CYLINDER FORMULAS

Thrust or force of any cylinder:

F = A x P
P = F ÷ A
A = F ÷ P

F = Force or thrust, in pounds
A = Piston area in square inches (.7854 x D^2)
P = PSI (Gauge pressure in pounds per square inch)

HP = Pounds of push (or pull) x Distance (in feet) / 550 x Time (in seconds)

HP = Horsepower

Circle Formula:

A = D x D x .7854
$A = D^2 \times 0.7854$
$A = \pi \times R^2$
$A = \pi \times D^2 \div 4$

Circumference = 2 x R x π
Circumference = π x D

$D = \sqrt{A/.7854}$

A = Area in^2 (Area sq. in.)
R = Radius (1/2 of Diameter)
D = Diameter, inches
π = 3.14

Hydraulic Cylinder Piston travel speed:

V1 (in/min) = CIM ÷ A
V2 (ft/min) = Q x 19.25 ÷ A
V3 (ft/sec) = Q x 0.3208 ÷ A
Q (GPM) = 3.117 x V3 (ft/sec) x A
Q (GPM) = CIM ÷ 231

V1 = Velocity or piston travel speed, inches per minute
V2 = Velocity or piston travel speed, feet per minute
V3 = Velocity or piston travel speed, feet per second
CIM = Flow rate in cubic inches per minute (in^3)
A = Effective area in square inches (in^2)
Q = GPM Gallons per minute
1 Gallon = 231 in^3 (cubic inch)

Volume required to move a piston a given distance:

V = A x L

V = Volume in cubic inches (in^3)
A = Area in square inches (in^2)
L = Length or stroke in inches

Regenerative Cylinder
Extend Speed = Rod Volume ÷ Flow Rate in^3

Area to Retract = Area to extend - Rod Area

Cylinder Ratio = Area to extend ÷ Area to retract

Note:
Ratio can be used to calculate pressure intensification and flow intensification.

Effective force of a cylinder working at an angle to direction of the load travel:

F = T x sin A

T = Total cylinder force, in pounds
F = Part of the force which is effective, in pounds
A = Least angle, in degrees, between cylinder axis and load direction.

Moment Arm Equations / Levers:

F x Df = W x Dw
$F = W \times Dw \div Df^w$
W = F x Df ÷ Dw
Df = W ÷ F x Dw
Dw = F ÷ W x Df

F = Cylinder force
Df = Cylinder force distance to pivot
W = Weight or Load Force
Dw = Weight or Load Force distance to pivot

Toggle Force:

T = F x A ÷ 2 x B

T = Toggle Force
F = Cylinder Force
A = Distance cylinder centerline to toggle
B = Remaining stroke

Force for piercing or shearing sheet metal:

F = P x T x PSI

F = Force required, in pounds
P = Perimeter around area to be sheared, in inches
T = Sheet thickness in inches
PSI = Sheer strength rating of the material in pounds per square inch.

P.O. Check Application:

Release PSI = Cap End Area x Max. W.P. - Load / Rod End Area

Max. W.P. = Pressure Rating of Components

Ratio = Max Working PSI / Release PSI

Example;
2 to 1 Ratio = 1 square inch (in^2) at 1000 psi working pressure will open when a Release pressure of 500 psi is applied to a 2 square inches (in^2) area.

HYDRAULIC PUMP EQUATIONS

Horsepower Required to Drive Hydraulic Pump:

HP = PSI x GPM ÷ 1714
HP = (PSI x GPM) ÷ (1714 x EFFICIENCY)

HP = Horsepower
PSI = Gauge pressure in pounds per square inch
GPM = Oil flow in gallons per minute
EFFICIENCY = Efficiency of hydraulic pump

Important:
As all systems are less than 10% efficient and efficiency factor must be added to the calculated input horsepower.

Example:
Input hp = 10 gpm x 1500 psi ÷ 1714 (constant) = 8.75 hp x 0.85 (efficiency) = required input 10 hp

Rule of thumb:
For every 1 HP of drive, the equivalent of 1 GPM @ 1500 PSI can be produced.

Rule of thumb:
To idle a pump when it is unloaded will require about 5% of its full rated horsepower.

Note:
1 hp = 33,000 ft lbs per min or 33,000 lbs raised 1 ft in 1 min

1 hp = 550 ft. lbs. per second

1 hp = 746 Watts or 0.746 kw

1 hp = 42.4 Btu per min

1 hp = 2545 Btu per hour

BTU = The energy to raise one pound of water one degree Fahrenheit.

Flow Formulas:

GPM (theoretical) = RPM x CIR ÷ 231

GPM = Oil flow in gallons per minute
CIR = Cubic Inch (in^3) per Revolution
RPM = Pump revolutions per minute

$$\text{Volume required (gpm)} = \frac{\text{Volume Displaced x 60}}{\text{Time (s) x 231}}$$

$$\text{Flow rate (gpm)} = \frac{\text{Velocity (ft/s) x Area } (in^2)}{0.3208}$$

Note:
Fluid is pushed or drawn into a pump
Pumps do not pump pressure, their purpose is to create flow. (Pressure is a result of resistance to flow).

