FLUID POWER FORMULAS

BASIC FORMULAS		
FORMULA FOR:	**WORD FORMULA**	**LETTER FORMULA**
Fluid pressure In Pounds/Square Inch	PRESSURE = $\frac{\text{FORCE (pounds)}}{\text{UNIT AREA (suare inches)}}$	$P = \frac{F}{A}$ or $psi = \frac{F}{A}$
Fluid flow rate In Gallons/Minute	FLOW RATE = $\frac{\text{VOLUME (gallons)}}{\text{UNIT TIME (Minutes)}}$	$Q = \frac{V}{T}$
Fluid power In Horsepower	HORSEPOWER = $\frac{\text{Pressure (PSI)x Flow (GPM)}}{1714}$	$HP = \frac{PQ}{1714}$

FLUID FORMULAS		
FORMULA FOR:	**WORD FORMULA**	**LETTER FORMULA**
Velocity through piping In feet/ sec. velocity	VELOCITY = $\frac{\text{.3208 x flow rate though I.D (GPM)}}{\text{Internal area (Square inches)}}$	$v = \frac{.3208Q}{A}$
Compressibility of oil In additional required oil to reach pressure	ADDITIONAL VOLUME = $\frac{\textit{Pressure x Vol.of oil under pessure}}{\text{Internal area (Square inches250,000 (Approx.)}}$	$VA = \frac{PV*}{250,000}$ * Approx. $\frac{1}{2}$% per 1000 psi
Compressibility of a fluid	COMPRESSIBILITY = $\frac{1}{\text{Bulk modulus of the fluid}}$	$C(ß) = \frac{1}{BM}$
Specific gravity of a fluid	SPECIFIC GRAVITY = $\frac{\textit{Weight of one cubic foot of fluid}}{\textit{Weight of one cubic foot of water}}$	$SG = \frac{W}{62.4283}$
Valve (CV) flow factor	VALVE FACTOR (CV) = $\frac{\textit{Flow rate (GMP) x } \sqrt{\textit{Specific gravity}}}{\textit{Pressure drop (psi)}}$	$CV = \frac{Q\sqrt{SG}}{\Delta P}$
Viscosity in centistokes	For viscosities of 32 to 100 Saybolt Uni. Seconds: CENTISTOKES = .2253 x SUS $\frac{194.4}{SUS}$	CS = .2253 SUS - $\frac{194.4}{SUS}$
Viscosity in centistokes	For viscosities of 100 to 240 Saybolt Uni. Seconds: CENTISTOKES = .2193 x SUS $\frac{134.6}{SUS}$	CS = .2193 SUS - $\frac{134.6}{SUS}$
Viscosity in centistokes	For viscosities greater than 240 Saybolt Uni. Seconds: CENTISTOKES = $\frac{SUS}{4.635}$	$CS = \frac{SUS}{4.635}$

PUMP FORMULAS		
FORMULA FOR:	**WORD FORMULA**	**LETTER FORMULA**
PUMP OUTLET FLOW In gallons/minute	FLOW = $\frac{\textit{RPM X PUMP DISPLACEMENT (Cu.In Rev.)}}{231}$	$Q = \frac{nd}{231}$
Pump input power In horsepower requires	HORSEPOWER INPUT = $\frac{\textit{Flow rate output (GPM)x Pressure (psi)}}{\text{1714 x efficiency (Overall)}}$	$HP_{IN} = \frac{QP}{1714\,Eff}$ or $\frac{GPM\ x\ psi}{1714\,Eff}$
Pump efficiency Overall in percent	OVERALL EFFICIENCY = $\frac{\textit{Outpower Horsepower}}{\textit{Input Horsepower}}$ x 100 OVERALL EFFICIENCY = Volumetric Eff. x Mechanical Eff.	$Eff_{ov} = \frac{HP_{out}}{HP_{in}}$ x 100 $Eff_{ov} = Eff_{vol}$ x Eff_{mech}
Pump efficiency Overall in percent	VOLUMETRIC EFFICIENCY = $\frac{\textit{Actual flow rate output (GPM)}}{\textit{Theoretical flow rate output (GPM)}}$ x 100	$Eff_{vol} = \frac{O_{Act}}{O_{Theo.}}$ x 100
Pump efficiency Mechanical in percent	MECHANICAL EFFICIENCY = $\frac{\textit{Theoretical torque to drive}}{\textit{Actual torque to drive}}$ x 100	$Eff_{mec} = \frac{T_{Theo}}{T_{Act}}$ x 100
Pump life B_{10} Bearing life	B_{10} HOURS OF BEARING LIFE = Rated life hrs. x $\frac{\textit{Rated speed (RPM)}}{\textit{New speed (RPM)}}$ x $\left(\frac{\textit{rated pressure (psi)}}{\textit{new pressure (psi)}}\right)^3$	B_{10} = Rated hrs. x $\frac{RPM_R}{RPM_N}$ - $\left(\frac{PR}{PR)}\right)^3$

