



Standard ASTM Butadiene Measurement Tables¹

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1. Scope

1.1 The ASTM Butadiene Measurement Tables are for use in the calculation of quantities of butadiene. The accompanying Tables 1-4 cover the normal operating ranges for the reduction of observed specific gravity and volume to 15.6/15.6°C (60/60°F) and for the calculation of weight-volume relationships of butadiene.

1.2 These tables are applicable to both butadiene and butadiene concentrates (minimum of 60 % butadiene).

NOTE 1—These tables replace the existing tables in the National Institute of Standards and Technology Letter Circulars LC-736 and LC-757 and the Rubber Reserve Corp., Butadiene Laboratory Manual.

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 and health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

2.1 *ASTM Standards*:²

D1250 Guide for Use of the Petroleum Measurement Tables

3. Significance and Use

3.1 Accurate knowledge of the weight and volume of butadiene is necessary for the orderly manufacture, storage, transfer, and sale of the material. These tables are suitable for use in these and similar aspects of butadiene commerce.

¹ These tables are under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and are the direct responsibility of Subcommittee D02.02.0A on Temperature, Density, Physical Properties.

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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.

TABLE 1 REDUCTION OF OBSERVED SPECIFIC GRAVITY TO SPECIFIC GRAVITY 15.6/15.6°C (60/60°F)

This table gives values of specific gravity 15.6/15.6°C (60/60°F) corresponding to specific gravities observed with a glass hydrometer at temperatures other than 60°F. The expression "Observed Specific Gravity" appears in this table because it is the term most generally used in industry. For specific gravities determined by hydrometer, a more exact expression would be "hydrometer indication at the observed temperature." This hydrometer indication differs slightly from the true specific gravity at the observed temperature owing to the expansion or contraction of the glass hydrometer when its temperature differs from its calibration temperature of 60°F.

It is generally impracticable to determine a specific gravity at exactly 15.6°C (60°F) although it is at this temperature only that strictly correct results are obtained with a standard glass hydrometer. In converting an observed specific gravity at the observed temperature $t^{\circ}\text{F}$ (hydrometer indication of specific gravity $t/60^{\circ}\text{F}$) to the corresponding 60/60°F value, two corrections are possible. The first arises from the change in volume of the glass hydrometer with temperature, and the second arises from the change in volume of the butadiene. This table takes into account only the change in volume of the butadiene because the change in volume of the hydrometer is insignificant in comparison with the accuracy of the values for the change in volume of the butadiene.

This table must be entered with specific gravities measured with a glass hydrometer calibrated at 15.6/15.6°C (60/60°F)

Example—If the specific gravity observed on a hydrometer in butadiene at 40°F is 0.642, what is its specific gravity 60/60°F?

Enter the table in the column for "Observed Specific Gravity," headed 0.640, and note that against an "Observed Temperature" of 40°F, the corresponding specific gravity 60/60°F is

Likewise, note that for 0.645 specific gravity opposite 40°F, the corresponding specific gravity 60/60°F is 0.627

This represents an increase of 0.005 in specific gravity 60/60°F for an increase of 0.005 in the value at 40°F. Therefore, by simple proportion, an increase 0.632

in the specific gravity value noted at 40°F from 0.640 to 0.642 increases the corresponding specific gravity 60/60°F by 0.4×0.005 or 0.002

Then, the specific gravity 60/60°F corresponding to the observed specific gravity of 0.642 at 40°F is $0.627 + 0.002$ or 0.629

TABLE 1 Reduction of Observed Specific Gravity to Specific Gravity 15.6/15.6°C (60/60°F)

18.3–43.0°C (65–110°F)

0.585–0.615

Observed Temperature °F ^A	Observed Specific Gravity						
	0.585	0.590	0.595	0.600	0.605	0.610	0.615
	Corresponding Specific Gravity 60/60°F						
65
66
67
68	0.621
69	0.621
70	0.622
71	0.623
72	0.623
73	0.624
74	0.625
75	0.621	0.625
76	0.621	0.626
77	0.622	0.627
78	0.623	0.627
79	0.623	0.628
80	0.624	0.629
81	0.625	0.629
82	0.621	0.625	0.630
83	0.621	0.626	0.631
84	0.622	0.627	0.631
85	0.623	0.627	0.632
86	0.623	0.628	0.633
87	0.624	0.629	0.633
88	0.625	0.629	0.634
89	0.621	0.625	0.630	...
90	0.622	0.626	0.631	...
91	0.622	0.627	0.631	...
92	0.623	0.627	0.632	...
93	0.624	0.628	0.633	...
94	0.624	0.629	0.633	...
95	0.625	0.629	0.634	...
96	0.621	0.625	0.630	0.634	...
97	0.622	0.626	0.631	...	...
98	0.622	0.627	0.631	...	...
99	0.623	0.627	0.632	...	...
100	0.624	0.628	0.632	...	...
101	0.624	0.629	0.633	...	...
102	...	0.621	0.625	0.629	0.634	...	...
103	...	0.621	0.626	0.630	0.634	...	...
104	...	0.622	0.626	0.631	...	...	...
105	...	0.623	0.627	0.631	...	...	...
106	...	0.623	0.628	0.632	...	...	...
107	...	0.624	0.628	0.633	...	...	...
108	...	0.625	0.629	0.633	...	...	...
109	0.621	0.625	0.629	0.634	...	...	...
110	0.622	0.626	0.630	0.634	...	...	...