Torque and horsepower relations:

T = HP x 63025 ÷ RPM
HP = T x RPM ÷ 63025
RPM = HP x 63025 ÷ T

T = Torque, inch-lbs
RPM = Speed, revs / minute
HP = Horsepower

Note:
For Torque in foot-lbs use 5252 in place of 63025

Note:
Work (in lbs) = force (lbs) x distance (in)

Power = Force x Distance ÷ Time

Theoretical Pressure = T x 6.28 ÷ CIR

T = Torque, inch-lbs
CIR = Cubic Inch (in^3) per Revolution

Pump Efficiencies:

$$\textbf{Volumetric Efficiency} = \frac{\textbf{Actual GPM x 100}}{\textbf{Theoretical Flow}}$$

$$\textbf{Mechanical Efficiency} = \frac{\textbf{Actual PSI x 100}}{\textbf{Theoretical Pressure}}$$

$$\textbf{Overall Efficiency} = \frac{\textbf{Output HP x 100}}{\textbf{Input HP}}$$

Overall Efficiency = Mech. Eff. x Volumetric Eff.

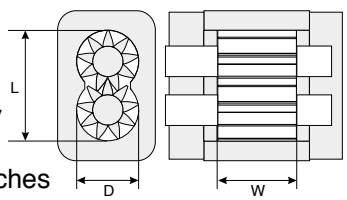
Theoretical Flow = RPM x CIR ÷ 231
Theoretical Pressure = T x 6.28 ÷ CIR
Input HP = PSI x GPM ÷ 1714
Output HP = T x RPM ÷ 63025

T = Torque, inch-lbs
CIR = Cubic Inch (in^3) per Revolution
GPM = Flow in gallons per minute
PSI = Gauge pressure in pounds per square inch
RPM = Pump revolutions per minute

Gear Displacement Calculation:

The volumetric displacement of a gear pump or motor can be approximated by measurement of the internal parts and substituting the values in the following formula:

V = 6.03 × W × (2 x D -L) × (L - D ÷ 2)



Where
V = displacement in in^3/rev
W = gear width in inches
D = gear tip diameter in inches
L = dimension across both gears when meshed in inches

HYDRAULIC MOTOR EQUATIONS

Note: Hydraulic motors are typically classified as high speed motors (500 - 10,000 rpm) or low speed motors (0 - 1,000) rpm.

Relationship between displacement and torque of a hydraulic motor:

T = HP x 63025 ÷ RPM
HP = T x RPM ÷ 63205
RPM = HP x 63025 ÷ T

Note:
For Torque in foot-lbs use 5252 in place of 63025

T = CIR x PSI ÷ 6.28
CIR = T ÷ PSI x 6.28
PSI = T x 6.28 ÷ CIR

T = (GPM x PSI x 36.77) ÷ 6.28
GPM = (T ÷ PSI ÷ 36.77) x 6.28
PSI = (T ÷ GPM ÷ 36.77) x 6.28

Note:
Divide PSI by Mechanical Efficiency if required.
For Torque in foot-lbs use 75.36 in place of 6.28

T = Torque, inch-lbs
CIR = Cubic Inch (in^3) per Revolution
GPM = Flow in gallons per minute
PSI = Pressure difference across motor
RPM = Pump revolutions per minute
HP = Horsepower

Torque General Info:

Torque = Radius x Load

Torque (in lbs) = Lever Length (in.) x Pull (lbs.)

Radius = 1/2 of Diameter

Circumference = 3.14 x Diameter

Foot Pound = Inch Pound ÷ 12

Inch Pound = Foot Pound x 12

Motor Speed:

GPM = RPM x CID ÷ 231
RPM = GPM x 231 ÷ CID
CID = GPM ÷ RPM x 231

Speed = (336 x MPH) ÷ Wheel Diameter (in.)

Side load on pump or motor shaft:

F = (HP x 63024) ÷ (RPM x R)

F = Side load, in pounds, against shaft
R = Pitch radius of sheave on pump shaft, in inches;
HP = Driving power applied to shaft.

Motor Efficiencies:

Volumetric Efficiency = Actual Speed x 100 / Theoretical Speed

Mechanical Efficiency = Actual Torque x 100 / Theoretical Torque

Overall Efficiency = Output HP x 100 / Input HP

Overall Efficiency = Mech. Eff. x Volumetric Eff.

