**Designation: D 1555 – 95 (Reapproved 2000)**

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

This standard is issued under the fixed designation D 1555; 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.

*This standard has been approved for use by agencies of the Department of Defense.*

## 1. Scope

1.1 These tables are for use in calculating the weight and volume of benzene, toluene, mixed xylenes, styrene, ortho-xylene, meta-xylene, para-xylene, cumene, ethylbenzene, 300 to 350°F aromatic hydrocarbons, 350° to 400°F aromatic hydrocarbons and cyclohexane. A method is given for calculating the volume at 60°F from an observed volume at *t*°F. Table 1 lists the density in pounds per gallon at 60°F for high purity chemicals.

1.2 A procedure for the calculation of density in pounds per gallon at 60°F 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 method is Test Method D 4052.

1.3 The following applies to all specified limits in this test method: for purposes 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 in expressing the specification limit, in accordance with the rounding-off method of Practice E 29.

1.4 *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 1250 Guide for Petroleum Measurement Tables[2]

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]

2.2 *Other Document:*

American Petroleum Institute Research Project 44[6]

**TABLE 1 Relative Density and Density Data**

| Product | Relative Density 60°F/60°F | Density in Air at 60°F lb per U.S. Gallon |
|---|---|---|
| Benzene | 0.8844 | 7.365 |
| Cumene | 0.8663 | 7.214 |
| Cyclohexane | 0.7834 | 6.522 |
| Ethylbenzene | 0.8718 | 7.259 |
| *m*-Xylene | 0.8687 | 7.234 |
| *o*-Xylene | 0.8848 | 7.367 |
| *p*-Xylene | 0.8657 | 7.209 |
| Styrene | 0.9110 | 7.586 |
| Toluene | 0.8718 | 7.260 |

## 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 method can be used for determining quantities of stated aromatic hydrocarbons in tanks, shipping containers, etc.

## 4. Basic Data

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

4.2 The basic data and conversion factors used are given in

[1] This 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.

Current edition approved Sept. 15, 1995. Published November 1995. Originally published as D 1555 – 57. Last previous edition D 1555 – 92.

[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] "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.

**TABLE 2 Application Range of Table 3**

| Commercial Product | |
|---|---|
| Benzene | 95 to 100 % |
| Toluene | 95 to 100 % |
| Mixed xylene | 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 % |
| 300–350°F Aromatic Hydrocarbons | all proportions |
| 350–400°F Aromatic Hydrocarbons | all proportions |
| Cumene | 95 to 100 % |
| Ethylbenzene | 95 to 100 % |

the Appendix to the 1963 Annual Report[7] of ASTM Committee D16. Densities listed in Table 1 are given in ASTM Data Series Publications.[8]

## 5. Tables

5.1 Table 3 contains 12 columns as follows:

[7] *Proceedings*, ASTM, Vol 63, 1963.
[8] "Physical Constants of Hydrocarbons $C_1$ to $C_{10}$," *ASTM Data Service Publication DS4A*, ASTM, 1971.

