

COMMON CONVERSION FACTORS USEFUL IN MECHANICAL POWER TRANSMISSION

Symbols and Abbreviations Used in Conversion Factors

Symbols and abbreviations found in this section are those currently used in many texts and product publications. Considerable effort is underway to standardize on abbreviations for metric and English units of measurement. Recently, ASTM (American Society for Testing and Materials) and IEEE (Institute of Electrical and Electronic Engineers) published a standard practice on the metric system. This publication consolidates a great deal of the current thinking and provides a system of abbreviations and symbols that differ somewhat from those used here.

This Handbook has retained use of familiar abbreviations consistent with existing product and trade literature rather than the abbreviations found in current publications of technical and scientific societies.

Prefixes Used in the Metric System

Common prefixes and symbols used in the metric system are listed below. An example of use is 1000 meters is equivalent to 1 kilometer, and 1/1000 of one meter is equivalent to 1 millimeter.

| Prefix | Symbol | Multiplication Factor-Decimal and Power of 10 |
|---------|--------|---|
| giga | G | 1,000,000,000 or 10^9 or one billion |
| mega | M | 1,000,000 or 10^6 or one million |
| kilo | k | 1,000 or 10^3 or one thousand |
| *hecto | h | 100 or 10^2 or one hundred |
| *deka | da | 10 or 10^1 or ten |
| **deci | d | 0.1 or 10^{-1} or one tenth |
| **centi | c | 0.01 or 10^{-2} or one hundredth |
| mill | m | 0.001 or 10^{-3} or one thousandth |
| micro | μ | 0.000,001 or 10^{-6} or one millionth |
| nano | n | 0.000,000,001 or 10^{-9} or one billionth |

* Not commonly used.

** Not commonly used except for special situations.

The centimeter as a unit of length is in common use.

The decibel is a unit in both electrical and acoustical work.

| Symbol or Abbreviation | Term |
|-------------------------|-------------------------------|
| atm | atmosphere |
| avdp | avoidupois |
| bbl | barrels |
| bu | bushels |
| C | degrees Centigrade or Celsius |
| cc | cubic centimeters |
| cfm | cubic feet per minute |
| cfs | cubic feet per second |
| cm | centimeter |
| cu | cubic |
| deg | degrees |
| F | degrees Fahrenheit |
| fps | feet per second |
| ft | feet |
| ft-lb | foot-pounds (work or energy) |
| ft per sec | feet per second (alternate) |
| ft per sec ² | feet per second per second |
| g | acceleration due to gravity |
| g | grams |
| gal | gallons |
| gpm | gallons per minute |
| hp | horsepower |
| hr | hour |
| in | inches |
| in-lb | inch-pounds (work or energy) |
| K | degrees Kelvin |
| kg | kilograms |
| km | kilometers |
| kn | knots |
| kW | kilowatts |

| Symbol or Abbreviation | Term |
|------------------------|---|
| l | liters |
| lb | pounds |
| lb-ft | pound-feet (torque) |
| m | meters |
| m per sec ² | meters per second per second |
| mi | miles |
| mm | millimeters |
| mph | miles per hour |
| MGD | millions of gallons per day |
| N | Newtons |
| oz | ounces |
| oz-in | ounce-inches (torque) |
| Pa | Pascals |
| psi | pounds per square inch |
| psia or psig | pounds per square inch "absolute" or gauge |
| pt | pint |
| qt | quart |
| R | degrees Rankine (Fahrenheit, absolute) |
| rad | radians |
| rev | revolutions |
| rpm | revolutions per minute |
| sec | seconds |
| sq | square |
| std | standard |
| temp | temperature |
| wt | weight |
| yd | yard |
| yr | year |

Rounding of Numbers

A minimum of four significant figures are used in conversion factors presented here. Where the conversion factor is exact (for example, 1 foot contains 12 inches), decimal fractions are not necessary. Also, where large whole numbers are used (for example, 1 square kilometer contains 1195990 square yards), decimal fractions are not used unless justified by the accuracy of ordinary computations.

