0	...	1.02337	...	1.02404	1.02322	1.02542	1.02303	1.02263	...	1.02240	1.02096
-8.5	...	1.02289	...	1.02354	1.02274	1.02489	1.02256	1.02216	...	1.02193	1.02052
-8.0	...	1.02240	...	1.02304	1.02226	1.02436	1.02208	1.02169	...	1.02146	1.02009
-7.5	...	1.02192	...	1.02255	1.02177	1.02383	1.02161	1.02122	...	1.02100	1.01965
-7.0	...	1.02144	...	1.02205	1.02129	1.02330	1.02113	1.02075	...	1.02053	1.01922
-6.5	...	1.02095	...	1.02155	1.02081	1.02277	1.02066	1.02028	...	1.02007	1.01878
-6.0	...	1.02047	...	1.02105	1.02033	1.02224	1.02018	1.01980	...	1.01960	1.01835
-5.5	...	1.01998	...	1.02055	1.01984	1.02171	1.01971	1.01933	...	1.01913	1.01791
-5.0	...	1.01950	...	1.02006	1.01936	1.02118	1.01923	1.01886	...	1.01867	1.01747
-4.5	...	1.01901	...	1.01956	1.01888	1.02065	1.01875	1.01839	...	1.01820	1.01704
-4.0	...	1.01853	...	1.01906	1.01840	1.02012	1.01828	1.01792	...	1.01773	1.01660
-3.5	...	1.01804	...	1.01856	1.01791	1.01959	1.01780	1.01745	...	1.01727	1.01617
-3.0	...	1.01756	...	1.01806	1.01743	1.01906	1.01732	1.01698	...	1.01680	1.01573
-2.5	...	1.01707	...	1.01756	1.01695	1.01853	1.01685	1.01651	...	1.01633	1.01529
-2.0	...	1.01659	...	1.01706	1.01646	1.01800	1.01637	1.01604	...	1.01587	1.01486
-1.5	...	1.01610	...	1.01656	1.01598	1.01747	1.01589	1.01557	...	1.01540	1.01442
-1.0	...	1.01562	...	1.01606	1.01550	1.01694	1.01541	1.01510	...	1.01493	1.01399
-0.5	...	1.01513	...	1.01557	1.01502	1.01641	1.01494	1.01462	...	1.01447	1.01355
0.0	...	1.01464	...	1.01507	1.01453	1.01588	1.01446	1.01415	...	1.01400	1.01311
0.5	...	1.01416	...	1.01457	1.01405	1.01535	1.01398	1.01368	...	1.01354	1.01268
1.0	...	1.01367	...	1.01407	1.01357	1.01482	1.01350	1.01321	...	1.01307	1.01224
1.5	...	1.01319	...	1.01357	1.01308	1.01429	1.01302	1.01274	...	1.01260	1.01180
2.0	...	1.01270	...	1.01307	1.01260	1.01376	1.01254	1.01227	...	1.01214	1.01137
2.5	...	1.01221	...	1.01257	1.01211	1.01324	1.01206	1.01180	...	1.01167	1.01093
3.0	...	1.01173	...	1.01206	1.01163	1.01271	1.01158	1.01132	...	1.01120	1.01049
3.5	...	1.01124	...	1.01156	1.01115	1.01218	1.01110	1.01085	...	1.01074	1.01006
4.0	...	1.01075	...	1.01106	1.01066	1.01165	1.01062	1.01038	...	1.01027	1.00962
4.5	...	1.01026	...	1.01056	1.01018	1.01112	1.01014	1.00991	...	1.00980	1.00918
5.0	...	1.00978	...	1.01006	1.00970	1.01059	1.00966	1.00944	...	1.00934	1.00875
5.5	...	1.00929	...	1.00956	1.00921	1.01006	1.00918	1.00897	...	1.00887	1.00831
6.0	1.01054	1.00880	...	1.00906	1.00873	1.00953	1.00870	1.00850	...	1.00840	1.00787
6.5	1.00995	1.00831	...	1.00856	1.00824	1.00900	1.00822	1.00802	...	1.00794	1.00744
7.0	1.00937	1.00782	1.00952	1.00805	1.00776	1.00847	1.00774	1.00755	...	1.00747	1.00700
7.5	1.00879	1.00734	1.00893	1.00755	1.00727	1.00794	1.00725	1.00708	...	1.00700	1.00656
8.0	1.00821	1.00685	1.00833	1.00705	1.00679	1.00741	1.00677	1.00661	...	1.00654	1.00612
8.5	1.00762	1.00636	1.00774	1.00655	1.00631	1.00688	1.00629	1.00614	...	1.00607	1.00569
9.0	1.00704	1.00587	1.00715	1.00605	1.00582	1.00635	1.00581	1.00566	...	1.00560	1.00525
9.5	1.00645	1.00538	1.00655	1.00554	1.00534	1.00582	1.00532	1.00519	...	1.00514	1.00481
10.0	1.00587	1.00489	1.00596	1.00504	1.00485	1.00529	1.00484	1.00472	...	1.00467	1.00437
10.5	1.00528	1.00440	1.00536	1.00454	1.00437	1.00476	1.00436	1.00425	...	1.00420	1.00394
11.0	1.00470	1.00391	1.00477	1.00403	1.00388	1.00423	1.00387	1.00378	...	1.00374	1.00350
11.5	1.00411	1.00342	1.00417	1.00353	1.00340	1.00370	1.00339	1.00330	...	1.00327	1.00306
12.0	1.00352	1.00294	1.00358	1.00303	1.00291	1.00317	1.00291	1.00283	...	1.00280	1.00262
12.5	1.00294	1.00245	1.00298	1.00252	1.00243	1.00264	1.00242	1.00236	...	1.00234	1.00219
13.0	1.00235	1.00196	1.00239	1.00202	1.00194	1.00212	1.00194	1.00189	...	1.00187	1.00175
13.5	1.00176	1.00147	1.00179	1.00152	1.00146	1.00159	1.00145	1.00141	1.00148	1.00140	1.00131
14.0	1.00117	1.00098	1.00119	1.00101	1.00097	1.00106	1.00097	1.00094	1.00099	1.00094	1.00087