**TABLE 3 Volume Corrections**

| Temperature, °F | Volume Corrections to 60°F[A] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Benzene | Toluene | *m*-Xylene and Mixed Xylene | Styrene | *o*-Xylene | *p*-Xylene | Cyclo-hexane[B] | Ethyl-benzene[B] | Cumene[B] | 300 to 350°F Aromatic Hydro-carbons | 350 to 400°F Aromatic Hydro-carbons |
| −5 | ... | 1.0383 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| −4 | ... | 1.0377 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| −3 | ... | 1.0371 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| −2 | ... | 1.0365 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| −1 | ... | 1.0359 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 0 | ... | 1.0353 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1 | ... | 1.0347 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 2 | ... | 1.0341 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 3 | ... | 1.0336 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 4 | ... | 1.0330 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 5 | ... | 1.0324 | 1.0293 | ... | 1.0288 | ... | ... | 1.0306 | 1.0297 | 1.0286 | 1.0266 |
| 6 | ... | 1.0318 | 1.0287 | ... | 1.0283 | ... | ... | 1.0300 | 1.0292 | 1.0280 | 1.0262 |
| 7 | ... | 1.0312 | 1.0282 | ... | 1.0278 | ... | ... | 1.0295 | 1.0287 | 1.0275 | 1.0257 |
| 8 | ... | 1.0306 | 1.0277 | ... | 1.0273 | ... | ... | 1.0289 | 1.0281 | 1.0270 | 1.0252 |
| 9 | ... | 1.0300 | 1.0272 | ... | 1.0267 | ... | ... | 1.0284 | 1.0276 | 1.0265 | 1.0248 |
| 10 | ... | 1.0294 | 1.0266 | ... | 1.0262 | ... | ... | 1.0278 | 1.0270 | 1.0260 | 1.0243 |
| 11 | ... | 1.0288 | 1.0261 | ... | 1.0257 | ... | ... | 1.0273 | 1.0265 | 1.0254 | 1.0238 |
| 12 | ... | 1.0283 | 1.0256 | ... | 1.0252 | ... | ... | 1.0267 | 1.0260 | 1.0249 | 1.0233 |
| 13 | ... | 1.0277 | 1.0251 | ... | 1.0246 | ... | ... | 1.0262 | 1.0254 | 1.0244 | 1.0228 |
| 14 | ... | 1.0271 | 1.0245 | ... | 1.0241 | ... | ... | 1.0256 | 1.0249 | 1.0239 | 1.0223 |
| 15 | ... | 1.0265 | 1.0240 | 1.0242 | 1.0236 | ... | ... | 1.0251 | 1.0244 | 1.0234 | 1.0218 |
| 16 | ... | 1.0259 | 1.0235 | 1.0237 | 1.0231 | ... | ... | 1.0245 | 1.0238 | 1.0228 | 1.0214 |
| 17 | ... | 1.0253 | 1.0230 | 1.0231 | 1.0225 | ... | ... | 1.0239 | 1.0233 | 1.0223 | 1.0209 |
| 18 | ... | 1.0247 | 1.0224 | 1.0226 | 1.0220 | ... | ... | 1.0234 | 1.0228 | 1.0218 | 1.0203 |
| 19 | ... | 1.0241 | 1.0219 | 1.0221 | 1.0215 | ... | ... | 1.0228 | 1.0222 | 1.0213 | 1.0199 |
| 20 | ... | 1.0235 | 1.0214 | 1.0215 | 1.0210 | ... | ... | 1.0223 | 1.0217 | 1.0208 | 1.0194 |
| 21 | ... | 1.0230 | 1.0208 | 1.0210 | 1.0204 | ... | ... | 1.0217 | 1.0211 | 1.0203 | 1.0189 |
| 22 | ... | 1.0224 | 1.0203 | 1.0204 | 1.0199 | ... | ... | 1.0212 | 1.0206 | 1.0197 | 1.0184 |
| 23 | ... | 1.0218 | 1.0198 | 1.0199 | 1.0194 | ... | ... | 1.0206 | 1.0201 | 1.0192 | 1.0180 |
| 24 | ... | 1.0212 | 1.0193 | 1.0194 | 1.0189 | ... | ... | 1.0201 | 1.0195 | 1.0187 | 1.0175 |
| 25 | ... | 1.0206 | 1.0187 | 1.0188 | 1.0184 | ... | ... | 1.0195 | 1.0190 | 1.0182 | 1.0170 |
| 26 | ... | 1.0200 | 1.0182 | 1.0183 | 1.0178 | ... | ... | 1.0190 | 1.0184 | 1.0177 | 1.0165 |
| 27 | ... | 1.0194 | 1.0177 | 1.0178 | 1.0173 | ... | ... | 1.0184 | 1.0179 | 1.0172 | 1.0160 |
| 28 | ... | 1.0188 | 1.0171 | 1.0172 | 1.0168 | ... | ... | 1.0179 | 1.0174 | 1.0166 | 1.0155 |
| 29 | ... | 1.0182 | 1.0166 | 1.0167 | 1.0163 | ... | ... | 1.0173 | 1.0168 | 1.0161 | 1.0151 |
| 30 | ... | 1.0177 | 1.0161 | 1.0162 | 1.0157 | ... | ... | 1.0167 | 1.0163 | 1.0156 | 1.0146 |
| 31 | ... | 1.0171 | 1.0155 | 1.0156 | 1.0152 | ... | ... | 1.0162 | 1.0157 | 1.0151 | 1.0141 |
| 32 | ... | 1.0165 | 1.0150 | 1.0151 | 1.0147 | ... | ... | 1.0156 | 1.0152 | 1.0145 | 1.0136 |
| 33 | ... | 1.0159 | 1.0145 | 1.0145 | 1.0142 | ... | ... | 1.0151 | 1.0147 | 1.0140 | 1.0131 |