TABLE 1 Reduction of Observed Specific Gravity to Specific Gravity 15.6/15.6°C (60/60°F)

-9.4 to + 10.0°C (15–50°F)

0.620–0.650

Observed Temperature, °F ^A	Observed Specific Gravity						
	0.620	0.625	0.630	0.635	0.640	0.645	0.650
Corresponding Specific Gravity 60/60°F							
15
16	0.621
17	0.621
18	0.622
19	0.623
20	0.623
21	0.624
22	0.625
23	0.625
24	0.621	0.626
25	0.621	0.627
26	0.622	0.628
27	0.623	0.628
28	0.624	0.629
29	0.624	0.630
30	0.625	0.630
31	0.626	0.631
32	0.621	0.626	0.632
33	0.622	0.627	0.632
34	0.622	0.628	0.633
35	0.623	0.628	0.634
36	0.624	0.629	0.634
37	0.625	0.630	...
38	0.625	0.630	...
39	0.621	0.626	0.631	...
40	0.621	0.627	0.632	...
41	0.622	0.627	0.632	...
42	0.623	0.628	0.633	...
43	0.624	0.629	0.634	...
44	0.624	0.629	0.634	...
45	0.625	0.630	...	...
46	0.626	0.631	...	...
47	0.621	0.626	0.631	...	...
48	0.622	0.627	0.632	...	...
49	0.623	0.628	0.633	...	...
50	0.623	0.628	0.633	...	...

TABLE 1 Reduction of Observed Specific Gravity to Specific Gravity 15.6/15.6°C (60/60°F)

10.0–29.4°C (50–85°F)

0.620–0.640

Observed Temperature, °F ^A	Observed Specific Gravity				
	0.620	0.625	0.630	0.635	0.640
	Corresponding Specific Gravity 60/60°F				
50	...	...	0.623	0.628	0.633
51	...	...	0.624	0.629	0.634
52	...	...	0.625	0.630	...
53	...	...	0.625	0.630	...
54	...	0.621	0.626	0.631	...
55	...	0.622	0.627	0.632	...
56	...	0.622	0.627	0.632	...
57	...	0.623	0.628	0.633	...
58	...	0.624	0.629	0.634	...
59	...	0.624	0.629	0.634	...
60	...	0.625	0.630	...	...
61	0.621	0.626	0.631	...	...
62	0.622	0.626	0.631	...	...
63	0.622	0.627	0.632	...	...
64	0.623	0.628	0.633	...	...
65	0.624	0.628	0.633	...	...
66	0.624	0.629	0.634	...	...
67	0.625	0.630	...	...	...
68	0.626	0.630	...	...	...
69	0.626	0.631	...	...	...
70	0.627	0.632	...	...	...
71	0.628	0.632	...	...	...
72	0.628	0.633	...	...	...
73	0.629	0.634	...	...	...
74	0.630	...	...	...	...
75	0.630	...	...	...	...
76	0.631	...	...	...	...
77	0.631	...	...	...	...
78	0.632	...	...	...	...
79	0.633	...	...	...	...
80	0.633	...	...	...	...
81	0.634	...	...	...	...
82	...	...	...	...	...
83	...	...	...	...	...
84	...	...	...	...	...
85	...	...	...	...	...

TABLE 1 Reduction of Observed Specific Gravity to Specific Gravity 15.6/15.6°C (60/60°F)

-23.3 to -1.1°C (-10 to +30°F)

0.655–0.675

Observed Temperature °F ^A	Observed Specific Gravity				
	0.655	0.660	0.665	0.670	0.675
	Corresponding Specific Gravity 60/60°F				
-10	...	...	...	0.624	0.630
-9	...	...	...	0.625	0.631
-8	...	...	...	0.626	0.632
-7	...	...	0.621	0.627	0.632
-6	...	...	0.622	0.627	0.633
-5	...	...	0.622	0.628	0.634
-4	...	...	0.623	0.629	0.634
-3	...	...	0.624	0.629	...
-2	...	...	0.624	0.630	...
-1	...	...	0.625	0.631	...
0	...	...	0.626	0.631	...
1	...	0.621	0.627	0.632	...
2	...	0.622	0.627	0.633	...
3	...	0.622	0.628	0.634	...
4	...	0.623	0.629	0.634	...
5	...	0.624	0.629	...	...
6	...	0.624	0.630	...	...
7	...	0.625	0.631	...	...
8	...	0.626	0.631	...	...
9	0.621	0.627	0.632	...	...
10	0.622	0.627	0.633	...	...
11	0.622	0.628	0.634	...	...
12	0.623	0.629	0.634	...	...
13	0.624	0.629	...	...	...
14	0.625	0.630	...	...	...
15	0.625	0.631	...	...	...
16	0.626	0.631	...	...	...
17	0.627	0.632	...	...	...
18	0.627	0.633	...	...	...
19	0.628	0.633	...	...	...
20	0.629	0.634	...	...	...
21	0.629	...	...	...	...
22	0.630	...	...	...	...
23	0.631	...	...	...	...
24	0.632	...	...	...	...
25	0.632	...	...	...	...
26	0.633	...	...	...	...
27	0.634	...	...	...	...
28	0.634	...	...	...	...
29	...	...	...	...	...
30	...	...	...	...	...

^A°C = (°F-32) × 5/9 .

TABLE 2 REDUCTION OF OBSERVED VOLUME TO 15.6°C (60°F) AGAINST SPECIFIC GRAVITY 60/60°F

This table gives the factors for converting butadiene volumes observed at temperatures other than 15.6°C (60°F) to the corresponding volumes at 60°F for values of specific gravity 60/60°F in the range 0.621 to 0.634.