| | |
|---------|--------------------------|
| 1195990 | (sq yd in a sq km) |
| 4389.12 | (cc in a cu ft) |
| 448.86 | (gpm in a liter per sec) |
| 14.70 | (psi in an atmosphere) |
| 0.4331 | (psi in a ft of water) |
| 0.0625 | (lb-in in an oz-in) |

VELOCITY

| | | |
|-------------------------------------|-------------------------------------|--------|
| centimeters per second (cm per sec) | feet per second (fps or ft per sec) | 0.3281 |
| feet per second (fps) | centimeters per second (cm per sec) | 30.48 |
| | meters per second (m per sec) | 0.3048 |
| | kilometers per hour (km per hr) | 1.097 |
| | miles per hour (mph) | 0.6818 |
| kilometers per hour (km per hr) | knots (kn) | 0.5396 |
| | feet per second (fps) | 1.467 |
| | kilometers per hour (km per hr) | 1.609 |
| | feet per minute (ft per min.) | 88 |
| knots (kn) | miles per hour (mph) | 1.152 |
| | kilometers per hour (km per hr) | 1.853 |
| radians per second (rad per sec) | revolutions per minute (rpm) | 9.55 |
| | degrees per minute (deg per min.) | 3437.7 |
| revolutions per minute (rpm) | radians per second (rad per sec) | 0.1047 |
| | degrees per minute (deg per min.) | 360 |

ACCELERATION

COLUMN A

| To Convert From... | To... | Multiply Col. A by |
|---|---|-----------------------|
| feet per second per second (ft per sec ²) | meters per second per second (m per sec ²) | 0.3048 |
| m per sec ² | ft per sec ² | 3.281 |
| revolutions per minute per second (rpm per sec) | radians per second per second (rad per sec ²) | 0.1047 |
| rad per sec ² | rpm per sec | 9.55 |

VOLUMETRIC FLOW RATES

| | | |
|--|------------------------------------|----------|
| gallons per minute, US (gpm) | liters per second (l per sec) | 0.008434 |
| | cubic feet per minute (cfm) | 0.1337 |
| | cubic feet per hour (cu ft per hr) | 8.022 |
| gallons per minute, UK or Canadian (gpm) | liters per second (l per sec) | 0.0101 |
| | cubic feet per minute (cfm) | 0.1606 |
| | cubic feet per hour (cu ft per hr) | 9.634 |
| cubic feet per second (cfs) | gpm (UK or Canadian) | 373.77 |
| | gpm (US) | 448.86 |
| | liters per second (l per sec) | 1699.2 |
| liters per second (l per sec) | cubic feet per minute (cfm) | 2.119 |
| | gpm (UK or Canadian) | 13.20 |
| | gpm (US) | 15.85 |
| millions of gallons per day, US (MGD) | liters per second (l per sec) | 43.81 |
| | cubic feet per minute (cfm) | 92.85 |
| | gallons per minute, US (gpm) | 694.44 |

PRESSURE

| | | |
|---|--|-----------|
| pascals (Pa) | pounds per square inch (psi) | 0.0001450 |
| | pounds per square foot (lb per ft ²) | 0.02089 |
| | newtons per square meter | 1 |
| pounds per square inch (psi) | atmospheres, std. (atm) | 0.0680 |
| | pounds per square foot (lb per ft ²) | 144 |
| | pascals (Pa) | 6894.8 |
| | foot of water (ft of H ₂ O) 60F | 2.301 |
| atmospheres (atm), standard | psi | 14.70 |
| | lb per ft ² | 2116.8 |
| | Pa | 101325 |
| inch of water, 60F (in of H ₂ O) | psi | 0.03609 |
| | lb per ft ² | 5.197 |
| | Pa | 248.84 |
| foot of water, 60F (ft of H ₂ O) | psi | 0.4331 |
| | lb per ft ² | 62.36 |
| | Pa | 2985.9 |