TABLE 3 *Continued*

| Temperature, °F | Volume Corrections to 60°F[A] Benzene | Toluene | *m*-Xylene and Mixed Xylene | Styrene | *o*-Xylene | *p*-Xylene | Cyclo-hexane[B] | Ethyl-benzene[B] | Cumene[B] | 300 to 350°F Aromatic Hydro-carbons | 350 to 400°F Aromatic Hydro-carbons |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 34 | ... | 1.0153 | 1.0139 | 1.0140 | 1.0136 | ... | ... | 1.0145 | 1.0141 | 1.0135 | 1.0126 |
| 35 | ... | 1.0147 | 1.0134 | 1.0135 | 1.0131 | ... | ... | 1.0140 | 1.0136 | 1.0130 | 1.0122 |
| 36 | ... | 1.0141 | 1.0129 | 1.0129 | 1.0126 | ... | ... | 1.0134 | 1.0130 | 1.0125 | 1.0116 |
| 37 | ... | 1.0135 | 1.0123 | 1.0124 | 1.0121 | ... | ... | 1.0129 | 1.0125 | 1.0120 | 1.0112 |
| 38 | ... | 1.0130 | 1.0118 | 1.0119 | 1.0115 | ... | ... | 1.0123 | 1.0120 | 1.0114 | 1.0107 |
| 39 | ... | 1.0124 | 1.0113 | 1.0113 | 1.0110 | ... | ... | 1.0117 | 1.0114 | 1.0109 | 1.0102 |
| 40 | 1.0130 | 1.0118 | 1.0107 | 1.0108 | 1.0105 | ... | 1.0132 | 1.0112 | 1.0109 | 1.0104 | 1.0097 |
| 41 | 1.0124 | 1.0112 | 1.0102 | 1.0102 | 1.0100 | ... | 1.0126 | 1.0106 | 1.0103 | 1.0099 | 1.0092 |
| 42 | 1.0117 | 1.0106 | 1.0097 | 1.0097 | 1.0094 | ... | 1.0119 | 1.0101 | 1.0098 | 1.0094 | 1.0087 |
| 43 | 1.0111 | 1.0100 | 1.0091 | 1.0092 | 1.0089 | ... | 1.0112 | 1.0095 | 1.0092 | 1.0088 | 1.0082 |
| 44 | 1.0104 | 1.0094 | 1.0086 | 1.0086 | 1.0084 | ... | 1.0106 | 1.0090 | 1.0087 | 1.0083 | 1.0078 |
| 45 | 1.0098 | 1.0088 | 1.0081 | 1.0081 | 1.0079 | ... | 1.0099 | 1.0084 | 1.0082 | 1.0078 | 1.0073 |
| 46 | 1.0091 | 1.0082 | 1.0075 | 1.0075 | 1.0074 | ... | 1.0093 | 1.0078 | 1.0076 | 1.0073 | 1.0068 |
| 47 | 1.0085 | 1.0077 | 1.0070 | 1.0070 | 1.0068 | ... | 1.0085 | 1.0073 | 1.0071 | 1.0068 | 1.0063 |
| 48 | 1.0078 | 1.0071 | 1.0065 | 1.0065 | 1.0063 | ... | 1.0079 | 1.0067 | 1.0065 | 1.0063 | 1.0058 |
| 49 | 1.0072 | 1.0065 | 1.0059 | 1.0059 | 1.0058 | ... | 1.0073 | 1.0062 | 1.0060 | 1.0057 | 1.0054 |
| 50 | 1.0065 | 1.0059 | 1.0054 | 1.0054 | 1.0053 | ... | 1.0066 | 1.0056 | 1.0054 | 1.0052 | 1.0048 |
| 51 | 1.0059 | 1.0053 | 1.0048 | 1.0049 | 1.0047 | ... | 1.0060 | 1.0050 | 1.0049 | 1.0047 | 1.0044 |
| 52 | 1.0052 | 1.0047 | 1.0043 | 1.0043 | 1.0042 | ... | 1.0053 | 1.0045 | 1.0044 | 1.0042 | 1.0039 |
| 53 | 1.0046 | 1.0041 | 1.0038 | 1.0038 | 1.0037 | ... | 1.0046 | 1.0039 | 1.0038 | 1.0037 | 1.0034 |
| 54 | 1.0039 | 1.0035 | 1.0032 | 1.0032 | 1.0032 | ... | 1.0040 | 1.0034 | 1.0033 | 1.0032 | 1.0029 |
| 55 | 1.0033 | 1.0029 | 1.0027 | 1.0027 | 1.0026 | 1.0027 | 1.0033 | 1.0028 | 1.0027 | 1.0026 | 1.0024 |
| 56 | 1.0026 | 1.0024 | 1.0022 | 1.0022 | 1.0021 | 1.0022 | 1.0027 | 1.0022 | 1.0022 | 1.0021 | 1.0019 |
| 57 | 1.0020 | 1.0018 | 1.0016 | 1.0016 | 1.0016 | 1.0016 | 1.0020 | 1.0017 | 1.0016 | 1.0016 | 1.0014 |
| 58 | 1.0013 | 1.0012 | 1.0011 | 1.0011 | 1.0011 | 1.0011 | 1.0013 | 1.0011 | 1.0011 | 1.0012 | 1.0011 |
| 59 | 1.0007 | 1.0006 | 1.0005 | 1.0005 | 1.0005 | 1.0005 | 1.0007 | 1.0006 | 1.0005 | 1.0006 | 1.0005 |
| 60 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 61 | 0.9993 | 0.9994 | 0.9995 | 0.9995 | 0.9995 | 0.9994 | 0.9993 | 0.9994 | 0.9995 | 0.9995 | 0.9995 |
