**Designation: D 1142 – 95 (Reapproved 2000)**

# Standard Test Method for
## Water Vapor Content of Gaseous Fuels by Measurement of Dew-Point Temperature[1]

This standard is issued under the fixed designation D 1142; 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 This test method covers the determination of the water vapor content of gaseous fuels by measurement of the dew-point temperature and the calculation therefrom of the water vapor content.

NOTE 1—Some gaseous fuels contain vapors of hydrocarbons or other components that easily condense into liquid and sometimes interfere with or mask the water dew point. When this occurs, it is sometimes very helpful to supplement the apparatus in Fig. 1 with an optical attachment[2] that uniformly illuminates the dew–point mirror and also magnifies the condensate on the mirror. With this attachment it is possible, in some cases, to observe separate condensation points of water vapor, hydrocarbons, and glycolamines as well as ice points. However, if the dew point of the condensable hydrocarbons is higher than the water vapor dew point, when such hydrocarbons are present in large amounts, they may flood the mirror and obscure or wash off the water dew point. Best results in distinguishing multiple component dew points are obtained when they are not too closely spaced.

NOTE 2—Condensation of water vapor on the dew-point mirror may appear as liquid water at temperatures as low as 0 to −10°F (−18 to −23°C). At lower temperatures an ice point rather than a water dew point likely will be observed. The minimum dew point of any vapor that can be observed is limited by the mechanical parts of the equipment. Mirror temperatures as low as −150°F (−100°C) have been measured, using liquid nitrogen as the coolant with a thermocouple attached to the mirror, instead of a thermometer well.

1.2 *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. Terminology

2.1 *Definitions of Terms Specific to This Standard:*

2.1.1 *saturated water vapor or equilibrium water–vapor content*—the water vapor concentration in a gas mixture that is in equilibrium with a liquid phase of pure water that is saturated with the gas mixture. When a gas containing water vapor is at the water dew-point temperature, it is said to be saturated at the existing pressure.

2.1.2 *specific volume*—of a gaseous fuel, the volume of the gas in cubic feet per pound.

2.1.3 *water dew-point temperature*—of a gaseous fuel, the temperature at which the gas is saturated with water vapor at the existing pressure.

## 3. Significance and Use

3.1 Generally, contracts governing the pipeline transmission of natural gas contain specifications limiting the maximum concentration of water vapor allowed. Excess water vapor can cause corrosive conditions, degrading pipelines and equipment. It can also condense and freeze or form methane hydrates causing blockages. Water–vapor content also affects the heating value of natural gas, thus influencing the quality of the gas. This test method permits the determination of water content of natural gas.

## 4. Apparatus

4.1 Any properly constructed dew-point apparatus may be used that satisfies the basic requirements that means must be provided:

4.1.1 To permit a controlled flow of gas to enter and leave the apparatus while the apparatus is at a temperature at least 3°F above the dew point of the gas.

4.1.2 To cool and control the cooling rate of a portion (preferably a small portion) of the apparatus, with which the *flowing* gas comes in contact, to a temperature low enough to cause vapor to condense from the gas.