It is emphasized that the volume correction factors in this table make no allowance for the thermal expansion of tanks and other types of containers.

This table must be entered with specific gravity values 15.6/15.6°C (60/60°F) and volumes measured at Fahrenheit temperatures.

Example—What is the volume at 60°F of 45 500 U.S. gal at 35°F of butadiene whose specific gravity 60/60°F is 0.625?

Enter the table in the column for “Specific Gravity 60/60°F” headed 0.625, and note that against an “Observed Temperature” of 35°F the factor is

1.027

Hence, 1 U.S. gal of butadiene of specific gravity 0.625 at 60/60°F and measured at 35°F occupies a volume at 60°F of

1.027 U.S. gal

Then 45 500 U.S. gal measured at 35°F occupy a volume at 60°F of $45\,500 \times 1.027$ or

46 728 U.S. gal

TABLE 2 Reduction of Observed Volume to 15.6°C (60°F) Against Specific Gravity 60/60°F

-23.3 + 4.4°C (-10-40°F)

0.621-0.627

Observed Temperature °F ^A	Specific Gravity 60/60°F						
	0.621	0.622	0.623	0.624	0.625	0.626	0.627
	Factor for Reducing Volume to 60°F						
-10	1.074	1.074	1.073	1.073	1.073	1.072	1.072
-9	1.073	1.073	1.072	1.072	1.072	1.071	1.071
-8	1.072	1.072	1.071	1.071	1.071	1.070	1.070
-7	1.071	1.071	1.070	1.070	1.070	1.069	1.069
-6	1.070	1.070	1.069	1.069	1.069	1.068	1.068
-5	1.069	1.069	1.068	1.068	1.068	1.067	1.067
-4	1.068	1.068	1.067	1.067	1.067	1.067	1.066
-3	1.067	1.067	1.066	1.066	1.066	1.066	1.065
-2	1.066	1.066	1.065	1.065	1.065	1.065	1.064
-1	1.065	1.065	1.064	1.064	1.064	1.064	1.063
0	1.064	1.064	1.063	1.063	1.063	1.063	1.062
1	1.063	1.063	1.062	1.062	1.062	1.062	1.061
2	1.062	1.062	1.061	1.061	1.061	1.061	1.060
3	1.061	1.061	1.060	1.060	1.060	1.060	1.059
4	1.060	1.060	1.059	1.059	1.059	1.059	1.058
5	1.059	1.059	1.058	1.058	1.058	1.058	1.057
6	1.058	1.058	1.057	1.057	1.057	1.057	1.056
7	1.057	1.057	1.056	1.056	1.056	1.056	1.055
8	1.056	1.056	1.055	1.055	1.055	1.055	1.054
9	1.055	1.054	1.054	1.054	1.054	1.054	1.053
10	1.054	1.053	1.053	1.053	1.053	1.053	1.052
11	1.053	1.052	1.052	1.052	1.052	1.052	1.051
12	1.052	1.051	1.051	1.051	1.051	1.050	1.050
13	1.051	1.050	1.050	1.050	1.050	1.049	1.049
14	1.050	1.049	1.049	1.049	1.049	1.048	1.048
15	1.048	1.048	1.048	1.048	1.048	1.047	1.047
16	1.047	1.047	1.047	1.047	1.047	1.046	1.046
17	1.046	1.046	1.046	1.046	1.046	1.045	1.045
18	1.045	1.045	1.045	1.045	1.045	1.044	1.044
19	1.044	1.044	1.044	1.044	1.044	1.043	1.043
20	1.043	1.043	1.043	1.043	1.042	1.042	1.042
21	1.042	1.042	1.042	1.042	1.041	1.041	1.041
22	1.041	1.041	1.041	1.041	1.040	1.040	1.040
23	1.040	1.040	1.040	1.040	1.039	1.039	1.039
24	1.039	1.039	1.039	1.038	1.038	1.038	1.038
25	1.038	1.038	1.038	1.037	1.037	1.037	1.037
26	1.037	1.037	1.037	1.036	1.036	1.036	1.036
27	1.036	1.036	1.036	1.035	1.035	1.035	1.035
28	1.035	1.035	1.034	1.034	1.034	1.034	1.034
29	1.034	1.034	1.033	1.033	1.033	1.033	1.033
30	1.033	1.032	1.032	1.032	1.032	1.032	1.032
31	1.031	1.031	1.031	1.031	1.031	1.031	1.031
32	1.030	1.030	1.030	1.030	1.030	1.030	1.030
33	1.029	1.029	1.029	1.029	1.029	1.029	1.029
34	1.028	1.028	1.028	1.028	1.028	1.028	1.028
35	1.027	1.027	1.027	1.027	1.027	1.027	1.027
36	1.026	1.026	1.026	1.026	1.026	1.026	1.026
37	1.025	1.025	1.025	1.025	1.025	1.025	1.025
38	1.024	1.024	1.024	1.024	1.024	1.024	1.023
39	1.023	1.023	1.023	1.023	1.023	1.022	1.022
40	1.022	1.022	1.022	1.022	1.021	1.021	1.021

TABLE 2 Reduction of Observed Volume to 15.6°C (60°F) Against Specific Gravity 60/60°F

4.4–32.2°C (40–90°F)