| 62 | 0.9987 | 0.9988 | 0.9989 | 0.9989 | 0.9989 | 0.9989 | 0.9987 | 0.9989 | 0.9989 | 0.9990 | 0.9990 |
| 63 | 0.9980 | 0.9982 | 0.9984 | 0.9984 | 0.9984 | 0.9983 | 0.9980 | 0.9983 | 0.9984 | 0.9984 | 0.9986 |
| 64 | 0.9974 | 0.9976 | 0.9978 | 0.9978 | 0.9979 | 0.9978 | 0.9973 | 0.9978 | 0.9978 | 0.9980 | 0.9980 |
| 65 | 0.9967 | 0.9971 | 0.9973 | 0.9973 | 0.9974 | 0.9972 | 0.9967 | 0.9972 | 0.9973 | 0.9974 | 0.9976 |
| 66 | 0.9961 | 0.9965 | 0.9968 | 0.9968 | 0.9968 | 0.9967 | 0.9960 | 0.9966 | 0.9967 | 0.9969 | 0.9971 |
| 67 | 0.9954 | 0.9959 | 0.9962 | 0.9962 | 0.9963 | 0.9961 | 0.9953 | 0.9961 | 0.9962 | 0.9964 | 0.9966 |
| 68 | 0.9947 | 0.9953 | 0.9957 | 0.9957 | 0.9958 | 0.9956 | 0.9947 | 0.9955 | 0.9956 | 0.9959 | 0.9961 |
| 69 | 0.9941 | 0.9947 | 0.9951 | 0.9951 | 0.9953 | 0.9950 | 0.9940 | 0.9949 | 0.9951 | 0.9954 | 0.9956 |
| 70 | 0.9934 | 0.9941 | 0.9946 | 0.9946 | 0.9947 | 0.9945 | 0.9934 | 0.9944 | 0.9945 | 0.9948 | 0.9951 |
| 71 | 0.9928 | 0.9935 | 0.9940 | 0.9941 | 0.9942 | 0.9939 | 0.9927 | 0.9938 | 0.9940 | 0.9943 | 0.9946 |
| 72 | 0.9921 | 0.9929 | 0.9935 | 0.9935 | 0.9937 | 0.9934 | 0.9920 | 0.9933 | 0.9934 | 0.9938 | 0.9941 |
| 73 | 0.9914 | 0.9923 | 0.9930 | 0.9930 | 0.9932 | 0.9928 | 0.9914 | 0.9927 | 0.9929 | 0.9933 | 0.9936 |
| 74 | 0.9908 | 0.9918 | 0.9924 | 0.9924 | 0.9926 | 0.9923 | 0.9907 | 0.9921 | 0.9923 | 0.9928 | 0.9932 |
| 75 | 0.9901 | 0.9912 | 0.9919 | 0.9919 | 0.9921 | 0.9917 | 0.9900 | 0.9916 | 0.9918 | 0.9922 | 0.9927 |
| 76 | 0.9894 | 0.9905 | 0.9913 | 0.9914 | 0.9916 | 0.9912 | 0.9893 | 0.9910 | 0.9912 | 0.9917 | 0.9922 |
| 77 | 0.9888 | 0.9900 | 0.9908 | 0.9908 | 0.9911 | 0.9906 | 0.9887 | 0.9904 | 0.9907 | 0.9912 | 0.9917 |
| 78 | 0.9881 | 0.9894 | 0.9902 | 0.9903 | 0.9905 | 0.9901 | 0.9880 | 0.9899 | 0.9902 | 0.9907 | 0.9912 |
| 79 | 0.9874 | 0.9888 | 0.9897 | 0.9897 | 0.9900 | 0.9895 | 0.9873 | 0.9893 | 0.9896 | 0.9902 | 0.9907 |
| 80 | 0.9868 | 0.9882 | 0.9891 | 0.9892 | 0.9895 | 0.9890 | 0.9867 | 0.9887 | 0.9891 | 0.9897 | 0.9902 |
| 81 | 0.9861 | 0.9876 | 0.9886 | 0.9886 | 0.9889 | 0.9884 | 0.9860 | 0.9882 | 0.9885 | 0.9892 | 0.9898 |
| 82 | 0.9854 | 0.9870 | 0.9880 | 0.9881 | 0.9884 | 0.9878 | 0.9853 | 0.9876 | 0.9880 | 0.9886 | 0.9893 |
| 83 | 0.9848 | 0.9865 | 0.9875 | 0.9876 | 0.9879 | 0.9873 | 0.9847 | 0.9870 | 0.9874 | 0.9881 | 0.9888 |
| 84 | 0.9841 | 0.9859 | 0.9869 | 0.9870 | 0.9874 | 0.9867 | 0.9840 | 0.9865 | 0.9869 | 0.9876 | 0.9883 |
| 85 | 0.9834 | 0.9853 | 0.9864 | 0.9865 | 0.9868 | 0.9862 | 0.9833 | 0.9859 | 0.9863 | 0.9870 | 0.9878 |
| 86 | 0.9828 | 0.9847 | 0.9859 | 0.9859 | 0.9863 | 0.9856 | 0.9827 | 0.9853 | 0.9858 | 0.9865 | 0.9873 |
| 87 | 0.9821 | 0.9841 | 0.9853 | 0.9854 | 0.9858 | 0.9851 | 0.9820 | 0.9848 | 0.9852 | 0.9860 | 0.9868 |
| 88 | 0.9814 | 0.9835 | 0.9848 | 0.9849 | 0.9852 | 0.9845 | 0.9813 | 0.9842 | 0.9847 | 0.9855 | 0.9863 |
| 89 | 0.9808 | 0.9829 | 0.9842 | 0.9843 | 0.9847 | 0.9840 | 0.9806 | 0.9836 | 0.9841 | 0.9850 | 0.9858 |
| 90 | 0.9801 | 0.9823 | 0.9837 | 0.9838 | 0.9842 | 0.9834 | 0.9800 | 0.9831 | 0.9836 | 0.9844 | 0.9853 |