TABLE 4 *Continued*

Volume Correction to ~~15°C~~15 °C											
Temperature °C	Benzene	Cumene	Cyclohexane	Ethyl Benzene	Styrene	Toluene	*m*-Xylene and Mixed Xylenes	*o*-Xylene	*p*-Xylene	148.9 to ~~176.7°C~~176.7 °C Aromatic Hydrocarbons	176.7 to ~~204.4°C~~204.4 °C Aromatic Hydrocarbons
14.5	1.00058	1.00049	1.00060	1.00051	1.00049	1.00053	1.00048	1.00047	1.00050	1.00047	1.00043
15.0	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
15.5	0.99941	0.99950	0.99940	0.99950	0.99952	0.99947	0.99951	0.99952	0.99951	0.99954	0.99956
16.0	0.99882	0.99901	0.99881	0.99899	0.99903	0.99894	0.99903	0.99905	0.99902	0.99907	0.99912
16.5	0.99822	0.99852	0.99821	0.99849	0.99854	0.99841	0.99854	0.99858	0.99852	0.99860	0.99868
17.0	0.99763	0.99803	0.99761	0.99798	0.99806	0.99788	0.99806	0.99810	0.99803	0.99814	0.99824
17.5	0.99704	0.99754	0.99702	0.99748	0.99757	0.99735	0.99757	0.99763	0.99754	0.99767	0.99781
18.0	0.99645	0.99705	0.99642	0.99697	0.99709	0.99682	0.99708	0.99716	0.99704	0.99720	0.99737
18.5	0.99586	0.99656	0.99582	0.99647	0.99660	0.99629	0.99659	0.99668	0.99655	0.99674	0.99693
19.0	0.99527	0.99607	0.99522	0.99596	0.99612	0.99576	0.99611	0.99621	0.99605	0.99627	0.99649
19.5	0.99467	0.99557	0.99462	0.99545	0.99563	0.99523	0.99562	0.99574	0.99556	0.99580	0.99605
20.0	0.99408	0.99508	0.99402	0.99495	0.99514	0.99470	0.99513	0.99526	0.99506	0.99534	0.99561
20.5	0.99349	0.99459	0.99343	0.99444	0.99466	0.99417	0.99464	0.99479	0.99457	0.99487	0.99518
21.0	0.99289	0.99410	0.99283	0.99393	0.99417	0.99364	0.99416	0.99432	0.99407	0.99440	0.99474
21.5	0.99230	0.99361	0.99223	0.99343	0.99368	0.99311	0.99367	0.99384	0.99358	0.99393	0.99430
22.0	0.99170	0.99311	0.99163	0.99292	0.99320	0.99258	0.99318	0.99337	0.99308	0.99347	0.99386
22.5	0.99111	0.99262	0.99103	0.99241	0.99271	0.99206	0.99269	0.99289	0.99258	0.99300	0.99342
23.0	0.99051	0.99213	0.99043	0.99191	0.99223	0.99153	0.99220	0.99242	0.99209	0.99253	0.99298
23.5	0.98991	0.99164	0.98983	0.99140	0.99174	0.99100	0.99171	0.99195	0.99159	0.99207	0.99254
24.0	0.98932	0.99114	0.98923	0.99089	0.99125	0.99047	0.99122	0.99147	0.99109	0.99160	0.99210
24.5	0.98872	0.99065	0.98863	0.99038	0.99076	0.98994	0.99073	0.99100	0.99060	0.99113	0.99167