4.1.3 To observe the deposition of dew on the cold portion of the apparatus.

4.1.4 To measure the temperature of the cold portion on the apparatus on which the dew is deposited, and
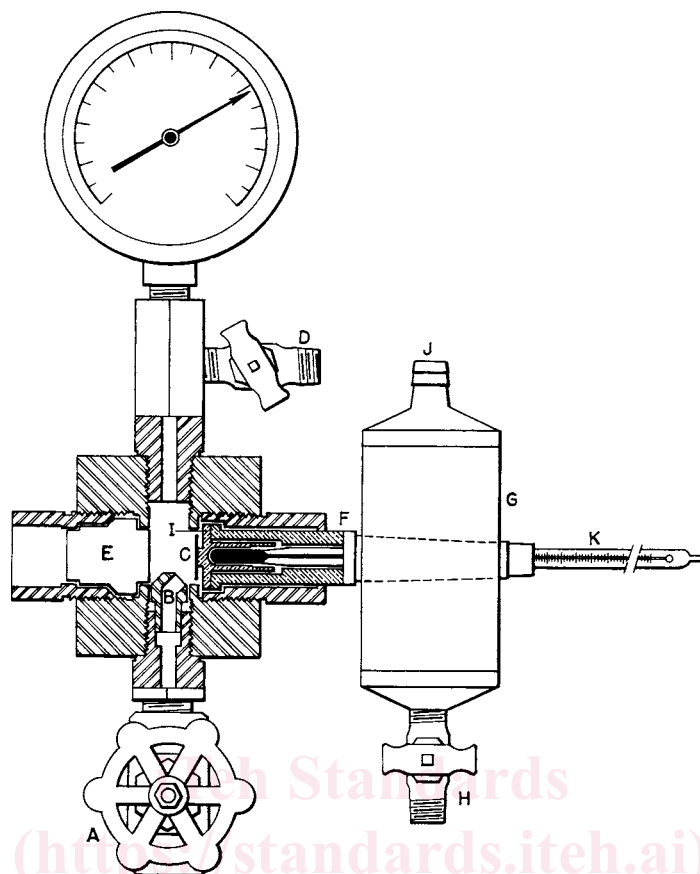
**FIG. 1 Bureau of Mines Dew-Point Apparatus**

4.1.5 To measure the pressure of the gas within the apparatus or the deviation from the known existing barometric pressure.

4.1.6 The apparatus should be constructed so that the "cold spot," that is, the cold portion of the apparatus on which dew is deposited, is protected from all gases other than the gas under test. The apparatus may or may not be designed for use under pressure.

4.2 The Bureau of Mines type of dew-point apparatus[3] shown in Fig. 1 fulfills the requirements specified in 4.1. Within the range of conditions in Section 1, this apparatus is satisfactory for determining the dew point of gaseous fuels. Briefly, this apparatus consists of a metal chamber into and out of which the test gas is permitted to flow through control valves *A* and *D*. Gas entering the apparatus through valve *A* is deflected by nozzle *B* towards the cold portion of the apparatus, *C*. The gas flows across the face of *C* and out of the apparatus through valve *D*. Part *C* is a highly polished stainless steel "target mirror," cooled by means of a copper cooling rod, *F*. The mirror, *C*, is silver-soldered to a nib on the copper thermometer well fitting, *I*, which is soft-soldered to the cooling rod, *F*. The thermometer well is integral with the fitting, *I*. Cooling of rod *F* is accomplished by vaporizing a refrigerant such as liquid butane, propane, carbon dioxide, or some other liquefied gas in the chiller, *G*. The refrigerant is throttled into the chiller through valve *H* and passes out at *J*. The chiller body is made of copper and has brass headers on either end. The lower header is connected with the upper header by numerous small holes drilled in the copper body through which the vaporized refrigerant passes. The chiller is attached to the cooling rod, *F*, by means of a taper joint. The temperature of the target mirror, *C*, is indicated by a calibrated mercury-in-glass thermometer, *K*, whose bulb fits snugly into the thermometer well. Observation of the dew deposit is made through the pressure-resisting transparent window, *E*.

4.2.1 Note that only the central portion of the stainless steel target mirror, *C*, is thermally bonded to the fitting, *I*, through which *C* is cooled. Since stainless steel is a relatively poor thermal conductor, the central portion of the mirror is thus maintained at a slightly lower temperature than the outer portion, with the result that the dew first appears on the central portion of the mirror and its detection is aided materially by the contrast afforded. The arrangement for measuring the temperature of the target mirror, *C*, also should be noted. The temperature is read with a thermometer or RTD, *K*, inserted in the cooling rod, *F*, so that the bulb of the temperature measuring device is entirely within the thermometer well in fitting, *I*. The stud to which the stainless steel mirror is silver-soldered is a part of the base of the thermometer well, and as there is no metallic contact between the thermometer

---

[3] Deaton, W. M., and Frost, E. M., Jr., "Bureau of Mines Apparatus for Determining the Dew Point of Gases Under Pressure," *Bureau of Mines Report of Investigation 3399*, May 1938.

2

well and the cooling tube, other than through its base, the thermometer or RTD indicates the temperature of the mirror rather than some compromise temperature influenced by the temperature gradient along the cooling tube as would be the case if this type of construction were not used. The RTD will include suitable electronics and display.