0.621–0.627

Observed Temperature °F ^A	Specific Gravity 60/60°F						
	0.621	0.622	0.623	0.624	0.625	0.626	0.627
	Factor for Reducing Volume to 60°F						
40	1.022	1.022	1.022	1.022	1.021	1.021	1.021
41	1.021	1.021	1.021	1.021	1.020	1.020	1.020
42	1.020	1.020	1.019	1.019	1.019	1.019	1.019
43	1.018	1.018	1.018	1.018	1.018	1.018	1.018
44	1.017	1.017	1.017	1.017	1.017	1.017	1.017
45	1.016	1.016	1.016	1.016	1.016	1.016	1.016
46	1.015	1.015	1.015	1.015	1.015	1.015	1.015
47	1.014	1.014	1.014	1.014	1.014	1.014	1.014
48	1.013	1.013	1.013	1.013	1.013	1.013	1.013
49	1.012	1.012	1.012	1.012	1.012	1.012	1.012
50	1.011	1.011	1.011	1.011	1.011	1.011	1.011
51	1.010	1.010	1.010	1.010	1.010	1.010	1.010
52	1.009	1.009	1.009	1.009	1.009	1.009	1.009
53	1.007	1.007	1.007	1.007	1.007	1.007	1.007
54	1.006	1.006	1.006	1.006	1.006	1.006	1.006
55	1.005	1.005	1.005	1.005	1.005	1.005	1.005
56	1.004	1.004	1.004	1.004	1.004	1.004	1.004
57	1.003	1.003	1.003	1.003	1.003	1.003	1.003
58	1.002	1.002	1.002	1.002	1.002	1.002	1.002
59	1.001	1.001	1.001	1.001	1.001	1.001	1.001
60	1.000	1.000	1.000	1.000	1.000	1.000	1.000
61	0.999	0.999	0.999	0.999	0.999	0.999	0.999
62	0.997	0.997	0.997	0.998	0.998	0.998	0.998
63	0.996	0.996	0.996	0.996	0.997	0.997	0.997
64	0.995	0.995	0.995	0.995	0.995	0.995	0.996
65	0.994	0.994	0.994	0.994	0.994	0.994	0.994
66	0.993	0.993	0.993	0.993	0.993	0.993	0.993
67	0.992	0.992	0.992	0.992	0.992	0.992	0.992
68	0.991	0.991	0.991	0.991	0.991	0.991	0.991
69	0.989	0.990	0.990	0.990	0.990	0.990	0.990
70	0.988	0.988	0.989	0.989	0.989	0.989	0.989
71	0.987	0.987	0.987	0.987	0.988	0.988	0.988
72	0.986	0.986	0.986	0.986	0.986	0.987	0.987
73	0.985	0.985	0.985	0.985	0.985	0.985	0.986
74	0.984	0.984	0.984	0.984	0.984	0.984	0.984
75	0.983	0.983	0.983	0.983	0.983	0.983	0.983
76	0.981	0.982	0.982	0.982	0.982	0.982	0.982
77	0.980	0.980	0.981	0.981	0.981	0.981	0.981
78	0.979	0.979	0.979	0.980	0.980	0.980	0.980
79	0.978	0.978	0.978	0.978	0.979	0.979	0.979
80	0.977	0.977	0.977	0.977	0.977	0.978	0.978
81	0.976	0.976	0.976	0.976	0.976	0.976	0.977
82	0.975	0.975	0.975	0.975	0.975	0.975	0.976
83	0.973	0.974	0.974	0.974	0.974	0.974	0.974
84	0.972	0.972	0.973	0.973	0.973	0.973	0.973
85	0.971	0.971	0.971	0.972	0.972	0.972	0.972
86	0.970	0.970	0.970	0.970	0.971	0.971	0.971
87	0.969	0.969	0.969	0.969	0.969	0.970	0.970
88	0.968	0.968	0.968	0.968	0.968	0.969	0.969
89	0.966	0.967	0.967	0.967	0.967	0.967	0.968
90	0.965	0.965	0.966	0.966	0.966	0.966	0.966

TABLE 2 Reduction of Observed Volume to 15.6°C (60°F) Against Specific Gravity 60/60°F

32.2–43.0°C (90–110°F)

0.621–0.627

Observed Temperature °F ^A	Specific Gravity 60/60°F						
	0.621	0.622	0.623	0.624	0.625	0.626	0.627
Factor for Reducing Volume to 60°F							
90	0.965	0.965	0.966	0.966	0.966	0.966	0.966
91	0.964	0.964	0.964	0.965	0.965	0.965	0.965
92	0.963	0.963	0.963	0.964	0.964	0.964	0.964
93	0.962	0.962	0.962	0.962	0.963	0.963	0.963
94	0.960	0.961	0.961	0.961	0.961	0.962	0.962
95	0.959	0.960	0.960	0.960	0.960	0.961	0.961
96	0.958	0.958	0.959	0.959	0.959	0.959	0.960
97	0.957	0.957	0.958	0.958	0.958	0.958	0.958
98	0.956	0.956	0.956	0.957	0.957	0.957	0.957
99	0.955	0.955	0.955	0.955	0.956	0.956	0.956
100	0.953	0.954	0.954	0.954	0.954	0.955	0.955
101	0.952	0.952	0.953	0.953	0.953	0.954	0.954
102	0.951	0.951	0.952	0.952	0.952	0.952	0.953
103	0.950	0.950	0.950	0.951	0.951	0.951	0.952
104	0.949	0.949	0.949	0.949	0.950	0.950	0.950
105	0.947	0.948	0.948	0.948	0.949	0.949	0.949
106	0.946	0.946	0.947	0.947	0.947	0.948	0.948
107	0.945	0.945	0.946	0.946	0.946	0.947	0.947
108	0.944	0.944	0.944	0.945	0.945	0.945	0.946
109	0.943	0.943	0.943	0.944	0.944	0.944	0.945
110	0.941	0.942	0.942	0.942	0.943	0.943	0.943