**TABLE 3** *Continued*

| Temperature, °F | Volume Corrections to 60°F[A] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Benzene | Toluene | *m*-Xylene and Mixed Xylene | Styrene | *o*-Xylene | *p*-Xylene | Cyclohexane[B] | Ethylbenzene[B] | Cumene[B] | 300 to 350°F Aromatic Hydrocarbons | 350 to 400°F Aromatic Hydrocarbons |
| 91 | 0.9794 | 0.9818 | 0.9831 | 0.9832 | 0.9837 | 0.9828 | 0.9793 | 0.9825 | 0.9830 | 0.9839 | 0.9848 |
| 92 | 0.9787 | 0.9812 | 0.9826 | 0.9827 | 0.9831 | 0.9823 | 0.9786 | 0.9819 | 0.9825 | 0.9834 | 0.9844 |
| 93 | 0.9781 | 0.9806 | 0.9820 | 0.9821 | 0.9826 | 0.9817 | 0.9780 | 0.9814 | 0.9819 | 0.9829 | 0.9839 |
| 94 | 0.9774 | 0.9800 | 0.9815 | 0.9816 | 0.9821 | 0.9812 | 0.9773 | 0.9808 | 0.9813 | 0.9824 | 0.9834 |
| 95 | 0.9767 | 0.9794 | 0.9809 | 0.9811 | 0.9815 | 0.9806 | 0.9766 | 0.9802 | 0.9808 | 0.9819 | 0.9829 |
| 96 | 0.9761 | 0.9788 | 0.9804 | 0.9805 | 0.9810 | 0.9801 | 0.9759 | 0.9797 | 0.9802 | 0.9813 | 0.9824 |
| 97 | 0.9754 | 0.9782 | 0.9798 | 0.9800 | 0.9805 | 0.9795 | 0.9753 | 0.9791 | 0.9797 | 0.9808 | 0.9819 |
| 98 | 0.9747 | 0.9776 | 0.9793 | 0.9794 | 0.9800 | 0.9789 | 0.9746 | 0.9785 | 0.9791 | 0.9803 | 0.9814 |
| 99 | 0.9740 | 0.9770 | 0.9787 | 0.9789 | 0.9794 | 0.9784 | 0.9739 | 0.9780 | 0.9786 | 0.9798 | 0.9810 |
| 100 | 0.9734 | 0.9765 | 0.9782 | 0.9783 | 0.9789 | 0.9778 | 0.9733 | 0.9774 | 0.9780 | 0.9793 | 0.9805 |
| 101 | 0.9727 | 0.9759 | 0.9776 | 0.9778 | 0.9784 | 0.9773 | 0.9726 | 0.9768 | 0.9775 | 0.9787 | 0.9800 |
| 102 | 0.9720 | 0.9753 | 0.9771 | 0.9773 | 0.9778 | 0.9767 | 0.9719 | 0.9763 | 0.9769 | 0.9782 | 0.9795 |
| 103 | 0.9713 | 0.9747 | 0.9765 | 0.9767 | 0.9773 | 0.9761 | 0.9712 | 0.9757 | 0.9764 | 0.9777 | 0.9790 |
| 104 | 0.9706 | 0.9741 | 0.9759 | 0.9762 | 0.9768 | 0.9756 | 0.9706 | 0.9751 | 0.9758 | 0.9772 | 0.9785 |
| 105 | 0.9700 | 0.9735 | 0.9754 | 0.9756 | 0.9762 | 0.9750 | 0.9689 | 0.9746 | 0.9753 | 0.9766 | 0.9780 |
| 106 | 0.9693 | 0.9729 | 0.9748 | 0.9751 | 0.9757 | 0.9745 | 0.9692 | 0.9740 | 0.9747 | 0.9762 | 0.9775 |
| 107 | 0.9686 | 0.9723 | 0.9743 | 0.9745 | 0.9752 | 0.9739 | 0.9685 | 0.9734 | 0.9742 | 0.9756 | 0.9770 |
| 108 | 0.9679 | 0.9717 | 0.9737 | 0.9740 | 0.9746 | 0.9733 | 0.9679 | 0.9729 | 0.9736 | 0.9751 | 0.9766 |
| 109 | 0.9672 | 0.9712 | 0.9732 | 0.9734 | 0.9741 | 0.9728 | 0.9672 | 0.9723 | 0.9731 | 0.9746 | 0.9760 |
| 110 | 0.9666 | 0.9706 | 0.9726 | 0.9729 | 0.9736 | 0.9722 | 0.9665 | 0.9717 | 0.9725 | 0.9741 | 0.9756 |
| 111 | 0.9659 | 0.9700 | 0.9721 | 0.9724 | 0.9731 | 0.9716 | 0.9658 | 0.9711 | 0.9720 | ... | ... |
| 112 | 0.9652 | 0.9694 | 0.9714 | 0.9718 | 0.9725 | 0.9711 | 0.9652 | 0.9706 | 0.9714 | ... | ... |
| 113 | 0.9645 | 0.9688 | 0.9710 | 0.9713 | 0.9720 | 0.9705 | 0.9645 | 0.9700 | 0.9708 | ... | ... |
