

What They Are...How to Use Them

The heat quantities and temperature/pressure relationships referred to in this section are taken from the Properties of Saturated Steam table.

Definitions of Terms Used

Saturated Steam is pure steam at the temperature that corresponds to the boiling temperature of water at the existing pressure.

Absolute and Gauge Pressures

Absolute pressure is pressure in pounds per square inch (psia) above a perfect vacuum. Gauge pressure is pressure in pounds per square inch above atmospheric pressure, which is 14.7 pounds per square inch absolute. Gauge pressure (psig) plus 14.7 equals absolute pressure. Or, absolute pressure minus 14.7 equals gauge pressure.

Pressure/Temperature Relationship

(Columns 1, 2 and 3). For every pressure of pure steam there is a corresponding temperature. Example: The temperature of 250 psig pure steam is always 406°F.

Heat of Saturated Liquid (Column 4).

This is the amount of heat required to raise the temperature of a pound of water from 32°F to the boiling point at the pressure and temperature shown. It is expressed in British thermal units (Btu).

Latent Heat or Heat of Vaporization

(Column 5). The amount of heat (expressed in Btu) required to change a pound of boiling water to a pound of steam. This same amount of heat is released when a pound of steam is condensed back into a pound of water. This heat quantity is different for every pressure/temperature combination, as shown in the steam table.

Total Heat of Steam (Column 6). The sum of the Heat of the Liquid (Column 4) and Latent Heat (Column 5) in Btu. It is the total heat in steam above 32°F.

Specific Volume of Liquid (Column 7).

The volume per unit of mass in cubic feet per pound.

Specific Volume of Steam (Column 8).

The volume per unit of mass in cubic feet per pound.

How the Table Is Used

In addition to determining pressure/

temperature relationships, you can compute the amount of steam that will be condensed by any heating unit of known Btu output. Conversely, the table can be used to determine Btu output if steam condensing rate is

known. In the application portion of this section, there are several references to the use of the steam table.

Table CG-1. Properties of Saturated Steam

(Abstracted from Keenan and Keyes, THERMODYNAMIC PROPERTIES OF STEAM, by permission of John Wiley & Sons, Inc.)

	Col. 1 Gauge Pressure	Col. 2 Absolute Pressure (psia)	Col. 3 Steam Temp. (°F)	Col. 4 Heat of Sat. Liquid (Btu/lb)	Col. 5 Latent Heat (Btu/lb)	Col. 6 Total Heat of Steam (Btu/lb)	Col. 7 Specific Volume of Sat. Liquid (cu ft/lb)	Col. 8 Specific Volume of Sat. Steam (cu ft/lb)
Inches of Vacuum	29.743	0.08854	32.00	0.00	1075.8	1075.8	0.016022	3306.00
	29.515	0.2	53.14	21.21	1063.8	1085.0	0.016027	1526.00
	27.886	1.0	101.74	69.70	1036.3	1106.0	0.016136	333.60
	19.742	5.0	162.24	130.13	1001.0	1131.0	0.016407	73.52
	9.562	10.0	193.21	161.17	982.1	1143.3	0.016590	38.42
	7.536	11.0	197.75	165.73	979.3	1145.0	0.016620	35.14
	5.490	12.0	201.96	169.96	976.6	1146.6	0.016647	32.40
	3.454	13.0	205.88	173.91	974.2	1148.1	0.016674	30.06
PSIG	1.418	14.0	209.56	177.61	971.9	1149.5	0.016699	28.04
	0.0	14.696	212.00	180.07	970.3	1150.4	0.016715	26.80
	1.3	16.0	216.32	184.42	967.6	1152.0	0.016746	24.75
	2.3	17.0	219.44	187.56	965.5	1153.1	0.016768	23.39
	5.3	20.0	227.96	196.16	960.1	1156.3	0.016830	20.09
	10.3	25.0	240.07	208.42	952.1	1160.6	0.016922	16.30
	15.3	30.0	250.33	218.82	945.3	1164.1	0.017004	13.75
	20.3	35.0	259.28	227.91	939.2	1167.1	0.017078	11.90
	25.3	40.0	267.25	236.03	933.7	1169.7	0.017146	10.50
	30.3	45.0	274.44	243.36	928.6	1172.0	0.017209	9.40
	40.3	55.0	287.07	256.30	919.6	1175.9	0.017325	7.79
	50.3	65.0	297.97	267.50	911.6	1179.1	0.017429	6.66
	60.3	75.0	307.60	277.43	904.5	1181.9	0.017524	5.82
	70.3	85.0	316.25	286.39	897.8	1184.2	0.017613	5.17
	80.3	95.0	324.12	294.56	891.7	1186.2	0.017696	4.65
	90.3	105.0	331.36	302.10	886.0	1188.1	0.017775	4.23
	100.0	114.7	337.90	308.80	880.0	1188.8	0.017850	3.88
	110.3	125.0	344.33	315.68	875.4	1191.1	0.017922	3.59
	120.3	135.0	350.21	321.85	870.6	1192.4	0.017991	3.33
	125.3	140.0	353.02	324.82	868.2	1193.0	0.018024	3.22
	130.3	145.0	355.76	327.70	865.8	1193.5	0.018057	3.11
	140.3	155.0	360.50	333.24	861.3	1194.6	0.018121	2.92
	150.3	165.0	365.99	338.53	857.1	1195.6	0.018183	2.75
	160.3	175.0	370.75	343.57	852.8	1196.5	0.018244	2.60
	180.3	195.0	379.67	353.10	844.9	1198.0	0.018360	2.34
	200.3	215.0	387.89	361.91	837.4	1199.3	0.018470	2.13
	225.3	240.0	397.37	372.12	828.5	1200.6	0.018602	1.92
	250.3	265.0	406.11	381.60	820.1	1201.7	0.018728	1.74
		300.0	417.33	393.84	809.0	1202.8	0.018896	1.54
		400.0	444.59	424.00	780.5	1204.5	0.019340	1.16
		450.0	456.28	437.20	767.4	1204.6	0.019547	1.03
		500.0	467.01	449.40	755.0	1204.4	0.019748	0.93
		600.0	486.21	471.60	731.6	1203.2	0.02013	0.77
		900.0	531.98	526.60	668.8	1195.4	0.02123	0.50
		1200.0	567.22	571.70	611.7	1183.4	0.02232	0.36
		1500.0	596.23	611.60	556.3	1167.9	0.02346	0.28
		1700.0	613.15	636.30	519.6	1155.9	0.02428	0.24
		2000.0	635.82	671.70	463.4	1135.1	0.02565	0.19
		2500.0	668.13	730.60	360.5	1091.1	0.02860	0.13
		2700.0	679.55	756.20	312.1	1068.3	0.03027	0.11
		3206.2	705.40	902.70	0.0	902.7	0.05053	0.05