TABLE 2 Reduction of Observed Volume to 15.6°C (60°F) Against Specific Gravity 60/60°F

-23.3 to +4.4°C (-10 to +40°F)

0.628–0.634

Observed Temperature °F ^A	Specific Gravity 60/60°F						
	0.628	0.629	0.630	0.631	0.632	0.633	0.634
	Factor for Reducing Volume to 60°F						
-10	1.072	1.071	1.071	1.071	1.070	1.070	1.070
-9	1.071	1.070	1.070	1.070	1.069	1.069	1.069
-8	1.070	1.069	1.069	1.069	1.068	1.068	1.068
-7	1.069	1.068	1.068	1.068	1.067	1.067	1.067
-6	1.068	1.067	1.067	1.067	1.067	1.066	1.066
-5	1.067	1.067	1.066	1.066	1.066	1.065	1.065
-4	1.066	1.066	1.065	1.065	1.065	1.064	1.064
-3	1.065	1.065	1.064	1.064	1.064	1.063	1.063
-2	1.064	1.064	1.063	1.063	1.063	1.062	1.062
-1	1.063	1.063	1.062	1.062	1.062	1.061	1.061
0	1.062	1.062	1.061	1.061	1.061	1.060	1.060
1	1.061	1.061	1.060	1.060	1.060	1.060	1.059
2	1.060	1.060	1.059	1.059	1.059	1.059	1.058
3	1.059	1.059	1.058	1.058	1.058	1.058	1.057
4	1.058	1.058	1.057	1.057	1.057	1.057	1.056
5	1.057	1.057	1.056	1.056	1.056	1.056	1.055
6	1.056	1.056	1.056	1.055	1.055	1.055	1.054
7	1.055	1.055	1.055	1.054	1.054	1.054	1.054
8	1.054	1.054	1.054	1.053	1.053	1.053	1.053
9	1.053	1.053	1.053	1.052	1.052	1.052	1.052
10	1.052	1.052	1.052	1.051	1.051	1.051	1.051
11	1.051	1.051	1.051	1.050	1.050	1.050	1.050
12	1.050	1.050	1.050	1.049	1.049	1.049	1.049
13	1.049	1.049	1.049	1.048	1.048	1.048	1.048
14	1.048	1.048	1.048	1.047	1.047	1.047	1.047
15	1.047	1.047	1.047	1.046	1.046	1.046	1.046
16	1.046	1.046	1.046	1.045	1.045	1.045	1.045
17	1.045	1.045	1.045	1.044	1.044	1.044	1.044
18	1.044	1.044	1.044	1.043	1.043	1.043	1.043
19	1.043	1.043	1.043	1.042	1.042	1.042	1.042
20	1.042	1.042	1.042	1.041	1.041	1.041	1.041
21	1.041	1.041	1.041	1.040	1.040	1.040	1.040
22	1.040	1.040	1.040	1.039	1.039	1.039	1.039
23	1.039	1.039	1.039	1.038	1.038	1.038	1.038
24	1.038	1.038	1.038	1.037	1.037	1.037	1.037
25	1.037	1.037	1.037	1.036	1.036	1.036	1.036
26	1.036	1.036	1.036	1.035	1.035	1.035	1.035
27	1.035	1.035	1.035	1.034	1.034	1.034	1.034
28	1.034	1.034	1.034	1.033	1.033	1.033	1.033
29	1.033	1.033	1.032	1.032	1.032	1.032	1.032
30	1.032	1.032	1.031	1.031	1.031	1.031	1.031
31	1.031	1.031	1.030	1.030	1.030	1.030	1.030
32	1.030	1.030	1.029	1.029	1.029	1.029	1.029
33	1.029	1.029	1.028	1.028	1.028	1.028	1.028
34	1.028	1.027	1.027	1.027	1.027	1.027	1.027
35	1.027	1.026	1.026	1.026	1.026	1.026	1.026
36	1.025	1.025	1.025	1.025	1.025	1.025	1.025
37	1.024	1.024	1.024	1.024	1.024	1.024	1.024
38	1.023	1.023	1.023	1.023	1.023	1.023	1.023
39	1.022	1.022	1.022	1.022	1.022	1.022	1.022
40	1.021	1.021	1.021	1.021	1.021	1.021	1.021

TABLE 2 Reduction of Observed Volume to 15.6°C (60°F) Against Specific Gravity 60/60°F

4.4–32.2°C (40–90°F)