Theoretical Speed = GPM x 231 ÷ CIR
Theoretical Torque (in lbs) = CIR x PSI ÷ 6.28
Input HP = PSI x GPM ÷ 1714
Output HP = T x RPM ÷ 63025

T = Torque, inch-lbs
CIR = Cubic Inch (in^3) per Revolution
GPM = Flow in gallons per minute
PSI = Pressure difference across motor
RPM = Pump revolutions per minute

Note:
For Torque in foot-lbs use 5252 in place of 63025

Draw Bar Pull, Moving a load up an incline:

F = L x sin

F = Force
W = Weight or load
sin = Sin of incline or angle

Rule of thumb:
Grades less than or equal to 10^0 use the degree of the angle. Grades greater than 10^0 use sin.

Grade (% of Slope) = Rise ÷ Run

Draw Bar Pull, Friction:

F = W x M

F = Force
W = Weight or load
M = Coefficient of friction

Draw Bar Pull, Moving a load up an incline with friction:

F to move load = (W x sin) + (W x cos x M)
F to hold load = (W x sin) - (W x cos x M)

F = Force
W = Weight or load
M = Coefficient of friction
sin = Sin of incline or angle
cos = Cosine of incline or angle

Velocity of oil flow in pipe:

V = GPM x 0.3208 ÷ A
A = GPM x 0.3208 ÷ V
GPM = A x V ÷ 0.3208

V = Oil velocity in feet per second
GPM = Flow in gallons per minute
A = Inside area of pipe in square inches.

Rule of thumb:
Pump suction lines 2 to 4 feet/second
Pressure lines up to 500 PSI - 10 to 15 fps
Pressure lines 500 to 3000 PSI - 15 to 20 fps
Pressure lines over 3000 PSI - 25 fps
All oil lines in air-over-oil system - 4 fps
fps = feet per second

Barlow formula (hoop stress):

P = 2 x t x S ÷ D

P = Working pressure in PSI with a 4:1 Design Factor
t = Wall thickness, in inches
S = Allowable stress (12,500 with a 4:1 Design Factor)
D = Outside diameter, in inches.
$D = \sqrt{A/.7854}$

Atmosphere:

Atmospheric pressure is 14.7 psi at sea level
One Bar is equal to 14.5 psi (Atmos. - 1.01 Bar)
The pressure created by one fooot of water is .433 psi

Atmospheric Ratio = 14.7 ÷ PSI = 33.9 ÷ (X)

Atmospheric will lift water 33.9 feet
1 inch Hg = .491 psi
14.7 psi = 29.92 hg
Y inch Hg Absolute = (29.92 - Y) x .491 = PSI
PSI = lbs ÷ in^2
Hg = Inches of mercury

Filtration:

1 Micron = .000039"
149 Micron = 100 Mesh
74 Micron = 200 Mesh
44 Micron = 325 Mesh
Beta 75 = 98.7%
Beta 100 = 99%
Beta 200 = 99.5%Gas

Beta Ratio = Upstream Count ÷ Downstream Count

Efficiency Percent (%) = 1 - (1 ÷ Beta Ratio) x 100

Gas Formulas:

PSIG (PSI Gage) = PSIA - 14.7
PSIA (PSI Absolute) = PSIG + 14.7

Isothermal

P_1 x V_1 = P_2 x V_2

P_1 = Pre-charge Pressure + 14.7
V_1 = Intial Gas Volume
P_2 = System Pressure + 14,7
V_2 = Compressed Gas Volume

P_1, V_1 are initial pressure and volume; P_2 and V_2 are final conditions.

Note:
Isothermal operatiion occurs when compression or expansion is slow enough to allow transfer of heat out of or into the accumulator.

Adiabatic

P_1 x V_1 x T_2 = P_2 x V_2 x **T_1**
P_1 x V_1 ÷ T_1 = P_2 x V_2 ÷ T_2

P_1 = Pre-charge Pressure + 14.7
V_1 = Intial Gas Volume
P_2 = System Pressure + 14.7
V_2 = Compressed Gas Volume
T_1 = Initial Temp. Absolute (Rankine)
T_2 = Increased Temp. Absolute (Rankine)

T_1, P_1 and V_1 are initial temperature, pressure and volume and, T_2, P_2 and V_2 are final conditions.

Note:
Adiabatic operatiion occurs when compression or expansion is rapid so that there is no transfer of heat. The adiabatic equation is used where compression or expansion occurs in less than 1 minute.

Rule of thumb:
Compressibility of hydraulic oil: Volume reduction is approximately 0.5% for every 1000 PSI pressure.
Compressibility of water: Volume reduction is about 0.3% for every 1000 PSI pressure.

Rankine = Fahrenheit + 460
Kelvin = Celsius + 278

Celsius to Fahrenheit = (C + 17.78) x 1.8 = Fahrenheit
Fahrenheit to Celsius = F - 32 ÷ 1.8 = Celsius

Intial Gas Volume - Compressed **Gas =** Usual Oil

Reservoir Cooling:

HP Radiated = Sq. Ft. x TD ÷ 1000
Sq. Ft. = HP x 1000 ÷ TD
TD = HP x 1000 ÷ Sq. Ft.