| 114 | 0.9638 | 0.9682 | 0.9704 | 0.9707 | 0.9715 | 0.9700 | 0.9638 | 0.9694 | 0.9703 | ... | ... |
| 115 | 0.9632 | 0.9676 | 0.9698 | 0.9702 | 0.9709 | 0.9694 | 0.9631 | 0.9689 | 0.9697 | ... | ... |
| 116 | 0.9625 | 0.9670 | 0.9693 | 0.9696 | 0.9704 | 0.9688 | 0.9625 | 0.9683 | 0.9692 | ... | ... |
| 117 | 0.9618 | 0.9664 | 0.9687 | 0.9691 | 0.9699 | 0.9683 | 0.9618 | 0.9677 | 0.9686 | ... | ... |
| 118 | 0.9611 | 0.9659 | 0.9682 | 0.9685 | 0.9693 | 0.9677 | 0.9611 | 0.9672 | 0.9681 | ... | ... |
| 119 | 0.9604 | 0.9653 | 0.9676 | 0.9680 | 0.9688 | 0.9671 | 0.9604 | 0.9666 | 0.9675 | ... | ... |
| 120 | 0.9597 | 0.9647 | 0.9671 | 0.9675 | 0.9683 | 0.9666 | 0.9597 | 0.9660 | 0.9670 | ... | ... |
| 121 | ... | ... | ... | ... | ... | 0.9660 | ... | ... | ... | ... | ... |
| 122 | ... | ... | ... | ... | ... | 0.9655 | ... | ... | ... | ... | ... |
| 123 | ... | ... | ... | ... | ... | 0.9649 | ... | ... | ... | ... | ... |
| 124 | ... | ... | ... | ... | ... | 0.9643 | ... | ... | ... | ... | ... |
| 125 | ... | ... | ... | ... | ... | 0.9638 | ... | ... | ... | ... | ... |
| 126 | ... | ... | ... | ... | ... | 0.9632 | ... | ... | ... | ... | ... |
| 127 | ... | ... | ... | ... | ... | 0.9626 | ... | ... | ... | ... | ... |
| 128 | ... | ... | ... | ... | ... | 0.9621 | ... | ... | ... | ... | ... |
| 129 | ... | ... | ... | ... | ... | 0.9615 | ... | ... | ... | ... | ... |
| 130 | ... | ... | ... | ... | ... | 0.9609 | ... | ... | ... | ... | ... |
| 131 | ... | ... | ... | ... | ... | 0.9604 | ... | ... | ... | ... | ... |
| 132 | ... | ... | ... | ... | ... | 0.9598 | ... | ... | ... | ... | ... |
| 133 | ... | ... | ... | ... | ... | 0.9592 | ... | ... | ... | ... | ... |
| 134 | ... | ... | ... | ... | ... | 0.9587 | ... | ... | ... | ... | ... |
| 135 | ... | ... | ... | ... | ... | 0.9581 | ... | ... | ... | ... | ... |
| 136 | ... | ... | ... | ... | ... | 0.9575 | ... | ... | ... | ... | ... |
| 137 | ... | ... | ... | ... | ... | 0.9570 | ... | ... | ... | ... | ... |
| 138 | ... | ... | ... | ... | ... | 0.9564 | ... | ... | ... | ... | ... |
| 139 | ... | ... | ... | ... | ... | 0.9558 | ... | ... | ... | ... | ... |
| 140 | ... | ... | ... | ... | ... | 0.9553 | ... | ... | ... | ... | ... |
| 141 | ... | ... | ... | ... | ... | 0.9547 | ... | ... | ... | ... | ... |
| 142 | ... | ... | ... | ... | ... | 0.9541 | ... | ... | ... | ... | ... |
| 143 | ... | ... | ... | ... | ... | 0.9535 | ... | ... | ... | ... | ... |
| 144 | ... | ... | ... | ... | ... | 0.9530 | ... | ... | ... | ... | ... |
| 145 | ... | ... | ... | ... | ... | 0.9524 | ... | ... | ... | ... | ... |
| 146 | ... | ... | ... | ... | ... | 0.9518 | ... | ... | ... | ... | ... |
| 147 | ... | ... | ... | ... | ... | 0.9513 | ... | ... | ... | ... | ... |
| 148 | ... | ... | ... | ... | ... | 0.9507 | ... | ... | ... | ... | ... |