0.628–0.634

Observed Temperature °F ^A	Specific Gravity 60/60°F						
	0.628	0.629	0.630	0.631	0.632	0.633	0.634
	Factor for Reducing Volume to 60°F						
40	1.021	1.021	1.021	1.021	1.021	1.021	1.021
41	1.020	1.020	1.020	1.020	1.020	1.020	1.020
42	1.019	1.019	1.019	1.019	1.019	1.019	1.019
43	1.018	1.018	1.018	1.018	1.018	1.018	1.018
44	1.017	1.017	1.017	1.017	1.017	1.017	1.017
45	1.016	1.016	1.016	1.016	1.016	1.016	1.016
46	1.015	1.015	1.015	1.015	1.015	1.015	1.015
47	1.014	1.014	1.014	1.014	1.014	1.014	1.014
48	1.013	1.013	1.013	1.013	1.013	1.013	1.013
49	1.012	1.012	1.012	1.012	1.012	1.012	1.012
50	1.011	1.011	1.011	1.011	1.011	1.011	1.011
51	1.010	1.010	1.010	1.010	1.010	1.010	1.010
52	1.009	1.009	1.009	1.009	1.009	1.009	1.009
53	1.008	1.008	1.008	1.008	1.008	1.008	1.008
54	1.006	1.006	1.006	1.006	1.006	1.006	1.007
55	1.005	1.005	1.005	1.005	1.005	1.005	1.005
56	1.004	1.004	1.004	1.004	1.004	1.004	1.004
57	1.003	1.003	1.003	1.003	1.003	1.003	1.003
58	1.002	1.002	1.002	1.002	1.002	1.002	1.002
59	1.001	1.001	1.001	1.001	1.001	1.001	1.001
60	1.000	1.000	1.000	1.000	1.000	1.000	1.000
61	0.999	0.999	0.999	0.999	0.999	0.999	0.999
62	0.998	0.998	0.998	0.998	0.998	0.998	0.998
63	0.997	0.997	0.997	0.997	0.997	0.997	0.997
64	0.996	0.996	0.996	0.996	0.996	0.996	0.996
65	0.995	0.995	0.995	0.995	0.995	0.995	0.995
66	0.993	0.994	0.994	0.994	0.994	0.994	0.994
67	0.992	0.992	0.993	0.993	0.993	0.993	0.993
68	0.991	0.991	0.991	0.992	0.992	0.992	0.992
69	0.990	0.990	0.990	0.990	0.991	0.991	0.991
70	0.989	0.989	0.989	0.989	0.989	0.990	0.990
71	0.988	0.988	0.988	0.988	0.988	0.988	0.989
72	0.987	0.987	0.987	0.987	0.987	0.987	0.988
73	0.986	0.986	0.986	0.986	0.986	0.986	0.986
74	0.985	0.985	0.985	0.985	0.985	0.985	0.985
75	0.984	0.984	0.984	0.984	0.984	0.984	0.984
76	0.982	0.983	0.983	0.983	0.983	0.983	0.983
77	0.981	0.981	0.982	0.982	0.982	0.982	0.982
78	0.980	0.980	0.980	0.981	0.981	0.981	0.981
79	0.979	0.979	0.979	0.980	0.980	0.980	0.980
80	0.978	0.978	0.978	0.978	0.979	0.979	0.979
81	0.977	0.977	0.977	0.977	0.977	0.978	0.978
82	0.976	0.976	0.976	0.976	0.976	0.977	0.977
83	0.975	0.975	0.975	0.975	0.975	0.975	0.976
84	0.973	0.974	0.974	0.974	0.974	0.974	0.975
85	0.972	0.973	0.973	0.973	0.973	0.973	0.973
86	0.971	0.971	0.972	0.972	0.972	0.972	0.972
87	0.970	0.970	0.970	0.971	0.971	0.971	0.971
88	0.969	0.969	0.969	0.970	0.970	0.970	0.970
89	0.968	0.968	0.968	0.968	0.969	0.969	0.969
90	0.967	0.967	0.967	0.967	0.968	0.968	1.968

TABLE 2 Reduction of Observed Volume to 15.6°C (60°F) Against Specific Gravity 60/60°F

32.2–43.0°C (90–110°F)

0.628–0.634

Observed Temperature °F ^A	Specific Gravity 60/60°F						
	0.628	0.629	0.630	0.631	0.632	0.633	0.634
	Factor for Reducing Volume to 60°F						
90	0.967	0.967	0.967	0.967	0.968	0.968	0.968
91	0.966	0.966	0.966	0.966	0.966	0.967	0.967
92	0.964	0.965	0.965	0.965	0.965	0.966	0.966
93	0.963	0.964	0.964	0.964	0.964	0.964	0.965
94	0.962	0.962	0.963	0.963	0.963	0.963	0.964
95	0.961	0.961	0.961	0.962	0.962	0.962	0.962
96	0.960	0.960	0.960	0.961	0.961	0.961	0.961
97	0.959	0.959	0.959	0.959	0.960	0.960	0.960
98	0.958	0.958	0.958	0.958	0.959	0.959	0.959
99	0.956	0.957	0.957	0.957	0.957	0.958	0.958
100	0.955	0.956	0.956	0.956	0.956	0.957	0.957
101	0.954	0.954	0.955	0.955	0.955	0.956	0.956
102	0.953	0.953	0.954	0.954	0.954	0.954	0.955
103	0.952	0.952	0.952	0.953	0.953	0.953	0.954
104	0.951	0.951	0.951	0.952	0.952	0.952	0.952
105	0.949	0.950	0.950	0.950	0.951	0.951	0.951
106	0.948	0.949	0.949	0.949	0.950	0.950	0.950
107	0.947	0.947	0.948	0.948	0.948	0.949	0.949
108	0.946	0.946	0.947	0.947	0.947	0.948	0.948
109	0.945	0.945	0.945	0.946	0.946	0.946	0.947
110	0.944	0.944	0.944	0.945	0.945	0.945	0.946

$$^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times \frac{5}{9}$$

TABLE 3 WEIGHT PER UNIT VOLUME AT 15.6°C (60°F) AGAINST SPECIFIC GRAVITY 60/60°F

This table gives the weight in air in kilograms of one litre of butadiene at 15.6°C (60°F) for values of specific gravity 60/60°F in the range 0.621 to 0.634.