HP = Power radiating capacity expressed in horsepower
Sq. Ft. = Surface area, in square feet
TD = Temperature difference (Delta) in °F between oil and surrounding air.

If the tank is half full, divide the answer by 2.
If the tank is stainless steel (CRES), divide the answer by 2.
If the tank is aluminum, multiply the answer by 2.8.

1 HP = 2545 BTU
1 HP = 746 Watts
BTU = the energy to raise one pound of water one degree Farenheit

Rule of thumb:
Each watt will raise the temperature of 1 gallon of oil by 1 °F per hour.

Reservoir Heating:

BTU's to heat a reservoir = Oil volume (ft^3) x 62.4 Specific Heat (.5) x Specific Gravity (.89) Temp. Delta (Differential)

BTU ÷ 2545 = HP per Hour
HP x 746 = Watts

Note:
The following applies to petroleum based hydraulic fluids.

Hydraulic oil serves as a lubricant and is practically non-compressible. It will compress approximately 0.5% at 1000 psi.

The weight of hydraulic oil may vary with a change in viscosity, however, 55 to 58 lbs/ft^3 covers the viscosity range from 150 SUS to 900 SUS @ 100 degrees F.

Pressure at the bottom of a one foot column of oil will be approximately 0.4 psi.
To find the pressure at the bottom of any column of oil, multiply the height in feet by 0.4.

Atmospheric pressure equals 14.7 psia at sea level.

psia (pounds per square inch absolute).

Gauge readings to not include atmospheric pressure unless marked psia.

Energy Formulas:

1 Kw = 1.3 hp
1 hp = 550 ft lbs/s
Hydraulic hp = gpm x psi ÷ 1714
Torque (in lbs) = psi x disp. (in^3/rev) ÷ 6.28
Torque (in lbs) = hp x 63025 ÷ Rpm
hp = Torque (ft lbs) x rpm ÷ 5252
Btu (per hour) = Δpsi x gpm x 1.5

Formulae in SI Metric Units

Familiar fluid power formulae in English units are shown in the left column. When the industry converts to SI (International) units, these formulae will take the form shown in the right column.

English Units	Metric Units
Torque, HP, Speed Relations in Hydraulic Pumps and Motors	
T = HP x 5252 ÷ RPM	**T = Kw x 9543 ÷ RPM**
HP = T x RPM ÷ 5252	**Kw = T x RPM ÷ 9543**
RPM = HP x 5252 ÷ T	**RPM = Kw x 9543 ÷ T**
T = Torque, foot-lbs.	T = Torque, Nm (Newton-meters)
RPM = Speed, revs/min	RPM = Speed, revs/min
HP = Horsepower	Kw = Power in kilowatts
Hydraulic Power Flowing Through the Pipes	
HP = PSI x GPM ÷ 1714	**Kw = Bars x dm^3/min ÷ 600**
HP = Horsepower	Kw = Powers in kilowatts
PSI = Gauge pressure, lbs/sq. inch	Bars = System pressure
GPM = Flow, gallons per minute	dm^3/min = Flow, cu. dm/minute
Force Developed by an Air or Hydraulic Cylinder	
T = A x PSI	**N = A x Bars x 10**
T = Force or thrust, in lbs.	N = Cylinder force in Newtons
A = Piston area, square inches	A = Piston area, sq. centimeters
PSI = Gauge pressure, lbs/sq. inch	Bars = Gauge pressure
Travel Speed of a Hydraulic Cylinder Piston	
S = V ÷ A	**S = V ÷ 6A**
S = Travel speed, inches/minute	S = Travel speed, meter/sec
V = Vol. of oil to cyl., cu.in/min	V = Oil flow dm^3/minute
A = Piston area, square inches	A = Piston area, square centimeters
Barlow's Formula - Burst Pressure of Pipe & Tubing	
P = 2t x S ÷ O	**P = 2t x S ÷ O**
P = Burst pressure, PSI	P = Burst pressure, bars
t = Pipe wall thickness, inches	t = Pipe wall thickness, mm
S = Tensile str., pipe material, PSI	S = Tensile str., pipe material, bars
O = Outside diameter of pipe, inches	O = Outside diameter of pipe, mm
Velocity of Oil Flow in Hydraulic Lines	
V = GPM x 0.3208 ÷ A	**V = dm^3/min ÷ 6A**
V = Velocity, feet per second	V = Oil velocity, meters/second
GPM = Oil flow, gallons/minute	dm^3/min = Oil flow, cu.dm/minute
A = Inside area of pipe, sq. inches	A = Inside area of pipe, sq.cm.
Recommended Maximum Oil Velocity in Hydraulic Lines	
fps = feet per second	mps = meters per second
Pump suction lines - 2 to 4 fps	Pump suction lines - .6 to 1.2 mps
Pres. lines to 500 PSI - 10 to 15 fps	Pres. lines to 350 bar - 3 to 4½ mps
Pres. lines to 3000 PSI - 15 to 20 fps	Pres. lines to 200 bar - 4½ to 6 mps
Pres. lines over 3000 PSI - 25 fps	Pres. lines over 200 bar - 7½ mps
Oil lines in air/oil system - 4 fps	Oil lines in air/oil system - 1¼ mps

LENGTH
1 micron (μ) = 0.00004 inch (in.)
1 millimeter (mm) = 0.039 in.
1 centimeter (cm) = 0.3937 in.
1 decimeter (dm) = 0.3281 foot (ft.)
1 meter (m) = 39.37 in.
= 3.281 ft.
= 1.0937 yards (yds.)

