

Fluid Power Formulas

Basic Formulas

<p>Fluid Pressure</p> $\text{Pressure} = \frac{\text{Force (pounds)}}{\text{Unit Area (square inches)}}$	<p>Fluid Power</p> $\text{Horsepower} = \frac{\text{Pressure(psi)} \times \text{Flow (GPM)}}{1714}$
<p>Fluid Flow Rate</p> $\text{Flow Rate} = \frac{\text{Volume (Gallons)}}{\text{Unit Time(Minute)}}$	

Fluid Formulas

<p>Velocity Through Piping</p> $\text{Velocity} = \frac{.3208 \times \text{GPM}}{\text{Internal Area (Square Inches)}}$	<p>Compressibility of Oil</p> $\text{Additional Volume} = \frac{\text{PSI} \times \text{Vol of Oil under Pressure}}{250,000 \text{ (approx.)}}$
<p>Compressibility of a Fluid</p> $\text{Compressibility} = \frac{1}{\text{Bulk Modulus of the Fluid}}$	<p>Specific Gravity of a Fluid</p> $\text{Specific Gravity} = \frac{\text{Weight of 1 Cubic Ft of Fluid}}{62.4283}$
<p>Valve Flow Factor</p> $\text{Valve Factor} = \frac{(\text{GPM} \sqrt{\text{Specific Gravity}})}{\sqrt{\text{Pressure Drop } (\Delta\text{PSI})}}$	
<p>Viscosity in Centistokes</p> <p>For Viscosities of 32 -100 Saybolt Universal Seconds:</p> $\text{Centistokes} = .2253 \times \text{SUS} - \left(\frac{194.4}{\text{SUS}} \right)$	
<p>For Viscosities of 100-240 Saybolt Universal Seconds:</p> $\text{Centistokes} = .2193 \times \text{SUS} - \left(\frac{134.6}{\text{SUS}} \right)$	
<p>For Viscosities greater than 240 Saybolt Universal Seconds:</p> $\text{Centistokes} = \frac{\text{SUS}}{4.635}$	

Pump Formulas

<p>Pump Outlet Flow</p> $\text{Flow} = \frac{\text{RPM} \times \text{Pump Displacement (Cu.In./Ref.)}}{231}$	<p>Pump Input Power</p> $\text{Horsepower} = \frac{\text{Flow Rate Output (GPM)} \times \text{Pressure (PSI)}}{1714 \text{ Efficiency (Overall)}}$
<p>Pump Efficiency (Overall in Percent)</p> $\text{Overall Efficiency} = \frac{\text{HP}_{\text{out}}}{\text{HP}_{\text{in}}} \times 100$ <p>Overall Efficiency = Volumetric Eff. x Mechanical Eff.</p>	<p>Pump Efficiency (Volumetric in Percent)</p> $\text{Volumetric Eff.} = \frac{\text{Actual Flow Rate (GPM)}}{\text{Theoretical Flow Rate (GPM)}} \times 100$
<p>Pump Efficiency (Mechanical in Percent)</p> $\text{Mechanical Eff.} = \frac{\text{Theoretical Torque}}{\text{Actual Torque}} \times 100$	<p>Pump Life B₁₀ Bearing Life</p> $B_{10} = \text{Rated Hrs} \times \left(\frac{\text{RPM}_r}{\text{RPM}_n} \right) \times \left(\frac{\text{PSI}^r}{\text{PSI}_n} \right)^3$

Actuator Formulas

<p>Cylinder Area</p> $\text{Area} = \pi \times \text{Radius}^2$ $\text{Area} = .7854 \times \text{Diameter}^2$	<p>Cylinder Force</p> $F = P \times A$
<p>Cylinder Velocity</p> $\text{Velocity} = \frac{231 \times \text{Flow Rate (GPM)}}{12 \times 60 \times \text{Net Area (sq.in.)}}$	<p>Cylinder Flow Rate</p> $\text{Flow Rate} = \frac{12 \times 60 \times \text{Velocity} \times \text{Net Area}}{231}$
<p>Cylinder Volume Capacity</p> $\text{Volume} = \frac{\pi \times \text{Radius}^2 (\text{in.}) \times \text{Stroke (in.)}}{231}$	<p>Cylinder Volume Capacity</p> $\text{Volume} = \frac{\text{Area (in.}^2\text{)} \times \text{Stroke (in.)}}{231}$
<p>Fluid Motor Torque</p> $\text{Torque} = \frac{\text{Pressure} \times \text{F.M. Displacement (Cu .In./Rev)}}{2\pi}$ $\text{Torque} = \frac{\text{Horsepower} \times 63025}{\text{RPM}}$	

$\text{Torque} = \frac{\text{Flow Rate} \times \text{Pressure} \times 36.77}{\text{RPM}}$	
$\frac{\text{Torque}}{100} = \frac{\text{F.M. Displacement (Cu. In./Rev)}}{.0628}$	
Fluid Motor Torque/100 psi	
Fluid Motor Speed (Revolutions per Minute)	Fluid Motor Power (Horsepower Output)
$\text{RPM} = \frac{231 * \text{GPM}}{\text{Displacement (Cu. In./Rev)}}$	$\text{Horsepower} = \frac{\text{Torque Output} \times \text{RPM}}{63025}$

Thermal Formulas

Reservoir Cooling Capacity $\text{Heat(BTU/HR)} = 2.0 \times \text{Temp. Difference between Reservoir Walls and Air (F}^0\text{)} \times \text{Area of Reservoir (Sq. Ft.)}$	
Heat in Hydraulic Oil $\text{Heat(BTU/HR)} = \text{Flow Rate (GPM)} \times 210 \times \text{Temp. Diff. (F}^0\text{)}$	
Heat in Fresh Water $\text{Heat(BTU/HR)} = \text{Flow Rate (GPM)} \times 500 \times \text{Temp. Diff. (F}^0\text{)}$	

Accumulator Formulas

Pressure or Volume - Constant Temperature $P_1V_1 = P_2V_2 \text{ Isothermic}$	
Pressure or Temperature - Constant Volume $P_1T_2 = P_2T_1 \text{ Isochoric}$	

<p>Volume or Temperature – Constant Pressure</p> $V_1 T_2 = V_2 T_1 \quad \text{Isobaric}$
<p>Pressure or Volume - Temperature Change due to Heat of Compression</p> $P_1 V_1^n = P_2 V_2^N$ <hr style="width: 50%; margin: auto;"/> $\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{n-1} = \left(\frac{P_2}{P_1}\right)^{(n-1)/n}$

Volume and Capacity Formulas

					Water at Max. Density	
	Cubic Inches	Cubic Centimeters	Liters	U.S. Gallons	Pounds of Water	Kilograms of Water
Cubic Inches	1	16.384	0.016384	0.004329	0.361275	0.0163872
Cubic Centimeters	0.0610	1	0.001	.000264	0.0002205	0.0001
Liters	61.0234	0.001308	1	0.264170	2.20462	1
U.S. Gallons	231	0.004951	3.78543	1	8.34545	3.78543
Pounds of Water	27.6798	0.0005929	0.453592	0.119825	0.0998281	0.453593