

Area..... A
 Change in specific volume during vaporization..... v_g
 Density, Weight per unit volume, Specific weight..... d or ρ (rho)

$$d = \frac{W}{V}$$

Distance, linear..... L
 Dry saturated vapor, Dry saturated gas at saturation pressure and temperature, vapor in contact with liquid..... S or s

Efficiency..... η

Elevation above some datum..... z

Emissivity..... ϵ

Energy in general; work, total; work, molar..... E

Entropy. (The capital should be used for any weight, and the small letter for unit weight)..... S or s

Force, total load..... F

Gas Constant, in equation $pV = nRT$ R

Head..... H or h

Heat content, Total heat, Enthalpy. (The capital should be used for any weight and the small letter for unit weight)..... H or h

Heat content of saturated liquid, Total heat of saturated liquid, Enthalpy of saturated liquid, sometimes called heat of the liquid..... h_f

Heat content of dry saturated vapor, Total heat of dry saturated vapor, Enthalpy of dry saturated vapor..... h_g

Heat of vaporization at constant pressure..... L or h_{fg}

Hydraulic radius..... R_H

Internal energy, Intrinsic energy. (The capital should be used for any weight and the small letter for unit weight)..... U or u

Length of path of heat flow, thickness..... L

Load, total..... W

Mechanical efficiency..... ϵ_m

Mechanical equivalent of heat..... J

Power, Horsepower, Work per unit time..... P

Pressure, Absolute pressure, Gage pressure, Force per unit area..... p

Quantity (total) of fluid, water, gas, heat; Quantity by volume; Total quantity of heat transferred..... Q

Quality of steam, Pounds of dry steam per pound of mixture..... x

Reynolds Number..... N_R

Saturated liquid at saturation pressure and temperature, Liquid in contact with vapor..... S or s

Specific heat..... c

Specific heat at constant pressure..... c_p

Specific heat at constant volume..... c_v

Specific volume, Volume per unit weight, Volume per unit mass..... v

Temperature (ordinary) F or C. (Theta is used preferably only when t is used for Time in the same discussion)..... t or θ (theta)

Temperature (absolute) F abs or K. (Capital theta is used preferably only when small theta is used for ordinary temperature)..... T or Θ (capital theta)

Thermal conductance: heat transferred per (unit time) (unit area) (degree)..... C

$$C = \frac{1}{R} = \frac{kA}{L} = \frac{q}{t_i - t_o}$$

Thermal conductance per unit area, Unit conductance: heat transferred per (unit time) (unit area) (degree)..... C_s

$$C_s = \frac{C}{A} = \frac{1}{R_s} = \frac{q}{A(t_i - t_o)} = \frac{k}{L}$$

* Terms ending only designate properties independent of size or shape, sometimes called specific properties. Examples: conductivity, resistivity. Terms ending also designate quantities depending not only on the material, but also upon size and shape, sometimes called total quantities. Examples: conductance, transmittance. Terms ending in t designate rate of heat transfer. Examples: conduction, transmission.

Thermal conductivity: heat transferred per (unit time) (unit area) (degree per unit length)..... k

$$k = \frac{q}{A(t_i - t_o) L}$$

Surface coefficient of heat transfer, Film coefficient of heat transfer, Individual coefficient of heat transfer: heat transferred per (unit time) (unit area) (degree)..... f

$$f = \frac{q}{A(t_i - t_o)}$$

(In general f is not equal to k/L , where L is the actual thickness of the fluid film.)

Overall coefficient of heat transfer, Thermal transmittance per unit area: heat transferred per (unit time) (unit area) (degree overall)..... U

$$U = \frac{q}{A(t_i - t_o)}$$

Thermal transmission (heat transferred per unit time)..... q

$$q = \frac{Q}{t}$$

Thermal resistance (degree per unit of heat transferred per unit time)..... R

$$R = \frac{t_i - t_o}{q} = \frac{L}{kA}$$

Thermal resistivity..... $1/k$

Vaporization values at constant pressure, Differences between values for saturated vapor and saturated liquid at the same pressure..... S or s

Velocity..... V

Viscosity, absolute..... μ

Viscosity, kinematic..... ν

Volume (total)..... V

Volume per unit time, Rate at which quantity of material passes through a machine, Quantity of heat per unit time, Quantity of heat per unit weight..... q

Weight of a major item, Total weight..... W

Weight rate, Weight per unit of power, Weight per unit time of..... w

Work (total)..... W

CONVERSION EQUATIONS*

Heat, Power and Work

1 ton refrigeration = { 12,000 Btu per hour
200 Btu per minute

Latent heat of ice = 143.4 Btu per pound

1 Btu = { 778.3 ft-lb
0.2930 Int. whr
252.0 I.T. calories

1 Int. watt-hour = { 2656 ft-lb
3.413 Btu
3600 Int. joules
860 I.T. calories

1 Int. kilowatt-hour = { 3.413 Btu
3.517 lb water evaporated from and at 212 F

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* Checked in 1944 by National Bureau of Standards. Abbreviations Int. and I.T. refer to International and International (Steam) Table, respectively.