4.2.2 Tests with the Bureau of Mines type of dew-point apparatus are reported[3] to permit a determination with a precision (reproducibility) of $\pm 0.2°F$ ($\pm 0.1°C$) and with an accuracy of $\pm 0.2°F$ ($\pm 0.1°C$) when the dew-point temperatures range from room temperature to a temperature of $32°F$ ($0°C$). It is estimated that water dew points may be determined with an accuracy of $\pm 0.5°F$ ($0.3°C$) when they are below $32°F$ ($0°C$) and not lower than $0°F$ ($-17.8°C$), provided ice crystals do not form during the determination.

## 5. Procedure

5.1 *General Considerations*—Take the specimen so as to be representative of the gas at the source. Do not take at a point where isolation would permit condensate to collect or would otherwise allow a vapor content to exist that is not in equilibrium with the main stream or supply of gas, such as the sorption or desorption of vapors from the sampling line or from deposits therein. The temperature of the pipelines leading the specimen directly from the gas source to the dew-point apparatus, and also the temperature of the apparatus, shall be at least $3°F$ ($1.7°C$) higher than the observed dew point. The determination may be made at any pressure, but the gas pressure within the dew-point apparatus must be known with an accuracy appropriate to the accuracy requirements of the test. The pressure may be read on a calibrated bourdon-type pressure gage; for very low pressures or more accurate measurements, a mercury-filled manometer or a dead-weight gage should be used.

5.2 *Detailed Procedure for Operation of Bureau of Mines Dew-Point Apparatus*—Introduce the gas specimen through valve *A* (Fig. 1), opening this valve wide if the test is to be made under full source pressure (Note 3), and controlling the flow by the small outlet valve, *D*. The rate of flow is not critical but should not be so great that there is a measurable or objectionable drop in pressure through the connecting lines and dew-point apparatus. A flow of 0.05 to 0.5 ft³/min (1.4 to 14 L/min) (measured at atmospheric pressure) usually will be satisfactory. With liquefied refrigerant gas piped to the chiller throttle valve, *H*, "crack" the valve momentarily, allowing the refrigerant to vaporize in the chiller to produce suitable lowering in temperature of the chiller tube, *F*, and target mirror, *C*, as indicated by the thermometer, *K*. The rate of cooling may be as rapid as desired in making a preliminary test. After estimating the dew-point temperature, either by a preliminary test or from other knowledge, control the cooling or warming rate so that it does not exceed $1°F/min$ ($0.5°C/min$) when this temperature is approached. For accurate results, the cooling and warming rates should approximate isothermal

conditions as nearly as possible. The most satisfactory method is to cool or warm the target mirror stepwise. Steps of about $0.2°F$ ($0.1°C$) allow equilibrium conditions to be approached closely and favor an accurate determination. When dew has been deposited, allow the target mirror to warm up at a rate comparable to the recommended rate of cooling. The normal warming rate usually will be faster than desired. To reduce the rate, "crack" valve *H* momentarily at intervals to supply cooling to the cooling tube, *F*. Repeat the cooling and warming cycles several times. The arithmetic average of the temperatures at which dew is observed to appear and disappear is considered to be the observed dew point.

NOTE 3—If the water–vapor content is to be calculated as described in 6.2, the gas specimen should be throttled at the inlet valve, *A*, to a pressure within the apparatus approximately equal to atmospheric pressure. The outlet valve may be left wide open or restricted, as desired. The pressure existing within the apparatus must, however, be known to the required accuracy.

## 6. Calculation

6.1 If an acceptable chart showing the variation of water-vapor content with saturation or water dew-point temperatures over a suitable range of pressures for the gas being tested is available, the water-vapor content may be read directly, using the observed water dew-point temperature and the pressure at which the determination was made.