Steam Tables

Flash Steam (Secondary)

What is flash steam? When hot condensate or boiler water, under pressure, is released to a lower pressure, part of it is re-evaporated, becoming what is known as flash steam.

Why is it important? This flash steam is important because it contains heat units that can be used for economical plant operation—and which are otherwise wasted.

How is it formed? When water is heated at atmospheric pressure, its temperature rises until it reaches 212°F, the highest temperature at which water can exist at this pressure. Additional heat does not raise the temperature, but converts the water to steam.

The heat absorbed by the water in raising its temperature to boiling point is called “sensible heat” or heat of saturated liquid. The heat required to convert water at boiling point to steam at the same temperature is called “latent heat.” The unit of heat in common use is the Btu, which is the amount of heat required to raise the temperature of one pound of water 1°F at atmospheric pressure.

If water is heated under pressure, however, the boiling point is higher than 212°F, so the sensible heat required is greater. The higher the pressure, the higher the boiling temperature and the higher the heat content. If pressure is reduced, a certain amount of sensible heat is released. This excess heat will be absorbed in the form of latent heat, causing part of the water to “flash” into steam.

Condensate at steam temperature and under 100 psig pressure has a heat content of 308.8 Btu per pound. (See Column 4 in Steam Table.) If this condensate is discharged to atmospheric pressure (0 psig), its heat content instantly drops to 180 Btu per pound. The surplus of 128.8 Btu re-evaporates or flashes a portion of the condensate. The percentage that will flash to steam can be computed using the formula:

$$\% \text{ flash steam} = \frac{SH - SL}{H} \times 100$$

SH = Sensible heat in the condensate at the higher pressure before discharge.

SL = Sensible heat in the condensate at the lower pressure to which discharge takes place.

H = Latent heat in the steam at the lower pressure to which the condensate has been discharged.

$$\% \text{ flash steam} = \frac{308.8 - 180}{970.3} \times 100 = 13.3\%$$

Chart CG-3 shows the amount of secondary steam that will be formed when discharging condensate to different pressures.

Chart CG-3.

Percentage of flash steam formed when discharging condensate to reduced pressure.

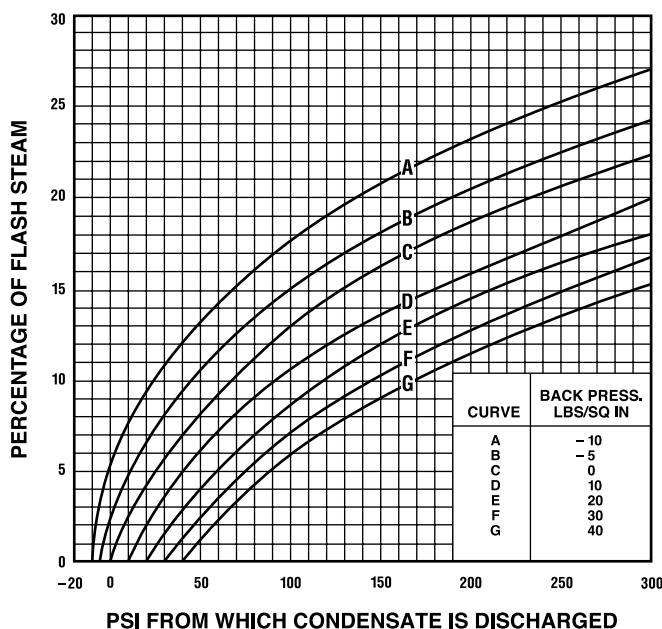


Chart CG-4.

Volume of flash steam formed when one cubic foot of condensate is discharged to atmospheric pressure.