**TABLE 3** *Continued*

| Temperature, °F | Volume Corrections to 60°F[A] Benzene | Toluene | *m*-Xylene and Mixed Xylene | Styrene | *o*-Xylene | *p*-Xylene | Cyclo-hexane[B] | Ethyl-benzene[B] | Cumene[B] | 300 to 350°F Aromatic Hydro-carbons | 350 to 400°F Aromatic Hydro-carbons |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 149 | ... | ... | ... | ... | ... | 0.9500 | ... | ... | ... | ... | ... |
| 150 | ... | ... | ... | ... | ... | 0.9496 | ... | ... | ... | ... | ... |

[A] Based on API Project 44 data—essentially correct for all purities above 95 %.
[B] Based on API Project 44 data and non-linear regression analysis of those data using this equation:

$$RHO = EXP[-ALPHT \times (TEMP - 60) \times (1 + 0.8 \times ALPHT \times (TEMP - 60))] \times RHOT$$

where:
RHO = the density of the material in kg/m$^3$ at the observed temperature
ALPHT = the coefficient of expansion of the material at 60°F
TEMP = the observed temperature in° F, and
RHOT = the density of the material in kg/m$^3$ at 60°F.

5.1.1 *Column 1*—Observed temperature in degrees Fahrenheit.

5.1.2 *Columns 2 to 12, Inclusive*—Multiplying factors for the reduction to 60°F, specifically the ratio of the volume at 60°F to the volume at *t*°F.

## 6. Use of Tables

6.1 *Volume Reduction to 60°F*—Enter the appropriate Column of Table 3, selecting that temperature to the nearest degree Fahrenheit at which the bulk volume was measured (temperature *t*), and select the corresponding volume reduction factor (ratio) in Columns 2 to 12. Multiply the bulk volume measurement at temperature, *t*, by the factor selected from the table (see Note 1).

*Example 1*—What is the volume at 60°F of a tank care of para-xylene whose volume was measured to be 9280 U.S. gal at a mean temperature of 88.7°F?
Enter Table 3, Column 7, at 89.0°F and note that the "volume ratio" is 0.9840. The volume at 60°F is 9280 × 0.9840 = 9131.5 U.S. gal.

6.2 *Converting Volume to Weight for Chemicals other than Mixed Xylenes Listed in* Table 1—Multiply the volume in gallons at 60°F (5 digits) by the density in pounds per gallon at 60°F (see Table 1).

*Example 2*—What is the weight of para-xylene whose volume is 9280 U.S. gal at 88.7°F?
See Example 1. The weight is 9131.5 × 7.209 = 65 829 lb.

6.3 *Converting Volume to Weight for Mixed Xylenes*—Correct the measured bulk volume to 60°F as described in 6.1. Determine the density (all weights in vacuum) at 60°F in grams per millilitre as described in Section 7. Obtain the value for pounds per U.S. gallon in standard air at 60°F, by means of the following equation, and round to five digits:

$$a = (b - A) \times 8.34522 \quad (1)$$

where:
*a* = pounds per U.S. gallon in standard air at 60°F,
*b* = grams per millilitre in vacuum at 60°F, and
*A* = correction factor as given in Table 4.

Multiply the corrected volume by the calculated pounds per U.S. gallon at 60°F value in order to obtain the weight in pounds in air (see Note 1).

**TABLE 4 Converting to Densities in Standard Air**

| Density at 60°F, 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 |

*Example 3*—What is the weight (in air) of the contents of a tank car of mixed xylenes having a calculated density (Section 7) of 0.87638 g/mL (in vacuum), whose volume was measured to be 9280 U.S. gal at a mean temperature of 88.7°F?
Enter Table 3 at 89°F and note that the "Factor for Reducing Volume to 60°F" is 0.9842. The volume at 60°F is 9280 × 0.9842 = 9133.4 U.S. gal. From Eq 1: (0.87638–0.001090) (8.34522) = 7.30449 lb per U.S. gal. The weight of mixed xylenes in the tank car is then 9133.4 × 7.30449 = 66 715 lb.

## 7. Density Calculation

7.1 Density determinations 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) which is required for the computation described herein.

7.2 If the methods described in Test Methods D 3505 are used, relative density in air is first converted to density in grams per millilitre in air by use of the factors given in Table 5.

