

Basis Formulas

Formula For:	Word Formula:	Letter Formula:
FLUID PRESSURE In Pounds/Square Inch	Pressure = $\frac{\text{Force (Pounds)}}{\text{Unit Area (Square Inches)}}$	P = F/A or psi = F/A
FLUID FLOW RATE In Gallons/Minute	Flow Rate = $\frac{\text{Volume (Gallons)}}{\text{Unit Time (Minute)}}$	Q = V/T
FLUID POWER In Horsepower	Horsepower = $\frac{\text{Pressure (psi)} \times \text{Flow (GPM)}}{1714}$	hp = PQ/1714

Fluid Formulas

Formula For:	Word Formula:	Letter Formula:
VELOCITY THROUGH PIPING In Feet/Second Velocity	Velocity = $\frac{.3208 \times \text{Flow Rate through I.D. (GPM)}}{\text{Internal Area (Square Inches)}}$	V = .3208Q/A
COMPRESSIBILITY OF OIL In Additional Required Oil to Reach Pressure	Additional Volume = $\frac{\text{Pressure (psi)} \times \text{Volume of Oil under Pressure}}{250,000 \text{ (approx.)}}$	V _A = PV/250,000 (approx.)
COMPRESSIBILITY OF A FLUID	Compressibility = $\frac{1}{\text{Bulk Modulus of the Fluid}}$	C(β) = 1/BM
SPECIFIC GRAVITY OF A FLUID	Specific Gravity = $\frac{\text{Weight of One Cubic Foot of Fluid}}{\text{Weight of One Cubic Foot of Water}}$	SG = W/62.4283
VALVE (Cv) FLOW FACTOR	Valve Factor = $\frac{\text{Flow Rate (GPM)} \sqrt{\text{Specific Gravity}}}{\sqrt{\text{Pressure Drop (psi)}}}$	Cv = (Q √ SG) / (√ Δp)
VISCOSITY IN CENTISTOKES	For Viscosities of 32 to 100 Saybolt Universal Seconds: Centistokes = $.2253 \times \text{SUS} - \left(\frac{194.4}{\text{SUS}} \right)$	CS = .2253 SUS - (194.4/SUS)
	For Viscosities of 100 to 240 Saybolt Universal Seconds: Centistokes = $.2193 \times \text{SUS} - \left(\frac{134.6}{\text{SUS}} \right)$	CS = .2193 SUS - (134.6/SUS)
	For Viscosities greater than 240 Saybolt Universal Seconds: Centistokes = $\left(\frac{\text{SUS}}{4.635} \right)$	CS = SUS/4.635

Note: Saybolt Universal Seconds can also be abbreviated as SSU.

Pump Formulas

Formula For:	Word Formula:	Letter Formula:
PUMP OUTLET FLOW In Gallons/Minute	Flow = $\frac{\text{rpm} \times \text{Pump Displacement (Cu. In./Ref.)}}{231}$	$Q = nd/231$
PUMP INPUT POWER In Horsepower Required	Horsepower Input = $\frac{\text{Flow Rate Output (GPM)} \times \text{Pressure (psi)}}{1714 \text{ Efficiency (Overall)}}$	$H_{p,in} = QP/1714\text{Eff. or } (GPM \times \text{psi})/1714\text{Eff.}$
PUMP EFFICIENCY Overall in Percent	Overall Efficiency = $\left(\frac{\text{Output Horsepower}}{\text{Input Horsepower}} \right) \times 100$ Overall Efficiency = Volumetric Eff. x Mechanical Eff.	$\text{Eff}_{ov} = (HP / HP_{in}) \times 100$ $\text{Eff}_{ov} = \text{Eff}_{vol} \times \text{Eff}_{mech}$
PUMP EFFICIENCY Volumetric in Percent	Volumetric Efficiency = $\frac{\text{Actual Flow Rate Output (GPM)}}{\text{Theoretical Flow Rate Output (GPM)}} \times 100$	$\text{Eff}_{vol} = (Q / Q_{theo}) \times 100$
PUMP EFFICIENCY Mechanical in Percent	Mechanical Efficiency = $\frac{\text{Theoretical Torque to Drive}}{\text{Actual Torque to Drive}} \times 100$	$\text{Eff}_{mech} = (T / T_{act}) \times 100$
PUMP LIFE B_{10} Bearing Life	$B_{10} \text{ Hrs. Bearing Life} = \text{Rated Life Hrs.} \times \frac{\text{Rated Speed (rpm)}}{\text{New Speed (rpm)}} \times \frac{\text{Rated Pressure (psi)}}{\text{New Pressure (psi)}}$	$B_{10} = \frac{1}{(RPM_n)^3} \times (P_r/P_n)^3$