AREA - SQUARE
1 square millimeter = 0.00155 square inch (sq. in.)
1 square centimeter = 0.155 sq. in.
1 square decimeter = 15.5 sq. in.
= 0.10764 square feet (sq. ft.)

AREA - CUBIC
1 cubic centimeter = 0.061 cubic inch (in.3)
= 0.0002642 U.S. liquid gallons
1 cubic decimeter = 61.023 in.3

LIQUID MEASURE
1 milliliter (ml) = 0.0338176 ounce (oz.)
1 deciliter (dl) = 3.381 oz.
1 liter (l) = 1.0569 quarts (qt.)
= 0.26417 gallon (gal.)
1 drop = 0.05 cubic centimeter (cc)
= 0.00169 oz.

WEIGHT
1 gram (g) = 0.0353 ounce (oz.)
1 kilogram (kg.) = 2.2046 pounds (lb.)
1 metric ton = 0.9842 U.S. ton

TEMPERATURE
°Celsius = 5/9 (°Fahrenheit - 32)

FLOW - LIQUID
1 liter/minute (lpm) = 0.2642 U.S. gallon/minute (gpm)

FORCE
1 Newton (N) = 0.225 pound (lb.)

FREQUENCY
1 cycle/second (cps) = 1 Hertz (H)

ABSOLUTE VISCOSITY
1 centipoise (@ 0.9 specific gravity) = 5.35 SUS

POWER
1 kilowat (kw) = 1.34 horsepower (HP)
1 horsepower (HP) = 33,000 foot-pounds (ft. lbs.)/minute
= 550 foot-pounds (ft. lbs.)/second
= 42.4 BTU/minute
= 746 watts

PRESSURE
1 bar = 14.5 pounds per square inch (psi) — above atmospheric
= 33.8 foot water column
= 42 foot oil column
= 29.92 inches of mercury (in. Hg)
1 millimeter of mercury (mm Hg) = 0.03937 in. Hg — below atmospheric
1 psi = 2.0416 in. Hg
= 27.71 in. water
1 foot column of water = 0.433 psi
1 foot column of oil = 0.390 psi

TORQUE
1 Newton-meter (Nm) = 8.88 pound-inches (lb.-in.)

VELOCITY
1 meter per second (m/s) = 3.28 feet/second (fps)