NOTE 3—"Relative density in air" means that all weighings were in air, and no air buoyancy correction was applied. "Apparent density" for the purposes of this test is defined as the density calculated when the apparent volume of the pycnometer is calibrated with water, weighed in air, and

**TABLE 5 Factors for Converting from Relative Density in Air to Apparent Density in Air in Grams per Millilitre (Note 3)**

| Measurement Temperature | Multiply Relative Density in Air by this Number to Get Apparent Density |
|---|---|
| 60/60°F or 15.56/15.56°C | 0.99904 at 60°F |
| 68/68°F or 20/20°C | 0.99823 at 68°F |
| 77/77°F or 25/25°C | 0.99708 at 77°F |

when the sample is weighed in air, and no air buoyancy correction is used for either weighing, even though the density in vacuum of water is used in calculating the apparent volume of the pycnometer. "Density in air" for the purpose of this method is the weight per unit volume in vacuum minus the weight of a volume of air equal to the difference between the volume of the sample and the volume of brass weights equivalent to the weight in vacuum of the sample. If it is desired to make a direct experimental determination of "density in air" using a pycnometer, apply the air buoyancy correction to the water weight, calculate the true volume of the pycnometer from the weight of water in vacuum, and then fill the pycnometer with sample, weigh in air, subtract the weight of the pycnometer in air, and apply no air buoyancy correction. This sample weight in air, divided by the true volume in millilitres is the "density in air" at the experimental temperatures. Densities given in Tables D 1250 are on this basis.

7.3 Convert apparent density in grams per millilitre in air to density in vacuum by use of Table 6.

7.4 Convert density in vacuum at *t* degrees to density at 60°F (15.56°C) using the multipliers given in Table 7 on interpolated values.

*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 1.00931. The density in vacuum at 60°F is 0.87095 × 1.00931 = 0.87905.

7.5 Calculate pounds per U.S. gallon 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 benzene; calculation; conversion; cumene; density; ethylbenzene; *m*-xylene; mixed xylene; *o*-xylene; *p*-xylene; specific gravity; styrene; 300 to 350°F aromatic hydrocarbons; 350 to 400°F aromatic hydrocarbons; toluene; volume; weight

**TABLE 6 Vacuum Corrections, Apparent Density to Density in Vacuum**

| Apparent Density, *W/V* | Correction,[A] plus | Apparent Density *W/V* | Correction,[A] plus |
|---|---|---|---|
| 0.70 | 0.00036 | 0.85 | 0.00018 |
| 0.71 | 0.00035 | 0.86 | 0.00017 |
| 0.72 | 0.00033 | 0.87 | 0.00016 |
| 0.73 | 0.00032 | 0.88 | 0.00014 |
| 0.74 | 0.00031 | 0.89 | 0.00013 |
| 0.75 | 0.00030 | 0.90 | 0.00012 |
| 0.76 | 0.00029 | 0.91 | 0.00011 |
| 0.77 | 0.00028 | 0.92 | 0.00010 |
| 0.78 | 0.00026 | 0.93 | 0.00009 |
| 0.79 | 0.00025 | 0.94 | 0.00007 |
| 0.80 | 0.00024 | 0.95 | 0.00006 |
| 0.81 | 0.00023 | 0.96 | 0.00005 |
| 0.82 | 0.00022 | 0.97 | 0.00004 |
| 0.83 | 0.00020 | 0.98 | 0.00003 |
| 0.84 | 0.00019 | 0.99 | 0.00001 |

[A] This table applies for all air density values between 0.0011 and 0.0013 g/mL. For air densities outside this range, the vacuum correction, *C*, should be calculated as follows:

$$C = d_a/0.99823 \times [0.99823 - (W/V)]$$

where:

$C$ = vacuum correction,
$d_a$ = density of air in the balance case, g/mL,
$W$ = weight of sample in pycnometer,
$V$ = volume of sample in pycnometer, and
$W/V$ = apparent density (Note 3).

**TABLE 7 Multipliers to Convert From Density in Vacuum at *t* Degrees to Density at 60°F (15.56°C) in Vacuum**

| Product | Multiplier for Temperature | | | |
|---|---|---|---|---|
| | 59°F (15°C) | 68°F (20°C) | 77°F (25°C) | 86°F (30°C) |
| Benzene | 0.99934 | 1.00529 | 1.01136 | 1.01753 |
| Toluene | 0.99941 | 1.00473 | 1.01011 | 1.01554 |
| Mixed xylenes | 0.99946 | 1.00435 | 1.00931 | 1.01435 |
| Styrene | 0.99946 | 1.00434 | 1.00927 | 1.01426 |
| *m*-Xylene | 0.99946 | 1.00435 | 1.00931 | 1.01435 |
| *o*-Xylene | 0.99919 | 1.00693 | 1.01573 | 1.02575 |
| *p*-Xylene | 0.99945 | 1.00443 | 1.00947 | 1.01459 |
| Cyclohexane | 0.99935 | 1.00528 | 1.01133 | 1.01750 |
| Cumene | 0.99946 | 1.00435 | 1.00931 | 1.01435 |
| Ethylbenzene | 0.99946 | 1.00435 | 1.00931 | 1.01435 |