WEIGHT, MASS, INERTIA

| | | |
|----------------|----------------|--------|
| pounds (lb)* | kilograms (kg) | 0.4536 |
| | ounces (oz) | 16 |
| kilograms (kg) | pounds (lb) | 2.205 |
| | ounces (oz) | 35.27 |

WEIGHT, MASS, INERTIA, continued

COLUMN A

| Convert From... | To | Multiply To Col. A by |
|---|---|-----------------------|
| tons (short) | metric tons | 0.9072 |
| | kilograms (kg) | 907.2 |
| | pounds (lb) | 2000 |
| metric tons | tons (short) | 1.102 |
| | kilograms | 1000 |
| | pounds | 2205 |
| pounds, weight (lb) | slugs, mass (lb-sec ² per ft) | 0.03106 |
| pound-foot ² (lb-ft ²) | kilogram-meters ² (kg-m ²) | 0.04214 |

*pounds and ounces are avoirdupois

FORCE AND TORQUE

| | | |
|----------------------------|----------------------------|----------|
| pounds (lb) | newtons(N) | 4.448 |
| newtons (N) | pounds (lb) | 0.2248 |
| newton-meters (N-m) | pound-feet (lb-ft) | 0.7376 |
| | pound-inches (lb-in) | 8.851 |
| | ounce-inches (oz-in) | 141.60 |
| ounce-inches (oz-in) | lb-ft | 0.005208 |
| | N-m | 0.007062 |
| | lb-in | 0.0625 |
| pound-inches (lb-in) | lb-ft | 0.0833 |
| | N-m | 0.1298 |
| | oz-in | 16 |
| pound-feet (lb-ft) | N-m | 1.356 |
| | lb-in | 12 |
| | oz-in | 192 |

POWER

| | | |
|-----------------------|---|--------|
| horsepower (hp) | kilowatts (kW) | 0.7457 |
| | foot-pounds per second (ft-lb per sec) | 550 |
| | foot-pounds per minute (ft-lb per min.) | 33000 |
| kilowatts (kW) | horsepower (hp) | 1.341 |

TEMPERATURE

| | | Use This Relationship |
|------------------------------|------------------------------|-----------------------|
| degrees Fahrenheit (F) | degrees Celsius (C) | C = 5/9 (F-32) |
| degrees Celsius (C) | degrees Fahrenheit (F) | F = 9/5C + 32 |
| degrees Fahrenheit (F) | degrees Rankine (R) | R = F + 459.69 |
| degrees Celsius (C) | degrees Kelvin (K) | K = C + 273.16 |

Examples:

- Convert 12F to C. $C = 5/9 (F-32) = 5/9 (12-32) = 5/9 (-20)$
Answer = -11.1C
- Convert 40C to F. $F = 9/5C + 32 = 9/5 (40) + 32 = 72 + 32$
Answer = 104F

GRAVITATIONAL CONSTANT

g = 32.174 feet per second per second (ft per sec²)
= 9.8067 meters per second per second (m per sec²)

APPROXIMATE DENSITIES OF COMMON MATERIALS

REPRESENTATIVE DENSITIES

Grams per cc lb per cu ft

GASES @ 68F, std atm

| | | |
|----------|----------------------|----------|
| Air | 1.30 grams per liter | 0.07528 |
| Oxygen | 1.45 grams per liter | 0.08305 |
| Hydrogen | 0.09 grams per liter | 0.005234 |
| Nitrogen | 1.25 grams per liter | 0.07274 |

All Other Materials
grams per cc

LIQUIDS

| | | |
|--------------------|--------------------|-------|
| Water @ 4C | 1.000 grams per cc | 62.43 |
| 20C | 0.998 | 62.32 |
| 40C | 0.992 | 61.94 |
| SeaWater | 1.02-1.03 | 64.00 |
| Ethyl alcohol 100% | 0.789 | 49.2 |
| Kerosene | 0.78-0.82 | 50 |
| Gasoline | 0.70-0.75 | 45 |