6.2 If such a chart is not available, the water–vapor content of the gas may be calculated from the water dew-point temperature and the pressure at which it was determined (see Note 3), as follows:
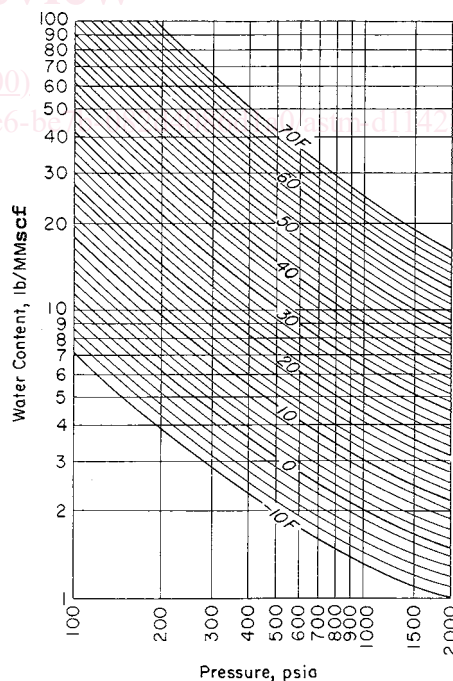


FIG. 2 Equilibrium Water Vapor Content of Natural Gases

$$W = w \times 10^6 \times (P_b/P \times (T/T_b)) \qquad (1)$$

where:

$W$ = lb of water/million ft$^3$ of gaseous mixture at pressure $P_b$ and temperature $T_b$;

$w$ = weight of saturated water vapor, lb/ft$^3$, at the water dew-point temperature, that is, the reciprocal of the specific volume of saturated vapor (see Table 1);

$P_b$ = pressure-base of gas measurement, psia;

$P$ = pressure at which the water dew point of gas was determined, psia;

$t$ = observed water dew-point temperature, °F;

$T$ = Rankine (absolute Fahrenheit scale) water dew point, $t + 460$, at pressure $P$; and

$T_b$ = base temperature of gas measurement, $t_b + 460$.

NOTE 4—*Example 1:*

Given: Water dew point = 37°F at 15.0-psia pressure.

What is the water–vapor content million ft$^3$ of gas (gas measurement base of 60°F and 14.7-psia pressure)?

From Table 1 the specific volume of saturated water at 37°F is 2731.9 ft$^3$/lb, from which:

$$w = (1/2731.9) = 0.000\ 366\ 0\ \text{lb/ft}^3$$

and

$$W = 0.000\ 366\ 0 \times 10^6 \times (14.7/15.0) \times [(460 + 37)/(460 + 60)]$$
$$= 342.8\ \text{lb/million ft}^3$$

*Example 2:*

Given: Water dew point = 5°F at 14.4 psia.

From Table 2, the specific volume of saturated water vapor with respect to ice at 5°F is 11 550 ft$^3$/lb from which $W_{\text{ice, 5F}} = 0.000\ 086\ 6$, but the observed water dew point was in equilibrium with subcooled liquid water at 5°F. From Table 2 (data from International Critical Tables[4]), the vapor pressures of subcooled liquid water and of ice at 5°F (−15°C) are 1.436 mm and 1.241 mm Hg, respectively.

Since the vapor pressure of subcooled liquid water is greater than ice at the same temperature, the weight per cubic foot of water vapor in equilibrium with liquid water will be proportionally larger than the value calculated from the specific volume read from the table, which is for equilibrium with ice.

Hence,

$W_{\text{liq., 5F}}$
$= W_{\text{ice 5F}} \times (1.436/1.241)$
$= 0.000\ 086\ 6 \times 1.157$
$= 0.000\ 100\ 2$ and
$W = 0.000\ 100\ 2 \times 10^6$
$\qquad \times (14.7/14.4) \times [(460 + 5)/(460 + 60)]$
$\qquad\qquad\qquad\qquad = 91.5\ \text{lb/million ft}^3$

6.3 A correlation of the available data on the equilibrium water content of natural gases has been reported by Bukacek.[5] This correlation is believed to be accurate enough for the requirements of the gaseous fuels industry, except for unusual situations where the dew point is measured at conditions close to the critical temperature of the gas. The correlation is a modified form of Raoult's law having the following form:

$$W = (A/P) + B \qquad (2)$$

where:

$W$ = water–vapor content, lb/million ft$^3$;

$P$ = total pressure, psia;

$A$ = a constant proportional to the vapor pressure of water; and

$B$ = a constant depending on temperature and gas composition.

NOTE 5—Values of $B$ were computed from available data on methane, methane-ethane mixtures, and natural gases.