25.0	0.98812	0.99016	0.98803	0.98988	0.99028	0.98941	0.99024	0.99053	0.99010	0.99067	0.99123
25.5	0.98752	0.98966	0.98743	0.98937	0.98979	0.98888	0.98975	0.99005	0.98960	0.99020	0.99079
26.0	0.98693	0.98917	0.98683	0.98886	0.98930	0.98835	0.98926	0.98958	0.98910	0.98973	0.99035
26.5	0.98633	0.98868	0.98622	0.98835	0.98882	0.98782	0.98877	0.98910	0.98861	0.98927	0.98991
27.0	0.98573	0.98818	0.98562	0.98784	0.98833	0.98729	0.98828	0.98863	0.98811	0.98880	0.98947
27.5	0.98513	0.98769	0.98502	0.98733	0.98784	0.98676	0.98779	0.98816	0.98761	0.98833	0.98903
28.0	0.98453	0.98719	0.98442	0.98683	0.98736	0.98623	0.98730	0.98768	0.98711	0.98786	0.98859
28.5	0.98393	0.98670	0.98382	0.98632	0.98687	0.98570	0.98680	0.98720	0.98661	0.98740	0.98815
29.0	0.98333	0.98621	0.98322	0.98581	0.98638	0.98517	0.98631	0.98673	0.98611	0.98693	0.98771
29.5	0.98272	0.98571	0.98261	0.98530	0.98589	0.98464	0.98582	0.98625	0.98561	0.98646	0.98727
30.0	0.98212	0.98522	0.98201	0.98479	0.98541	0.98411	0.98533	0.98578	0.98511	0.98600	0.98683
30.5	0.98152	0.98472	0.98141	0.98428	0.98492	0.98358	0.98484	0.98530	0.98461	0.98553	0.98639
31.0	0.98092	0.98423	0.98080	0.98377	0.98443	0.98305	0.98434	0.98483	0.98411	0.98506	0.98595
31.5	0.98032	0.98373	0.98020	0.98326	0.98394	0.98253	0.98385	0.98435	0.98361	0.98459	0.98552
32.0	0.97971	0.98324	0.97960	0.98275	0.98345	0.98200	0.98336	0.98388	0.98311	0.98413	0.98508
32.5	0.97911	0.98274	0.97899	0.98224	0.98297	0.98147	0.98286	0.98340	0.98261	0.98366	0.98464
33.0	0.97850	0.98225	0.97839	0.98173	0.98248	0.98094	0.98237	0.98293	0.98211	0.98319	0.98420
33.5	0.97790	0.98175	0.97779	0.98122	0.98199	0.98041	0.98187	0.98245	0.98161	0.98273	0.98376
34.0	0.97729	0.98125	0.97718	0.98071	0.98150	0.97988	0.98138	0.98198	0.98111	0.98226	0.98332
34.5	0.97669	0.98076	0.97658	0.98020	0.98101	0.97935	0.98088	0.98150	0.98061	0.98179	0.98288
35.0	0.97608	0.98026	0.97597	0.97969	0.98053	0.97882	0.98039	0.98102	0.98010	0.98132	0.98244
35.5	0.97548	0.97977	0.97537	0.97918	0.98004	0.97829	0.97989	0.98055	0.97960	0.98086	0.98200
36.0	0.97487	0.97927	0.97476	0.97867	0.97955	0.97776	0.97940	0.98007	0.97910	0.98039	0.98156
36.5	0.97426	0.97877	0.97416	0.97816	0.97906	0.97723	0.97890	0.97959	0.97860	0.97992	0.98112
37.0	0.97366	0.97828	0.97355	0.97765	0.97857	0.97670	0.97841	0.97912	0.97809	0.97945	0.98068