FRACTIONS, DECIMALS AND MILLIMETERS

Inches Fractions	Decimals	M M
-	0.0004	0.01
-	0.004	0.1
-	0.01	0.25
1/64	0.01562	0.397
-	0.0197	0.5
-	0.0295	0.75
1/32	0.03125	0.794
-	0.0394	1
3/64	0.04688	1.191
-	0.059	1.5
1/16	0.0625	1.588
5/64	0.07812	1.984
-	0.0787	2
3/32	0.09375	2.381
-	0.0984	2.5
7/64	0.10938	2.778
-	0.1181	3
1/8	0.125	3.175
-	0.1378	3.5
9/64	0.14062	3.572
5/32	0.15625	3.969
-	0.1575	4
11/64	0.17188	4.366
-	0.177	4.5
3/16	0.1875	4.763
-	0.1969	5
13/64	0.20312	5.159
-	0.2165	5.5
7/32	0.21875	5.556
15/64	0.23438	5.953
-	0.2362	6
1/4	0.25	6.35
-	0.2559	6.5
17/64	0.26562	6.747
-	0.2756	7
9/32	0.28125	7.144
-	0.2953	7.5
19/64	0.29688	7.541
5/16	0.3125	7.938
-	0.315	8
21/64	0.32812	8.334
-	0.335	8.5
11/32	0.34375	8.731
-	0.3543	9
23/64	0.35938	9.128
-	0.374	9.5
3/8	0.375	9.525
25/64	0.39062	9.922
-	0.3937	10
13/32	0.40625	10.319
-	0.413	10.5
27/64	0.42188	10.716
-	0.4331	11
7/16	0.4375	11.113
29/64	0.45312	11.509
15/32	0.46875	11.906
-	0.4724	12
31/64	0.48438	12.303
-	0.492	12.5
1/2	0.5	12.7
-	0.5118	13
33/64	0.51562	13.097
17/32	0.53125	13.494
35/64	0.54688	13.891
-	0.5512	14
9/16	0.5625	14.288
-	0.571	14.5
37/64	0.57812	14.684
-	0.5906	15
19/32	0.59375	15.081
39/64	0.60938	15.478
5/8	0.625	15.875
-	0.6299	16
41/64	0.64062	16.272
-	0.6496	16.5
21/32	0.65625	16.669
-	0.6693	17
43/64	0.67188	17.066
11/16	0.6875	17.463
45/64	0.70312	17.859
-	0.7087	18
23/32	0.71875	18.256
-	0.7283	18.5
47/64	0.73438	18.653
-	0.748	19
3/4	0.75	19.05
49/64	0.76562	19.447
25/32	0.78125	19.844
-	0.7874	20
51/64	0.79688	20.241
13/16	0.8125	20.638
-	0.8268	21
53/64	0.82812	21.034
27/32	0.84375	21.431
55/64	0.85938	21.828
-	0.8661	22
7/8	0.875	22.225
57/64	0.89062	22.622
-	0.9055	23
29/32	0.90625	23.019
59/64	0.92188	23.416
15/16	0.9375	23.813
-	0.9449	24
61/64	0.95312	24.209
31/32	0.96875	24.606
-	0.9843	25
63/64	0.98438	25.003
1	1	25.4
-	1.0236	26
1-1/32	1.0312	26.194
1-1/16	1.062	26.988
-	1.063	27
1-3/32	1.094	27.781
-	1.1024	25
1-1/8	1.125	28.575
-	1.1417	29
1-5/32	1.156	29.369
-	1.1811	30
1-3/16	1.1875	30.163
1-7/32	1.219	30.956
-	1.2205	31
1-1/4	1.25	31.75
-	1.2598	32
1-9/32	1.281	32.544
-	1.2992	33
1-5/16	1.312	33.338
-	1.3386	34
1-11/32	1.344	34.131
1-3/8	1.375	34.925
-	1.3779	35
1-13/32	1.406	35.719
-	1.4173	36
1-7/16	1.438	36.513
-	1.4567	37
1-15/32	1.469	37.306
-	1.4961	38
1-1/2	1.5	38.1
1-17/32	1.531	38.894
-	1.5354	39
1-9/16	1.562	39.688
-	1.5748	40
1-19/32	1.594	40.481
-	1.6142	41
1-5/8	1.625	41.275
-	1.6535	42
1-21/32	1.6562	42.069
1-11/16	1.6875	42.863
-	1.6929	43
1-23/32	1.719	43.656
-	1.7323	44
1-3/4	1.75	44.45
-	1.7717	45
1-25/32	1.781	45.244
-	1.811	46
1-13/16	1.8125	46.038
1-27/32	1.844	46.831
-	1.8504	47
1-7/8	1.875	47.625
-	1.8898	48
1-29/32	1.9062	48.419
-	1.9291	49
1-15/16	1.9375	49.213
-	1.9685	50
1-31/32	1.969	50.006
2	2	50.8
-	2.0079	51
2-1/32	2.0312	51.594
-	2.0472	52
2-1/16	2.062	52.388
-	2.0866	53
2-3/32	2.094	53.181
2-1/8	2.125	53.975
-	2.126	54
2-5/32	2.156	54.769
-	2.165	55
2-3/16	2.1875	55.563
-	2.2047	56
2-7/32	2.219	56.356
-	2.244	57
2-1/4	2.25	57.15
2-9/32	2.281	57.944
-	2.2835	58
2-5/16	2.312	58.738
-	2.3228	59
2-11/32	2.344	59.531
-	2.3622	60
2-3/8	2.375	60.325
-	2.4016	61
2-13/32	2.406	61.119
2-7/16	2.438	61.913
-	2.4409	62
2-15/16	2.469	62.706
-	2.4803	63
2-1/2	2.5	63.5
-	2.5197	64
2-17/32	2.531	64.294
-	2.559	65
2-9/16	2.562	65.088
2-19/32	2.594	65.881
-	2.5984	66
2-5/8	2.625	66.675
-	2.638	67
2-21/32	2.656	67.469
-	2.6772	68
2-11/16	2.6875	68.263
-	2.7165	69
2-23/32	2.719	69.056
2-3/4	2.75	69.85
-	2.7559	70
2-25/32	2.781	70.643
-	2.7953	71
2-13/16	2.8125	71.437
-	2.8346	72
2-27/32	2.844	72.231
-	2.874	73
2-7/8	2.875	73.025
2-29/32	2.9062	73.819
-	2.9134	74
2-15/16	2.9375	74.613
-	2.9527	75
2-31/32	2.969	75.406
-	2.9921	76
3	3	76.2
3-1/32	3.0312	76.994
-	3.0315	77
3-1/16	3.062	77.788
-	3.0709	78
3-3/32	3.094	75.581
-	3.1102	79
3-1/8	3.125	79.375
-	3.1495	80
3-5/32	3.156	80.169
3-3/16	3.1875	80.963
-	3.189	81
3-7/32	3.219	81.756
-	3.2283	82
3-1/4	3.25	82.55
-	3.2677	83
3-9/32	3.281	83.344
-	3.3071	84
3-5/16	3.312	84.137
3-11/32	3.344	84.931
-	3.3464	85
3-3/8	3.375	85.725
-	3.3858	86
3-13/32	3.406	86.519
-	3.4252	87
3-7/16	3.438	87.313
-	3.4646	88
3-15/32	3.469	88.106
3-1/2	3.5	88.9
-	3.5039	89
3-17/32	3.531	89.694
-	3.5433	90
3-9/16	3.562	90.487
-	3.5827	91
3-19/32	3.594	91.281
-	3.622	92
3-5/8	3.625	92.075
3-21/32	3.656	92.869
-	3.6614	93
3-11/16	3.6875	93.663
-	3.7008	94
3-23/32	3.719	94.456
-	3.7401	95
3-3/4	3.75	95.25
-	3.7795	96
3-25/32	3.781	96.044
3-13/16	3.8125	96.838
-	3.8189	97
3-27/32	3.844	97.631
-	3.8583	98
3-7/8	3.875	98.425
-	3.8976	99
3-29/32	3.9062	99.219
-	3.937	100
3-15/16	3.9375	100.013
3-31/32	3.969	100.806
-	3.9764	101
4	4	101.6
4-1/16	4.062	103.188
4-1/8	4.125	104.775
-	4.1338	105
4-3/16	4.1875	106.363
4-1/4	4.25	107.95
4-5/16	4.312	109.538
-	4.3307	110
4-3/8	4.375	111.125
4-7/16	4.438	112.716
4-1/2	4.5	114.3
-	4.5275	115
4-9/16	4.562	115.88
4-5/8	4.625	117.475
4-11/16	4.6875	119.063
-	4.7244	120
4-3/4	4.75	120.65
4-13/16	4.8125	122.238
4-7/8	4.875	123.825
-	4.9212	125
4-15/16	4.9375	125.413
5	5	127
-	5.1181	130
5-1/4	5.25	133.35
5-1/2	5.5	139.7
-	5.5118	140
5-3/4	5.75	146.05
-	5.9055	150
6	6	152.4
6-1/4	6.25	158.75
-	6.2992	160
6-1/2	6.5	165.1
-	6.6929	170
6-3/4	6.75	171.45
7	7	177.8
-	7.0866	180
-	7.4803	190
7-1/2	7.5	190.5
-	7.874	200
8	8	203.2
-	8.2677	210
8-1/2	8.5	215.9
-	8.6614	220
9	9	228.6
-	9.055	230
-	9.4488	240
9-1/2	9.5	241.3
-	9.8425	250
10	10	254.01
-	10.2362	260
-	10.6299	270
11	11	279.401
-	11.0236	280
-	11.4173	290
-	11.811	300
12	12	304.801
13	13	330.201
-	13.7795	350
14	14	335.601
15	15	381.001
-	15.748	400
16	16	406.401
17	17	431.801
-	17.7165	450
18	18	457.201
19	19	482.601
-	19.685	500
20	20	508.001