6.3.1 Table 2 lists values of the constants $A$ and $B$ for natural gases in the temperature range from −40 to 460°F (−40 to 238°C).

6.3.2 Tables 3-5 list values of water–vapor content from −40 to 250°F (−40° to 121°C) and from 14.7 to 5000 psia (101 to 34 475 kPa), covering the range of most natural gas processing applications.

6.3.3 A convenient graphical representation of the data in Tables 3-5 is illustrated in Fig. 2.[6] The moisture content values given can be corrected to base conditions other than 14.7 psia (101 kPa) and 60°F (15.5°C) by the same equations given in Table 2.

**7. Precision and Bias**

7.1 No precision data is available for this test method, however, the Committee is interested in conducting an inter-laboratory test program and encourages interested parties to contact the Staff Manager, Committee D03, ASTM Headquarters.

**8. Keywords**

8.1 gaseous fuels; natural gas

---

[4] *International Critical Tables*, Vol III, National Research Council, McGraw-Hill Book Co., Inc., New York, 1928, pp. 210–211.

[5] Bukacek, R. F., "Equilibrium Moisture Content of Natural Gases," *Research Bulletin 8*, Institute of Gas Technology, 1955. Reports work sponsored by the Pipeline Research Committee of the American Gas Association.

[6] Complete sets of these charts covering the entire range of pressures and temperatures of Tables 3-5 may be purchased from the Institute of Gas Technology, 1700 S. Mount Prospect Rd., Des Plaines, IL 60018.