37.5	0.97305	0.97778	0.97295	0.97713	0.97808	0.97617	0.97791	0.97864	0.97759	0.97899	0.98024
38.0	0.97244	0.97728	0.97234	0.97662	0.97760	0.97564	0.97741	0.97816	0.97709	0.97852	0.97980
38.5	0.97183	0.97679	0.97174	0.97611	0.97711	0.97511	0.97692	0.97769	0.97658	0.97805	0.97936
39.0	0.97122	0.97629	0.97113	0.97560	0.97662	0.97458	0.97642	0.97721	0.97608	0.97758	0.97892
39.5	0.97061	0.97579	0.97053	0.97509	0.97613	0.97405	0.97592	0.97673	0.97558	0.97712	0.97848
40.0	0.97000	0.97529	0.96992	0.97458	0.97564	0.97353	0.97543	0.97626	0.97207	0.97665	0.97804
40.5	0.96939	0.97480	0.96931	0.97407	0.97515	0.97300	0.97493	0.97578	0.97457	0.97618	0.97760
41.0	0.96878	0.97430	0.96871	0.97356	0.97466	0.97247	0.97443	0.97530	0.97407	0.97571	0.97716
41.5	0.96817	0.97380	0.96810	0.97304	0.97417	0.97194	0.97393	0.97483	0.97356	0.97525	0.97672
42.0	0.96756	0.97330	0.96749	0.97253	0.97368	0.97141	0.97343	0.97435	0.97306	0.97478	0.97627
42.5	0.96695	0.97281	0.96688	0.97202	0.97319	0.97088	0.97293	0.97387	0.97255	0.97431	0.97583
43.0	0.96634	0.97231	0.96628	0.97151	0.97270	0.97035	0.97244	0.97339	0.97205	0.97384	0.97539
43.5	0.96572	0.97181	0.96567	0.97100	0.97221	0.96982	0.97194	0.97291	0.97154	0.97338	0.97495
44.0	0.96511	0.97131	0.96506	0.97409	0.97172	0.96929	0.97144	0.97243	0.97104	0.97291	0.97451
44.5	0.96450	0.97081	0.96445	0.96998	0.97124	0.96876	0.97094	0.97196	0.97053	0.97244	0.97407
45.0	0.96388	0.97031	0.96385	0.96946	0.97075	0.96823	0.97044	0.97148	0.97002	0.97197	0.97363
45.5	0.96327	0.96981	0.96324	0.96895	0.97026	0.96770	0.96994	0.97101	0.96952	0.97151	0.97319
46.0	0.96265	0.96932	0.96263	0.96844	0.96977	0.96717	0.96944	0.97052	0.96901	0.97104	0.97275
46.5	0.96204	0.96882	0.96202	0.96793	0.96928	0.96664	0.96894	0.97004	0.96850	0.97057	0.97231
47.0	0.96142	0.96832	0.96141	0.96742	0.96879	0.96611	0.96843	0.96957	0.96800	0.97010	0.97187
47.5	0.96081	0.96782	0.96080	0.96691	0.96830	0.96558	0.96793	0.96909	0.96749	0.96964	0.97143
48.0	0.96019	0.96732	0.96019	0.96639	0.96781	0.96505	0.96743	0.96861	0.96698	0.96917	0.97099
48.5	0.95958	0.96682	0.95958	0.96588	0.96732	0.96453	0.96693	0.96813	0.96648	0.96870	0.97054
49.0	0.95896	0.96632	0.95897	0.96537	0.96683	0.96400	0.96643	0.96765	0.96597	0.96823	0.97010