This table must be entered with specific gravity 15.6/15.6°C (60/60°F). If the gravity has been observed at some other temperature, the equivalent gravity at 60/60°F must be obtained from [Table 1](#) Reduction of Observed Specific Gravity to Specific Gravity at 60/60°F.

Example—It is required to fill a container with exactly 40 U.S. gal of butadiene measured at 60°F, using a weight filling machine. If the specific gravity 60/60°F of the butadiene is 0.625, what weight should be set on the scale of the machine?

Enter the table with 0.625 specific gravity and note that the weight of 1 U.S. gal is

5.201 lb

Then 40 U.S. gal of butadiene at 60°F weighs 40 × 5.201 or

208.0 lb

The weight to be set on the filling machine is therefore

208 lb, 0 oz

TABLE 3 Weight in Air per Litre at 15.6°C (60°F) Against Specific Gravity 60/60°F

Specific Gravity 60/60°F ^A	Pounds in Air per Gallon ^B at 60°F ^C
0.621	5.168
0.622	5.176
0.623	5.185
0.624	5.193
0.625	5.201
0.626	5.210
0.627	5.218
0.628	5.226
0.629	5.235
0.630	5.243
0.631	5.251
0.632	5.260
0.633	5.268
0.634	5.276

$$^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times \frac{5}{9}$$

$$^{\text{B}}1 \text{ lb/gal} = 0.119826 \text{ kg/L}$$

^CThese values have been computed by the method described for Table 26 of the Petroleum Measurement Tables (Guide [D1250](#): IP No. 200) and is given in detail as Equation 32, p. 11, in the Report on the Development, Construction, Calculation and Preparation of the ASTM-IP Petroleum Measurement Tables, available from ASTM and IP as a separate publication.

TABLE 4 VAPOR VOLUME AND VAPOR DENSITY FACTORS AGAINST GAUGE PRESSURE OR TEMPERATURE

This table gives the volumes of liquid butadiene at 15.6°C (60°F) occupied by unit volume of butadiene vapor at temperature $t^{\circ}\text{F}$ or indicated gauge pressure, kPa (psi). It also gives the values for vapor density in air in kg per litre (pounds per gallon) at temperature $t^{\circ}\text{F}$ or indicated gauge pressure. This table must be entered with either Celsius (Fahrenheit) temperature or with gauge pressure, kilo Pascals (pounds per square inch). The purpose of this table is to calculate the amount of butadiene that is in the vapor space of a vessel that is partially full of liquid butadiene.

Examples:

A tank of 10 000 U.S. gal capacity is observed to contain 1500 gal of liquid at 95°F and consequently 40.1 psi gauge pressure and an observed specific gravity of 60/60°F 0.627. The volume of butadiene vapors in the tank is obviously 10 000 – 1500, or 8500 U.S. gal

Entering the table with either the temperature of 95°F, or the gauge pressure of 40.1 psi, the volume of 60°F butadiene liquid in each volume of vapor space is 0.01404

Then 8500 U.S. gal multiplied by 0.01404 gives the amount of butadiene in the vapor space expressed as U.S. gallons of 60°F butadiene liquid and is 119.3 gal

This 119.3 gal of 60°F butadiene liquid that is in the vapor space can be added to the liquid contents of the tank expressed as U.S. gallons of 60°F butadiene to obtain the total contents of the tank.

From **Table 2** the factor to correct the 1500 gal from 95°F and a specific gravity of 0.627 to 60°F is 0.961; therefore, the liquid content of the tank in U.S. gallons at 60°F is 0.961×1500 1441.5 gal

The total contents of the tank in U.S. gallons at 60°F is 119.3 + 1441.5 or 1560.8 gal

The table can also be entered with the temperature of 95°F or gauge pressure of 40.1 psi reading the vapor density in air of 0.0734 lb/gal

The weight of butadiene in the vapor space of 8500 U.S. gal is therefore (8500×0.0734) 623.9 lb

From **Table 2** the 1500 gal of liquid of 0.627 specific gravity and 95°F is multiplied by the factor of 0.961 to obtain the amount of butadiene at 60°F (1500×0.961) 1441.5 gal

From **Table 3** the 1441.5 gal of butadiene at 60°F with a specific gravity of 0.627 is noted to weigh 5.218 lb/gal; therefore, the weight of liquid butadiene is 1441.5×5.218 7521.7 lb