Actuator Formulas

Formula For:	Word Formula:	Letter
CYLINDER AREA In Square Inches	Area = $\pi \times \text{Radius}^2$ (Inches)	$A = \pi r^2$
	Area = $(P/4) \times \text{Diameter}^2$ (Inches)	$A = (\pi D^2)/4 \text{ or } A = .785D^2$
CYLINDER FORCE In Pounds, Push or Pull	Area = Pressure (psi) x Net Area (sq in.)	$F = \text{psi} \times A \text{ or } F = PA$
CYLINDER VELOCITY or SPEED In Feet/Second	Velocity = $\frac{231 \times \text{Flow Rate (GPM)}}{12 \times 60 \times \text{Net Area (sq in.)}}$	$v = 231Q/720A \text{ or } v = .3208Q/A$
CYLINDER VOLUME CAPACITY In Gallons of Fluid	Volume = $\frac{\pi \times \text{Radius}^2 \text{ (in.)} \times \text{Stroke (in.)}}{231}$	$V = (\pi r^2 L)/231$
	Volume = $\frac{\text{Net Area (sq. in.)} \times \text{Stroke (in.)}}{231}$	$V = (A L)/231$
CYLINDER FLOW RATE In Gallons/Minute	Flow Rate = $\frac{12 \times 60 \times \text{Velocity (Ft/Sec)} \times \text{Net Area (sq. in.)}}{231}$	$Q = (720vA)231 \text{ or } Q = 3.117vA$
FLUID MOTOR TORQUE In Inch Pounds	Torque = $\frac{\text{Pressure (psi)} \times \text{F.M. Displacement (Cu. In./Rev.)}}{2\pi}$	$T = \text{psi d}/2\pi \text{ or } T = Pd/2\pi$
	Torque = $\frac{\text{Horsepower} \times 63025}{\text{rpm}}$	$T = 63025 \text{ hp/n}$
	Torque = $\frac{\text{Flow Rate (GPM)} \times \text{Pressure (psi)} \times 36.77}{\text{rpm}}$	$T = 36.77QP/n \text{ or } T = 36.77Q\text{psi/n}$
FLUID MOTOR TORQUE/100 psi In Inch Pounds	$\frac{\text{Torque}}{100} = \frac{\text{F.M. Displacement (Cu. In./Rev.)}}{.0628}$	$T_{100\text{psi}} = d/.0628$
FLUID MOTOR SPEED In Revolutions/Minute	Speed = $\frac{231 \text{ Flow Rate (GPM)}}{\text{F.M. Displacement (Cu. In./Rev.)}}$	$n = 231 Q/d$
FLUID MOTOR POWER In Horsepower Output	Horsepower = $\frac{\text{Torque Output (Inch Pounds)} \times \text{rpm}}{63025}$	$hp = Tn/63025$

Thermal Formulas

Formula For:	Word Formula:	Letter Formula:
RESERVOIR COOLING CAPACITY Based on Adequate Air Circulation	Heat (BTU/Hr) = 2 x Temperature Difference Between Reservoir Walls and Air (F°) x Area of Reservoir (Sq. Ft.)	BTU/Hr = 2.0 x DT x A
HEAT IN HYDRAULIC OIL Due to System Inefficiency (SG=.89-.92)	Heat (BTU/Hr) = Flow Rate (GPM) x 210 x Temp. Difference (F°)	BTU/Hr = Q x 210 x DT
HEAT IN FRESH WATER	Heat (BTU/Hr) = Flow Rate (GPM) x 500 x Temp. Difference (F°)	BTU/Hr = Q x 500 x DT

Note: One British Thermal Unit (BTU) is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit.
One Horsepower = 2545 BTU/Hr.

Accumulator Formulas

Formula For:	Word Formula:	Letter Formula:
PRESSURE OR VOLUME With Constant T (Temperature)	Original Pressure x Original Volume = Final Pressure x Final Volume	$P_1V_1 = P_2V_2$ Isothermal
PRESSURE OR TEMPERATURE With Constant V (Volume)	Original Pressure x Final Temp. = Final Pressure x Original Temp.	$P_1T_2 = P_2T_1$ Isochoric
VOLUME OR TEMPERATURE With Constant P (Pressure)	Original Volume x Final Temp. = Final Volume x Original Temp.	$V_1T_2 = V_2T_1$ Isobaric
PRESSURE OR VOLUME With Temp. Change Due to Heat of Compression	Original Press. x Original Volume ⁿ = Final Press. x Final Volume ⁿ	$P_1V_1^n = P_2V_2^n$
	Final Temp./Orig. Temp. = (Orig. Vol./Final Vol.) ^{(n-1)/n} = (Final Press./Orig. Press.) ^{(n-1)/n}	$T_2/T_1 = (V_1/V_2)^{n-1} = (P_2/P_1)^{(n-1)/n}$

Volume and Capacity Equivalents

	Cubic Inches	Cubic Feet	Cubic Centimeters	Liters	U.S. Gallons	Imperial Gallons	Water at Max Density	
							Pounds of Water	Kilograms of Water
Cubic Inches	1	0.0005787	16.384	0.016384	0.004329	0.0036065	0.361275	0.0163872
Cubic Feet	1728	1	0.037037	28.317	7.48052	6.23210	62.4283	28.3170
Cubic Centimeters	0.0610	0.0000353	1	0.001	0.000264	0.000220	0.002205	0.0001
Liters	61.0234	0.0353145	0.004951	1	0.264170	0.220083	2.20462	1
U.S. Gallons	231	0.133681	3.78543	1	0.833111	0.833111	8.34545	3.78543
Imperial Gallons	277.274	0.160459	4.54374	1.20032	1	1	10.0172	4.54373
Pounds of Water	27.6798	0.0160184	0.453592	0.119825	0.0998281	0.0998281	1	0.453593