**TABLE 1 Vapor Pressures and Specific Volumes of Saturated Water Vapor at Various Temperatures**[A]

| Temperature, °F | Vapor Pressure of Liquid Water | | Vapor Pressure of Ice | | Specific Volume of Saturated Water Vapor ft³/lb | Temperature, °F | Vapor Pressure of Liquid Water, psia | Specific Volume of Saturated Water Vapor, ft³/lb |
|---|---|---|---|---|---|---|---|---|
| | mm Hg | psia | mm Hg | psia | | | | |
| 0 | 1.139 | 0.022 02 | 0.958 | 0.018 52 | 14 810 | | | |
| 1 | 1.195 | 0.023 11 | 1.010 | 0.019 53 | 14 080 | 51 | 0.184 85 | 1 644.2 |
| 2 | 1.251 | 0.024 19 | 1.063 | 0.020 56 | 13 400 | 52 | 0.191 82 | 1 587.6 |
| 3 | 1.310 | 0.025 33 | 1.120 | 0.021 66 | 12 750 | 53 | 0.199 01 | 1 533.2 |
| 4 | 1.373 | 0.026 55 | 1.180 | 0.022 82 | 12 140 | 54 | 0.206 44 | 1 480.9 |
| 5 | 1.436 | 0.027 77 | 1.241 | 0.024 00 | 11 550 | 55 | 0.214 11 | 1 430.6 |
| 6 | 1.505 | 0.029 10 | 1.308 | 0.025 29 | 11 000 | 56 | 0.222 03 | 1 382.2 |
| 7 | 1.573 | 0.030 42 | 1.374 | 0.026 57 | 10 480 | 57 | 0.230 21 | 1 335.6 |
| 8 | 1.647 | 0.031 85 | 1.446 | 0.027 96 | 9 979 | 58 | 0.238 65 | 1 290.9 |
| 9 | 1.723 | 0.033 32 | 1.521 | 0.029 41 | 9 507 | 59 | 0.247 36 | 1 247.8 |
| 10 | 1.807 | 0.034 94 | 1.599 | 0.030 92 | 9 060 | 60 | 0.256 35 | 1 206.3 |
| 11 | 1.883 | 0.036 41 | 1.681 | 0.032 51 | 8 636 | 61 | 0.265 62 | 1 166.4 |
| 12 | 1.970 | 0.038 09 | 1.767 | 0.034 17 | 8 234 | 62 | 0.275 19 | 1 128.0 |
| 13 | 2.057 | 0.039 78 | 1.856 | 0.035 89 | 7 851 | 63 | 0.285 06 | 1 091.0 |
| 14 | 2.149 | 0.041 56 | 1.950 | 0.037 71 | 7 489 | 64 | 0.295 24 | 1 055.4 |
| 15 | 2.247 | 0.043 45 | 2.050 | 0.039 64 | 7 144 | 65 | 0.305 73 | 1 021.1 |
| 16 | 2.345 | 0.045 35 | 2.151 | 0.041 59 | 6 817 | 66 | 0.316 55 | 988.03 |
| 17 | 2.450 | 0.047 37 | 2.260 | 0.043 70 | 6 505 | 67 | 0.327 70 | 956.19 |
| 18 | 2.557 | 0.049 44 | 2.373 | 0.045 89 | 6 210 | 68 | 0.339 20 | 925.51 |
| 19 | 2.607 | 0.051 63 | 2.489 | 0.048 13 | 5 929 | 69 | 0.351 05 | 895.94 |
| 20 | 2.785 | 0.053 85 | 2.610 | 0.050 47 | 5 662 | 70 | 0.363 26 | 867.44 |
| 21 | 2.907 | 0.056 21 | 2.740 | 0.052 98 | 5 408 | 71 | 0.375 84 | 839.97 |
| 22 | 3.032 | 0.058 63 | 2.872 | 0.055 54 | 5 166 | 72 | 0.388 79 | 813.48 |
| 23 | 3.163 | 0.061 16 | 3.013 | 0.058 26 | 4 936 | 73 | 0.402 14 | 787.94 |
| 24 | 3.299 | 0.063 79 | 3.160 | 0.061 10 | 4 717 | 74 | 0.415 88 | 763.31 |
| 25 | 3.433 | 0.066 38 | 3.310 | 0.064 01 | 4 509 | 75 | 0.430 04 | 739.55 |
| 26 | 3.585 | 0.069 32 | 3.471 | 0.067 12 | 4 311 | 76 | 0.444 61 | 716.62 |
| 27 | 3.735 | 0.072 22 | 3.636 | 0.070 31 | 4 122 | 77 | 0.459 61 | 694.51 |
| 28 | 3.893 | 0.075 28 | 3.810 | 0.073 67 | 3 943 | 78 | 0.475 05 | 673.16 |
| 29 | 4.054 | 0.078 39 | 3.989 | 0.077 14 | 3 771 | 79 | 0.490 94 | 652.56 |
| 30 | 4.224 | 0.081 68 | 4.178 | 0.080 79 | 3 608 | 80 | 0.507 29 | 632.68 |
| 31 | 4.397 | 0.085 02 | 4.373 | 0.084 56 | 3 453 | 81 | 0.524 11 | 613.48 |
| 32 | 4.579 | 0.088 66 | 4.579 | 0.088 54 | 3 301.9 | 82 | 0.541 42 | 594.95 |
| 33 | ... | 0.092 30 | ... | ... | 3 178.0 | 83 | 0.559 22 | 577.05 |
| 34 | ... | 0.096 07 | ... | ... | 3 059.2 | 84 | 0.577 53 | 559.76 |
| 35 | ... | 0.099 98 | ... | ... | 2 945.5 | 85 | 0.596 36 | 543.07 |
| 36 | ... | 0.104 04 | ... | ... | 2 836.4 | 86 | 0.615 73 | 526.94 |
| 37 | ... | 0.108 23 | ... | ... | 2 731.9 | 87 | 0.635 63 | 511.35 |
| 38 | ... | 0.112 58 | ... | ... | 2 631.7 | 88 | 0.656 09 | 496.29 |
| 39 | ... | 0.117 08 | ... | ... | 2 535.7 | 89 | 0.677 13 | 481.73 |
| 40 | ... | 0.121 73 | ... | ... | 2 443.5 | 90 | 0.698 74 | 467.66 |
| 41 | ... | 0.126 55 | ... | ... | 2 355.1 | 91 | 0.720 95 | 454.06 |
| 42 | ... | 0.131 54 | ... | ... | 2 270.3 | 92 | 0.743 77 | 440.91 |
| 43 | ... | 0.136 70 | ... | ... | 2 188.9 | 93 | 0.767 22 | 428.19 |
| 44 | ... | 0.142 04 | ... | ... | 2 110.8 | 94 | 0.791 30 | 415.89 |
| 45 | ... | 0.147 56 | ... | ... | 2 035.8 | 95 | 0.816 04 | 403.99 |
| 46 | ... | 0.153 28 | ... | ... | 1 963.8 | 96 | 0.841 44 | 392.48 |
| 47 | ... | 0.159 18 | ... | ... | 1 894.6 | 97 | 0.867 53 | 381.35 |
| 48 | ... | 0.165 28 | ... | ... | 1 828.2 | 98 | 0.894 31 | 370.58 |
| 49 | ... | 0.171 59 | ... | ... | 1 764.4 | 99 | 0.921 80 | 360.15 |
| 50 | ... | 0.178 12 | ... | ... | 1 703.1 | 100 | 0.950 03 | 350.06 |