Abbreviations, Symbols, Conversion Factors

1 Int. kilowatt (1000 watts) = { 1.341 hp
56.88 Btu per minute
44,267 ft-lb per minute

1000 I.T. calories
1 I.T. kilocalorie = { 3.968 Btu
3088 ft-lb
1.1628 Int. whr

1 horsepower = { 0.7455 Int. kw
42.40 Btu per minute
33,000 ft-lb per minute
550 ft-lb per second

1 boiler horsepower = { 33,475 Btu per hour
9.809 Int. kw

Weight and Volume

1 gal (U. S.) = { 231 cu in.
0.1337 cu ft

1 British or Imperial gallon = 277.42 cu in.

1 cu ft = { 7.481 gal
1728 cu in.

1 cu ft water at 60 F (in vacuo) = 62.37 lb

1 cu ft water at 212 F (in vacuo) = 59.53 lb

1 gal water at 60 F (in vacuo) = 8.338 lb

1 gal water at 212 F (in vacuo) = 7.998 lb

1 lb (avdp) = { 16 oz
7000 grains

1 bushel = 1.244 cu ft

1 short ton = 2000 lb

Pressure

1 lb per square inch = { 144 lb per square foot
2.0360 in. mercury at 32 F
2.0422 in. mercury at 62 F
2.309 ft water at 62 F
2.771 in. water at 62 F

1 oz per square inch = { 0.1276 in. mercury at 62 F
1.732 in. water at 62 F

1 atmosphere = { 14.696 lb per square inch
2116 lb per square foot
33.94 ft water at 62 F
30.01 in. mercury at 62 F
29.921 in. mercury at 32 F

1 in. water at 62 F (in vacuo) = { 0.03609 lb per square inch
5.774 oz per square inch
5.197 lb per square foot

1 ft water at 62 F (in vacuo) = { 0.4330 lb per square inch
62.37 lb per square foot

1 in. mercury at 62 F (in vacuo) = { 0.4897 lb per square inch
7.835 oz per square inch
1.131 ft water at 62 F
13.57 in. water at 62 F

1 in. mercury at 32 F (in vacuo) = 0.49115 lb per square inch

Metric Units

1 cm = 0.3937 in. = 0.0328 ft

1 in. = 2.540 cm

1 m = 3.281 ft

1 ft = 0.3048 m

1 sq cm = 0.1550 sq in.

1 sq in. = 6.452 sq cm

1 sq m = 10.76 sq ft

1 sq ft = 0.09290 sq m

1 cu cm = 0.06102 cu in.

1 cu in. = 16.39 cu cm

1 cu m = 35.31 cu ft

1 cu ft = 0.02832 cu m

1 liter = 1000 cu cm = 0.2642 gal

1 kg = 2.205 lb (avdp)

1 lb = 0.4536 kg

1 metric ton = 2205 lb (avdp)

1 gram = 0.002205 lb (avdp)

1 kilometer per hour = 0.6214 mph

1 gram per square centimeter = { 0.02905 in. mercury at 62 F
0.3942 in. water at 62 F

1 kg per sq cm (metric atmosphere) = 14.22 lb per square inch

1 gram per cubic centimeter = { 0.03613 lb per cubic inch
62.43 lb per cubic foot

1 dyne = 0.00007233 pounds

1 absolute joule = { 10,000,000 ergs
0.7376 ft-lb

1 Int. joule = 0.7378 ft-lb

1 metric horsepower = { 75 kg-m per second
0.986 hp (U. S.)

1 I.T. kilocalorie per kilogram = 1.8 Btu per pound

1 I.T. calorie per square centimeter = 3.687 Btu per square foot

1 I.T. calorie per (second) (square centimeter) for a temperature gradient of 1 C deg per centimeter = { 2903 Btu per (hour) (square foot) for a temperature gradient of 1 F deg per inch of thickness.

GRAPHICAL SYMBOLS FOR DRAWINGS*

Piping

Heating

1. High-Pressure Steam

2. Medium-Pressure Steam

3. Low-Pressure Steam

4. High-Pressure Return

5. Medium-Pressure Return

6. Low-Pressure Return

7. Boiler Blow Off

8. Condensate or Vacuum Pump Discharge

9. Feedwater Pump Discharge

10. Make-Up Water

11. Air Relief Line

12. Fuel Oil Flow

13. Fuel Oil Return

14. Fuel Oil Tank Vent

15. Compressed Air

16. Hot Water Heating Supply

17. Hot Water Heating Return

Air Conditioning

18. Refrigerant Discharge

19. Refrigerant Suction

20. Condenser Water Flow

21. Condenser Water Return

22. Circulating Chilled or Hot Water Flow

* Extracted from: American Standard Graphical Symbols for Pipe Fittings, Valves, and Piping (ASA Z39.3-1949) and American Standard Graphical Symbols for Heating, Ventilating, and Air Conditioning (ASA Z39.3.4-1949) with the permission of the publisher, The American Society of Mechanical Engineers, 22 West 57th St., New York 18, N. Y.