To convert →		Into →		Multiply by
Into ←	Symbol	To convert ←	Symbol	Divide by
Unit		Unit		Factor
Atmospheres	Atm	bar	bar	1.01325
Atmospheres	Atm	inches of mercury	in Hg	29.92
Atmospheres	Atm	mm of mercury	mm Hg	760
Atmospheres	Atm	pounds/square inch	psi	14.7
bar	bar	pounds/square inch	psi	14.5
British thermal unit	Btu	calorie	cal	252
British thermal unit	Btu	joule	J	1054.35
British thermal unit	Btu	foot pounds	ft-lbs	777.65
British thermal unit/hr	Btu/hr	kilowatts	kW	0.000293071
centimetres	cm	inches	in	0.3937
centimetres per sec	cm/sec	feet per minute	ft/min	1.969
centimetres per sec	cm/sec	feet per second	ft/sec	0.03281
Celsius	^{O}C	Fahrenheit	^{O}F	(F-32) ÷ 1.8
centiStokes	cSt	Saybolt	SUS	4.635 (>52 cSt)
cubic centimetres	cm³	cubic inches	in³	0.06102
cubic feet	cu ft	gallons US	US gal	7.481
cubic feet	cu ft	cubic metres	m³	0.0283168
cubic inches	in³	cubic centimetres	cm³	16.3871
cubic inches	in³	gallons US	US gal	0.004329
cubic yards	yd³	cubic metres	m³	0.7646
degrees	(angle)	^{O}radians	rad	0.0174533
Fahrenheit	^{O}F	Celsius	^{O}C	(C x 1.8) + 32
feet	ft	metres	m	0.3048
feet of water	ft H2 O	bar	bar	0.0298907
feet of water	ft H2 O	pounds/square inch	psi	0.4335
feet of water	ft H2 O	inches of mercury	in Hg	0.8826
feet of oil (sg = 0.87)		pounds/square inch	psi	0.377
feet of oil (sg = 0.87)		inches of mercury	in Hg	0.768
feet per minute	ft/min	centimetres per sec	cm/sec	0.5080
feet per second	ft/sec	centimetres per sec	cm/sec	30.48
feet per minute	ft/min	miles per hour	mph	0.01136
feet per second	ft/sec	miles per hour	mph	0.6818
fluid ounces UK	UK fl oz	cubic centimetres	cm³	28.413
fluid ounces US	US fl oz	cubic centimetres	cm³	29.5735
foot pounds per min	ft-lbs/min	horsepower	hp	0.00003030
foot pounds per sec	ft-lbs/sec	horsepower	hp	0.001818
foot pounds per min	ft-lbs/min	watts	W	81.3492
foot pound	ft-lb	kilogram metre	kgm	0.1383
foot pound	ft-lb	Newton metre	Nm	0.1356
foot pound	ft-lb	joule	J	1.35582
gallons US	US gal	cubic inches	in³	231
gallons US	US gal	gallons UK	UK gal	0.8327
gallons US	US gal	litres	l	3.78531
gallons US	US gal	cubic feet	cu ft	0.1337
gallons UK	UK gal	litres	l	4.54596
gallons UK	UK gal	gallons US	US gal	1.201
horsepower	hp	British thermal unit/min	Btu/min	42.44
horsepower	hp	foot pounds per min	ft-lbs/min	33
horsepower	hp	foot pounds per sec	ft-lbs/sec	550
horsepower	hp	kilowatts	kW	0.7457
horsepower	hp	Pferde Starke	PS	1.014
horsepower	hp	poncelet		0.7604