The total weight of butadiene in the tank is 623.9 + 7521.7 8145.6 lb

TABLE 4 Vapor Volume and Vapor Density Factors

Temperature, ° F ^A	Gauge Pressure, psi ^B	Volume of Liquid at 15.6°C (60°F) Equivalent to Unit Volume of Vapor at Temperature or Pressure Indicated	Vapor Density (in air), lb/gal ^{C,D}
110	54.4	0.01756	0.0918
109	53.4	0.01731	0.0905
108	52.4	0.01705	0.0892
107	51.4	0.01680	0.0879
106	50.4	0.01656	0.0866
105	49.4	0.01632	0.0853
104	48.4	0.01608	0.0841
103	47.5	0.01584	0.0828
102	46.5	0.01560	0.0816
101	45.6	0.01537	0.0804
100	44.6	0.01514	0.0792
99	43.7	0.01492	0.0780
98	42.8	0.01469	0.0768
97	41.9	0.01447	0.0757
96	41.0	0.01425	0.0745
95	40.1	0.01404	0.0734
94	39.3	0.01382	0.0723
93	38.4	0.01361	0.0712
92	37.6	0.01341	0.0701
91	36.7	0.01320	0.0690
90	35.9	0.01300	0.0680
89	35.1	0.01280	0.0669
88	34.3	0.01260	0.0659
87	33.5	0.01240	0.0648
86	32.7	0.01221	0.0638
85	31.9	0.01202	0.0628
84	31.1	0.01183	0.0618
83	30.4	0.01164	0.0609
82	29.6	0.01146	0.0599
81	28.9	0.01128	0.0590
80	28.2	0.01110	0.0580
79	27.4	0.01092	0.0571
78	26.7	0.01074	0.0562
77	26.0	0.01057	0.0553
76	25.3	0.01040	0.0544
75	24.6	0.01023	0.0535
74	24.0	0.01007	0.0526
73	23.3	0.00990	0.0518
72	22.7	0.00974	0.0509
71	22.0	0.00958	0.0501
70	21.4	0.00942	0.0493
69	20.7	0.00926	0.0484
68	20.1	0.00911	0.0476
67	19.5	0.00896	0.0468
66	18.9	0.00881	0.0460

TABLE 4 Vapor Volume and Vapor Density Factors

Temperature, ° F ^A	Gauge Pressure, psi ^B	Volume of Liquid at 15.6°C (60°F) Equivalent to Unit Volume of Vapor at Temperature or Pressure Indicated	Vapor Density (in air), lb/gal ^{C,D}
65	18.3	0.00866	0.0453
64	17.7	0.00851	0.0445
63	17.1	0.00837	0.0438
62	16.5	0.00823	0.0430
61	16.0	0.00809	0.0423
60	15.4	0.00795	0.0415
59	14.9	0.00781	0.0408
58	14.3	0.00767	0.0401
57	13.8	0.00754	0.0394
56	13.3	0.00741	0.0387
55	12.7	0.00728	0.0381
54	12.2	0.00715	0.0374
53	11.7	0.00703	0.0367
52	11.2	0.00690	0.0361
51	10.7	0.00678	0.0354
50	10.3	0.00666	0.0348
49	9.8	0.00654	0.0342
48	9.3	0.00642	0.0336
47	8.8	0.00631	0.0330
46	8.4	0.00619	0.0324
45	7.9	0.00608	0.0318
44	7.5	0.00597	0.0312
43	7.1	0.00586	0.0306
42	6.6	0.00575	0.0301
41	6.2	0.00564	0.0295
40	5.8	0.00554	0.0290
39	5.4	0.00543	0.0284
38	5.0	0.00533	0.0279
37	4.6	0.00523	0.0274
36	4.2	0.00513	0.0268
35	3.8	0.00504	0.0263
34	3.4	0.00494	0.0258
33	3.1	0.00485	0.0253
32	2.7	0.00475	0.0248
31	2.3	0.00466	0.0244
30	2.0	0.00457	0.0239
29	1.6	0.00448	0.0234
28	1.3	0.00439	0.0230
27	1.0	0.00431	0.0225
26	0.6	0.00422	0.0221

TABLE 4 Vapor Volume and Vapor Density Factors

Temperature, ° F ^A	Gauge Pressure, psi ^B	Volume of Liquid at 15.6°C (60°F) Equivalent to Unit Volume of Vapor at Temperature or Pressure Indicated	Vapor Density (in air), lb/gal ^{C,D}
25	0.3	0.00414	0.0216
24.06	0.0	0.00406	0.0212
23	-0.3	0.00397	0.0208
22	-0.6	0.00389	0.0204
21	-0.9	0.00382	0.0199
20	-1.2	0.00374	0.0195
19	-1.5	0.00366	0.0191
18	-1.8	0.00359	0.0188
17	-2.1	0.00351	0.0184
16	-2.4	0.00344	0.0180
15	-2.7	0.00337	0.0176
14	-2.9	0.00330	0.0172
13	-3.2	0.00323	0.0169
12	-3.5	0.00316	0.0165
11	-3.7	0.00309	0.0162
10	-4.0	0.00303	0.0158
9	-4.2	0.00296	0.0155
8	-4.5	0.00290	0.0152
7	-4.7	0.00284	0.0148
6	-4.9	0.00278	0.0145
5	-5.2	0.00272	0.0142
4	-5.4	0.00266	0.0139
3	-5.6	0.00260	0.0136
2	-5.8	0.00254	0.0133
1	-6.0	0.00248	0.0130
0	-6.2	0.00243	0.0127
-1	-6.4	0.00237	0.0124
-2	-6.6	0.00232	0.0121
-3	-6.8	0.00227	0.0119
-4	-7.0	0.00222	0.0116
-5	-7.2	0.00217	0.0113
-6	-7.4	0.00212	0.0111
-7	-7.6	0.00207	0.0108
-8	-7.8	0.00202	0.0106
-9	-7.9	0.00197	0.0103
-10	-8.1	0.00193	0.0101

^A °C = (°F-32) × 5/9 .

^B 1 psi = 6.894754 kPa.

^C 1 in. = 25.4 mm.

^D 1 lb/gal = 0.119826 kg/L.

4. Keywords

4.1 butadiene; relative density; tables; volume; weight

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