FLUID POWER FORMULAS

ACTUATOR FORMULAS		
FORMULA FOR:	**WORD FORMULA**	**LETTER FORMULA**
Cylinder area In square inches	AREA = ∏ x $Radius^2$ (Inches)	$A = \pi r^2$
	AREA = $\frac{\prod \text{ x } Diameter^2 \text{ (Inches)}}{4}$	$A = \frac{\pi r^2}{4}$ or A = $.785D^2$
Cylinder force In pounds, push or pull	FORCE = Pressure (psi) x Net area (square inches)	F = psi x A or F = PA
Cylinder velocity or speed In feet/second	VELOCITY = $\frac{231 \text{ x } Flow\ rate\ (GPM)}{12 \text{ x } 60 \text{ x } net\ area\ (square\ inches)}$	$F = \frac{231Q}{720A}$ or V = $\frac{.3208Q}{A}$
Cylinder Vol. capacity In gallons of fluid	VELOCITY = $\frac{\prod \text{ x } Radius^2 \text{ x stroke (inches)}}{231}$	$V = \frac{\pi r^2 l}{231}$
	NET AREA = $\frac{Net\ area\ (square\ inches)\ x\ stroke\ (inches)}{231}$	V = $\frac{Al}{231}$ l = length of stroke
Cylinder flow rate In gallons per min.	FLOW RATE = $\frac{12 \text{ x } 60 \text{ x } velocity\ (Feet/sec)\ x\ Net\ area\ (sq.inches)}{231}$	$Q = \frac{720vA}{231}$ or Q = 3.117vA
Fluid motor torque In inch pounds	TORQUE = $\frac{Pressure\ (psi) x\ F.M\ Displacement\ (Cu.In/Rev.)}{2\prod}$	T = $\frac{psid}{2\prod}$ or T = $\frac{pd}{2\prod}$
	$\frac{Horsepower\ x\ 63025}{RPM}$	T = $\frac{63025HP}{n}$
	$\frac{Flow\ rate\ (GPM) X\ pressure\ (psi)\ x\ 36.77}{RPM}$	T = $\frac{36.77QP}{n}$ or T = $\frac{36.77Qpsi}{n}$
Fluid motor torque/100 psi In inch pounds	TORQUE/ 100 psi = $\frac{F.M\ Displacement\ (Cu.In/Rev.)}{.0628}$	$T_{100psi} = \frac{d}{.0628}$
Fluid motor speed In revolutions/min	SPEED = $\frac{231\ X\ flow\ rate\ (GPM)}{F.M\ Displacement\ (Cu.In/Rev.)}$	n = $\frac{231Q}{d}$
Fluid motor power In horsepower output	Horsepower = $\frac{Torque\ output\ (Inch\ pounds) x\ RPM}{63025}$	HP = $\frac{Tn}{63025}$

THERMAL FORMULAS		
FORMULA FOR:	**WORD FORMULA**	**LETTER FORMULA**
Reservoir cooling capacity Based on adequate air circulation	HEAT (BTU/HR) = 2 x temp. diff btwn reservoir walls and air (°F) x area of reservoir (sq. feet)	BTU/HR = 2.0 x ΔT xA
Heat in hydraulic oil (approx.) Due to system efficiency (SG= .89.32)	HEAT (BTU/HR) = Flow rate (GPM) x 210 x Temp. difference (°F)	BTU/HR = Q x 210 xΔT
Heat in fresh water (approx.)	HEAT (BTU/HR) = Flow rate (GPM) x 500 x Temp. difference (°F)	BTU/HR = Q x 500 xΔT

ACCUMULATOR FORMULAS		
FORMULA FOR:	**WORD FORMULA**	**LETTER FORMULA**
Pressure or Volume With constant "T" temp.	Original pressure x original volume = Final pressure x Final volume	$P_1\ V_1 = P_2\ V_2$ Isothermic
Pressure or Temperature With constant "V" volume	Original pressure x Final temperature = Final pressure x Original temperature	$P_1\ T_2 = P_2\ T_1$ Isochoric
Pressure or Temperature With constant "P" pressure	Original volume x Final temperature = Final volume x original temperature	$V_1\ T_2 = V_2\ V_1$ Isobaric
Pressure or Temperature With temp. change due to heat of compression	Original pressure x original volume = Final pressure x Final volume	$P_1\ V_1^n = P_2\ V_2^n$
	$\frac{Final\ temp}{Orig.temp} = \left(\frac{Orig.\ volume}{Final\ volume}\right)^{n-1} = \left(\frac{Final\ pressure}{Orig.volume}\right)^{n-1/n}$	$\frac{T}{T} = \left(\frac{V_1}{V_2}\right)^{n-1} = \left(\frac{P_1}{P_2}\right)^{n-1/n}$