To convert → → → →			Into → → → → →		Multiply by
Into ← ← ← ← ←			To convert ← ← ← ←		Divide by
Unit	**Symbol**		**Unit**	**Symbol**	**Factor**
inches	in		centimetres	cm	2.54
inches	in		millimetres	mm	25.4
inch pounds	in-lbs		kilogram/metre	kgm	0.01152
inch pounds	in-lbs		Newton metre	Nm	0.1130
inches of mercury	in Hg		Pascal	Pa	3386 (32^0 F)
inches of mercury	in Hg		pounds/square inch	psi	0.4912
inches of mercury	in Hg		millibar	mbar	33.8639
kilogram	kg		pound	lb	2.205
kilogram	kg		Newton	N	9.80665
kilogram metre	kgm		Newton metre	Nm	9.80665
kilogram metre	kgm		inch pounds	in-lbs	86.80
kilogram metre	kgm		foot pound	ft-lb	7.233
kilogram per square centimetre	kg/cm^2		bar	bar	0.980665
kilopascals	kPa		bar	bar	0.01
kilometres	km		miles		0.6214
kilometres	km		feet	ft	3281
litres	l		gallons UK	UK gal	0.2199
litres	l		gallons US	US gal	0.2642
metric horse power			kilowatts	kW	0.735499
microinches	min		microns	mm	0.0254
miles			kilometres	km	1.609
millimetres mercury	mm Hg		millibar	mbar	1.33322
Newton	N		pound	lb	0.2248
Newton metre	Nm		foot pound	ft-lb	0.7376
Newton metre	Nm		inch pounds	in-lbs	8.851
Newtons per square centimetre	N/cm^2		bar	bar	0.1
Newtons per square metre	N/m^2		bar	bar	0.00001
Pascals	Pa		bar	bar	0.00001
pint UK	UK pt		litres	l	0.568245
pint US	US pt		litres	l	0.473163
pounds	lb		grams	g	453.6
pounds	lb		Newton	N	4.448
pounds/square inch	psi		Atmospheres	Atm	0.06804
pounds/square inch	psi		bar	bar	0.06895
pounds/square inch	psi		inches of mercury	in Hg	2.036
pounds/square inch	psi		feet of water	ft H2 O	2.307
pounds/square inch	psi		feet of oil (sg=0.87)		2.65
pounds/cubic foot	$lb\text{-}ft^3$		Kilograms/cubic metre	$kg\text{-}m^3$	16.02
square inches	in^2		square centimetres	cm^2	6.5416
square feet	ft^2		square metres	m^2	0.09290304
Saybolt	SUS		centiStokes	cSt	See below
32 – 99 SUS	cSt = 0.2253 x SUS – (194.4 ÷ SUS)				
100 – 240 SUS	cSt = 0.2193 x SUS – (134.6 ÷ SUS)				
>240 SUS	cSt = SUS ÷ 4.635				