TABLE 4 *Continued*

Volume Correction to ~~15°C~~15 °C											
Temperature °C	Benzene	Cumene	Cyclohexane	Ethyl Benzene	Styrene	Toluene	*m*-Xylene and Mixed Xylenes	*o*-Xylene	*p*-Xylene	148.9 to ~~176.7°C~~176.7 °C Aromatic Hydrocarbons	176.7 to ~~204.4°C~~204.4 °C Aromatic Hydrocarbons
49.5	0.95834	0.96582	0.95836	0.96486	0.96634	0.96347	0.96592	0.96717	0.96546	0.96777	0.96966
50.0	0.95772	0.96532	0.95775	0.96435	0.96584	0.96294	0.96542	0.96669	0.96495	0.96730	0.96922
50.5	0.95711	0.96482	0.95714	0.96384	0.96535	0.96241	0.96492	0.96621	0.96445	0.96683	0.96878
51.0	0.95649	0.96432	0.96653	0.96332	0.96486	0.96188	0.96442	0.96573	0.96394	0.96636	0.96834
51.5	0.95587	0.96382	0.95592	0.96281	0.96437	0.96135	0.96391	0.96525	0.96343	0.96589	0.96790
52.0	0.95525	0.96332	0.95531	0.96230	0.96388	0.96082	0.96341	0.96477	0.96292	0.96543	0.96746
52.5	0.95463	0.96282	0.95470	0.96179	0.96339	0.96029	0.96291	0.96429	0.96241	0.96496	0.96702
53.0	0.95401	0.96231	0.95409	0.96128	0.96290	0.95976	0.96240	0.96381	0.96190	0.96449	0.96657
53.5	0.95339	0.96181	0.95348	0.96077	0.96241	0.95923	0.96190	0.96333	0.96139	0.96402	0.96613
54.0	0.95277	0.96131	0.95287	0.96026	0.96192	0.95870	0.96139	0.96285	0.96089	0.96356	0.96569
54.5	0.95215	0.96081	0.95226	0.95975	0.96143	0.95817	0.96089	0.96237	0.96038	0.96309	0.96525
55.0	0.95153	0.96031	0.95165	0.95924	0.96094	0.95764	0.96038	0.96189	0.95987	0.96262	0.96481
55.5	0.95090	0.95981	0.95103	0.95873	0.96045	0.95711	0.95988	0.96141	0.95936	0.96215	0.96437
56.0	0.95028	0.95931	0.95042	0.95822	0.95995	0.95658	0.95937	0.96092	0.95885	0.96168	0.96393
56.5	0.94966	0.95881	0.94981	0.95771	0.95946	0.95605	0.95886	0.96044	0.95834	0.96122	0.96348
57.0	0.94904	0.95830	0.94920	0.95720	0.95897	0.95552	0.95836	0.95996	0.95783	0.96075	0.96304
57.5	0.94841	0.95780	0.94859	0.95669	0.95848	0.95500	0.95785	0.95948	0.95732	0.96028	0.96260
58.0	0.94779	0.95730	0.94797	0.05618	0.95799	0.95447	0.95735	0.95900	0.95680	0.95981	0.96216
58.5	0.94716	0.95680	0.94736	0.95567	0.95750	0.95394	0.95684	0.95852	0.95629	0.95934	0.96172
59.0	0.94654	0.95629	0.94675	0.95516	0.95700	0.95341	0.95633	0.95803	0.95578	0.95888	0.96128
59.5	0.94592	0.95579	0.94613	0.95465	0.95651	0.95288	0.95582	0.95755	0.95527	0.95841	0.96083
60.0	0.94529	0.95529	0.94552	0.95414	0.95602	0.95235	0.95532	0.95757	0.95476	0.95794	0.96039
60.5	...	...	...	...	...	...	...	...	0.95425	...	...
61.0	...	...	...	...	...	...	...	...	0.95374	...	...
61.5	...	...	...	...	...	...	...	...	0.95323	...	...
62.0	...	...	...	...	...	...	...	...	0.95271	...	...
62.5	...	...	...	...	...	...	...	...	0.95220	...	...
63.0	...	...	...	...	...	...	...	...	0.95169	...	...
63.5	...	...	...	...	...	...	...	...	0.95118	...	...
64.0	...	...	...	...	...	...	...	...	0.95066	...	...
64.5	...	...	...	...	...	...	...	...	0.95015	...	...
65.0	...	...	...	...	...	...	...	...	0.94964	...	...
65.5	...	...	...	...	...	...	...	...	0.94912	...	...

D3505, and D4052 are suitable and are written to give density *in vacuo*. They should be used with caution, however, as they may be using older data than that upon which this standard is based upon.

8. Precision and Bias

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

9. Keywords

9.1 aromatic; benzene; calculation; conversion; cumene; density; ethylbenzene; *in air*; *in vacuo*; *m*-xylene; mixed xylene; *o*-xylene; *p*-xylene; specific gravity; styrene; 148.9 to ~~176.7°C~~176.7 °C aromatic hydrocarbons; 176.7 to ~~204.4°C~~204.4 °C aromatic hydrocarbons; toluene; volume; weight