[A]The values for vapor pressure, from 0 to 32°F, were calculated from data in the International Critical Tables.[4] All other values were taken from Harr, Gallagher, and Kell, "NBS/NRC Steam Tables," National Standard Reference Data System, 1984, p. 9. Data on specific volumes of saturated water vapor from 0 to 32°F were obtained from Goff, J. A., and Gratch, S., " Low-Pressure Properties of Water from –160 to 212°F," *Heating, Piping, and Air Conditioning*, Vol 18, No. 2, Feb. 1946, pp. 125–136.

**TABLE 2 Values of Constants *A* and *B***
(Base Conditions = 14.7 psia, 60°F)

| Temperature, °F | A | B | Temperature, °F | A | B | Temperature, °F | A | B |
|---|---|---|---|---|---|---|---|---|
| −40 | 131 | 0.22 | 70 | 17 200 | 7.17 | 180 | 357 000 | 74.8 |
| −38 | 147 | 0.24 | 72 | 18 500 | 7.85 | 182 | 372 000 | 77.2 |
| −36 | 165 | 0.26 | 74 | 19 700 | 8.25 | 184 | 390 000 | 79.9 |
| −34 | 184 | 0.28 | 76 | 21 100 | 8.67 | 186 | 407 000 | 82.7 |
| −32 | 206 | 0.30 | 78 | 22 500 | 9.11 | 188 | 425 000 | 85.8 |
| −30 | 230 | 0.33 | 80 | 24 100 | 9.57 | 190 | 443 000 | 88.4 |
| −28 | 256 | 0.36 | 82 | 25 700 | 10.0 | 192 | 463 000 | 91.4 |
| −26 | 285 | 0.39 | 84 | 27 400 | 10.5 | 194 | 483 000 | 94.8 |
| −24 | 317 | 0.42 | 86 | 29 200 | 11.1 | 196 | 504 000 | 97.7 |
| −22 | 352 | 0.45 | 88 | 31 100 | 11.6 | 198 | 525 000 | 101 |
| −20 | 390 | 0.48 | 90 | 33 200 | 12.2 | 200 | 547 000 | 104 |
| −18 | 434 | 0.52 | 92 | 35 300 | 12.7 | 202 | 570 000 | 108 |
| −16 | 479 | 0.56 | 94 | 37 500 | 13.3 | 204 | 594 000 | 111 |
| −14 | 530 | 0.60 | 96 | 39 900 | 14.0 | 206 | 619 000 | 115 |
| −12 | 586 | 0.64 | 98 | 42 400 | 14.6 | 208 | 644 000 | 119 |
| −10 | 648 | 0.69 | 100 | 45 100 | 15.3 | 210 | 671 000 | 122 |
| −8 | 714 | 0.74 | 102 | 47 900 | 16.0 | 212 | 698 000 | 126 |
| −6 | 786 | 0.79 | 104 | 50 800 | 16.7 | 214 | 725 000 | 130 |
| −4 | 866 | 0.85 | 106 | 53 900 | 17.5 | 216 | 754 000 | 134 |
| −2 | 950 | 0.91 | 108 | 57 100 | 18.3 | 218 | 785 000 | 139 |
| 0 | 1 050 | 0.97 | 110 | 60 500 | 19.1 | 220 | 816 000 | 143 |
| 2 | 1 150 | 1.04 | 112 | 64 100 | 20.0 | 222 | 848 000 | 148 |
| 4 | 1 260 | 1.11 | 114 | 67 900 | 20.9 | 224 | 881 000 | 152 |
| 6 | 1 380 | 1.19 | 116 | 71 800 | 21.8 | 226 | 915 000 | 157 |
| 8 | 1 510 | 1.27 | 118 | 76 000 | 22.7 | 228 | 950 000 | 162 |