METALS

| | | |
|-------------------------|-------|------|
| Aluminum (95% Al) | 2.70 | 169 |
| Bronze (90% Cu, 10% Zn) | 8.80 | 549 |
| Copper (Annealed, ACS) | 8.89 | 555 |
| Gold | 19.32 | 1206 |
| Iron, gray cast | 7.10 | 443 |
| Lead | 11.36 | 709 |
| Magnesium | 1.74 | 109 |
| Steel (0.4-0.5% Carbon) | 7.80 | 487 |
| Steel, 410 stainless | 7.70 | 480 |

ENGINEERING PLASTICS

| | | |
|---|-------------|----|
| ABS, general purpose | 1.01-1.05 | 64 |
| Acrylics, cast sheet | 1.19 | 74 |
| Nylon 6/6 | 1.13-1.15 | 71 |
| Phenolic, general purpose | 1.35-1.46 | 87 |
| Polycarbonates, general purpose | 1.2 | 75 |
| Polyesters, thermoplastic, unreinforced | 1.31 - 1.43 | 86 |
| Polyethylene, medium density | 0.926-0.940 | 58 |
| Polyvinyl Chloride | 1.30-1.58 | 89 |

APPROXIMATE DENSITIES OF COMMON MATERIALS

| OTHER MATERIALS | REPRESENTATIVE DENSITIES | |
|--------------------------------------|--------------------------|--------------|
| | Grams per cc | lb per cu ft |
| Concrete (stone and sand) | 2.2-2.4 | 144 |
| Limestone | 1.5 | 94 |
| Anthracite coal, not piled. | 1.4-1.8 | 100 |
| Bituminous coal, not piled | 1.2-1.5 | 83 |
| Lignite coal, not piled | 1.1-1.4 | 78 |
| Wood, air dried: | | |
| Douglas fir | 0.48-0.55 | 32 |
| White oak | 0.77 | 48 |
| White maple | 0.53 | 33 |
| Oregon pine | 0.51 | 32 |
| Hickory | 0.74-0.80 | 48 |
| Mahogany | 0.56-0.85 | 44 |
| African teak. | 0.99 | 62 |
| Indian teak | 0.66-0.88 | 48 |

Formulas and Constants

1 HP = 33,000 Foot-pounds of work per minute.

1 HP = .746 K.W. = K.W.P 1.341.

1 HP = 2547 B.T.U. per hour.

1 B.T.U. = Heat required to raise 1 lb. water 1°F.

1 B.T.U. = 777.6 Foot-pounds work.

1 Kilowatt Hour = 3415 B.T.U.

Heat Value of Carbon = 14,600 B.T.U. per pound.

Latent Heat of Fusion of Ice = 143.15 B.T.U. per pound.

Latent Heat of Evaporation of Water at 212°F. =
970.4 B.T.U. per pound.

Total Heat of Saturated Steam at atmospheric pressure =
1,150.4 B.T.U. per pound.

1 Ton of Refrigeration = 288,000 B.T.U. per 24 hours.

g = Acceleration of Gravity (commonly taken as 32.16
feet per second per second).

1 Radian = 57.296 degrees.

1 Meter = 100 cm. = 39.37 inches.

1 Kilometer = .62137 miles.

1 Gallon = 231 cubic inches.

1 Barrel = 31.5 gallons.

Atmospheric Pressure = 14.7 pounds per sq. in. = 29.92
inches mercury at 32°F.

1 Lb. per Sq. In. Pressure = 2.3095 feet fresh water at
62°F. = 2.0355 inches mercury at 32°F. = 2.0416
inches mercury at 62°F.

Water Pressure (pounds per sq. in.) = .433 X height of
water in feet (Fresh water at 62°F.).

Weight of 1 cu. ft. fresh Water = 62.355 lbs. at 62°F. =
59.76 lbs. at 212°F.

Weight of 1 cu. ft. Air at 14.7 lbs. per sq. in. Pressure =
.07608 lbs. at 62°F. = .08073 lbs. at 32°F.

† Also look in the General Index under Weights,
Measures, or the subject material required.