SAWYER SYSTEMS | Fluid Power Engineers, Fabricators and Installers
"THE HYDRAULICS GUYS"

# Common Fluid Power Formulas

**Torque and horsepower relations:** **T = HP x 5252 ÷ RPM HP = T x RPM ÷ 5252 RPM = HP x 5252 ÷ T** Torque values are in foot pounds.

**Hydraulic (fluid power) horsepower:** **HP = PSI x GPM ÷ 1714** PSI is gauge pressure in pounds per square inch, GPM is oil flow in gallons per minute.

**Velocity of oil flow in pipe:** **V = GPM x 0.3208 ÷ A** V is oil velocity in feet per second, GPM is flow in gallons per minute, A is inside area of pipe in square inches.

**Charles' Law for behavior of gases:** **$T_1V_2 = T_2V_1$, or $T_1P_2 = T_2P_1$** $T_1$, $P_1$ and $V_1$ are initial temperature, pressure and volume, and $T_2$, $P_2$ and $V_2$ are final conditions.

**Boyle's Law for behavior of gases:** **$P_1V_1 = P_2V_2$** $P_1$, $V_1$ are initial pressure and volume; $P_2$ and $V_2$ are final conditions.

**Circle Formulae:** **Area = $\pi r^2$, or $\pi D^2 \div 4$ Circumference = $2\pi r$, or $\pi D$** r is radius, D is diameter, inches; $\pi$ is 3.14

**Heat equivalent of fluid power:** **BTU per hour = PSI x GPM x 1½**
**Hydraulic Cylinder Piston travel speed:** **S = CIM ÷ A** S is piston travel speed, inches per minute, CIM is oil flow into cylinder, cubic inches per minute, A is piston area in square inches.

**Thrust or force of any cylinder:** **T = A x PSI** T is thrust or force, in pounds, A is piston area in square inches, PSI is gauge pressure.

**Force for piercing or shearing sheet metal:** **F = P x T x PSI** F is force required, in pounds, P is perimeter around area to be sheared, in inches, T is sheet thickness in inches; PSI is the sheer strength rating of the material in pounds per square inch.

**Side load on pump or motor shaft:** **F = (HP x 63024) ÷ (RPM x R)** F is the side load, in pounds, against shaft; R is the pitch radius of sheave on pump shaft, in inches; HP is driving power applied to shaft.

**Effective force of a cylinder working at an angle to direction of the load travel:** **F = T x sin A** T is the total cylinder force, in pounds; F is the part of the force which is effective, in pounds, A is the least angle, in degrees, between cylinder axis and load direction.

**Heat radiating capacity of a steel reservoir:** **HP = 0.001 x A x TD** HP is the power radiating capacity expressed in horsepower; A is surface area, in square feet; TD is temperature difference in °F between oil and surrounding air.

WWW.SAWYERSYSTEMSLLC.COM
**1101 NE 144th Street, Suite A-103, VANCOUVER, WA 98685**
**(360) 574-7809**

**Burst pressure of pipe or tubing:** **P = 2t x S ÷ O** P is burst pressure in PSI, t is wall thickness, in inches; S is tensile strength of material in PSI; O is outside diameter, in inches.

**Relationship between displacement and torque of a hydraulic motor:** **T = D x PSI ÷ 24**Π T is torque in foot pounds, D is displacement in cubic inches per revolution, PSI is pressure difference across motor, Π is 3.14

## Rules of Thumb

**Horsepower for driving a pump:** For every 1 HP of drive, the equivalent of 1 GPM @ 1500 PSI can be produced.

**Horsepower for idling a pump:** To idle a pump when it is unloaded will require about 5% of its full rated horsepower.

**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.
**Wattage for heating hydraulic oil:** Each watt will raise the temperature of 1 gallon of oil by 1 °F per hour.

**Flow velocity in hydraulic lines:** Pump suction lines 2 to 4 feet/second; pressure lines up to 500 PSI, 10 to 15 feet/second; pressure lines 500 to 3000 PSI, 15 to 20 feet/second; pressure lines over 3000 PSI, 25 feet/second; all oil lines in air-over-oil system, 4 feet/second.