| 10 | 1 650 | 1.35 | 120 | 80 400 | 23.7 | 230 | 987 000 | 166 |
| 12 | 1 810 | 1.44 | 122 | 84 900 | 24.7 | 232 | 1 020 000 | 171 |
| 14 | 1 970 | 1.54 | 124 | 89 700 | 25.8 | 234 | 1 060 000 | 177 |
| 16 | 2 150 | 1.64 | 126 | 94 700 | 26.9 | 236 | 1 100 000 | 182 |
| 18 | 2 350 | 1.74 | 128 | 100 000 | 28.0 | 238 | 1 140 000 | 187 |
| 20 | 2 560 | 1.85 | 130 | 106 000 | 29.1 | 240 | 1 190 000 | 192 |
| 22 | 2 780 | 1.97 | 132 | 111 000 | 30.3 | 242 | 1 230 000 | 198 |
| 24 | 3 030 | 2.09 | 134 | 117 000 | 31.6 | 244 | 1 270 000 | 204 |
| 26 | 3 290 | 2.22 | 136 | 124 000 | 32.9 | 246 | 1 320 000 | 210 |
| 28 | 3 570 | 2.36 | 138 | 130 000 | 34.2 | 248 | 1 370 000 | 216 |
| 30 | 3 880 | 2.50 | 140 | 137 000 | 35.6 | 250 | 1 420 000 | 222 |
| 32 | 4 210 | 2.65 | 142 | 144 000 | 37.0 | 252 | 1 470 000 | 229 |
| 34 | 4 560 | 2.81 | 144 | 152 000 | 38.5 | 254 | 1 520 000 | 235 |
| 36 | 4 940 | 2.98 | 146 | 160 000 | 40.0 | 256 | 1 570 000 | 242 |
| 38 | 5 350 | 3.16 | 148 | 168 000 | 41.6 | 258 | 1 630 000 | 248 |
| 40 | 5 780 | 3.34 | 150 | 177 000 | 43.2 | 260 | 1 680 000 | 255 |
| 42 | 6 240 | 3.54 | 152 | 186 000 | 44.9 | 280 | 2 340 000 | 333 |
| 44 | 6 740 | 3.74 | 154 | 195 000 | 46.6 | 300 | 3 180 000 | 430 |
| 46 | 7 280 | 3.96 | 156 | 205 000 | 48.4 | 320 | 4 260 000 | 548 |
| 48 | 7 850 | 4.18 | 158 | 215 000 | 50.2 | 340 | 5 610 000 | 692 |
| 50 | 8 460 | 4.42 | 160 | 225 000 | 52.1 | 360 | 7 270 000 | 869 |
| 52 | 9 110 | 4.66 | 162 | 236 000 | 54.1 | 380 | 9 300 000 | 1090 |
| 54 | 9 800 | 4.92 | 164 | 248 000 | 56.1 | 400 | 11 700 000 | 1360 |
| 56 | 10 500 | 5.19 | 166 | 259 000 | 58.2 | 420 | 14 700 000 | 1700 |
| 58 | 11 300 | 5.48 | 168 | 272 000 | 60.3 | 440 | 18 100 000 | 2130 |
| 60 | 12 200 | 5.77 | 170 | 285 000 | 62.5 | 460 | 22 200 000 | |
| 62 | 13 100 | 6.08 | 172 | 298 000 | 64.8 | | | |
| 64 | 14 000 | 6.41 | 174 | 312 000 | 67.1 | | | |
| 66 | 15 000 | 6.74 | 176 | 326 000 | 69.5 | | | |
| 68 | 16 100 | 7.10 | 178 | 341 000 | 72.0 | | | |

NOTE 1—To correct *A* and *B* to other base conditions, multiply each by:

$$(P_b/14.7) \times [519.6/(t_b + 459.6)] \times (0.998/Z_b)$$

where:

$P_b$ = absolute base pressure, psia;
$t_b$ = base temperature, °F; and
$Z_b$ = compressibility factor under base conditions.