FLUID POWER DATA

FORMULAS

Basic Fluid Power Formulas:

Pressure	FORCE TRANSMITTED OVER AN AREA	$P = \frac{\text{FORCE (Pounds)}}{\text{AREA (Square Inches)}} = \frac{F}{A} = PSI$	
Flow	RATE EXPRESSED AS FLOW (GALLONS) VS. TIME (MIN)	$Q = \frac{\text{VOLUME (Gallons)}}{\text{TIME (Minutes)}} = \frac{GAL}{MIN} = GPM$	
Horsepower	FLUID POWER IN HORSEPOWER	$HP = \frac{\text{PRESSURE (PSI) X FLOW (GPM)}}{1714} = \frac{P \times Q}{1714}$	

Fluid Formulas:

Velocity	FLUID SPEED EXPRESSED AS FLOW (GPM) VS. INTERNAL PIPE FLOW AREA (SQ-IN)	$V = \frac{.3208 \times \text{FLOW (GPM)}}{\text{INTERNAL AREA (Sq In)}} = \frac{.3208 \times Q}{A}$ or $V = \frac{.4085 \times \text{FLOW (GPM)}}{\text{INTERNAL DIAMETER}^2} = \frac{.4085 \times Q}{ID^2}$	
Compressibility	APPROX. 1/2% PER 1000PSI- THEORETICAL. USE 3% PER 1000PSI AS A SAFE FIGURE ONCE AIR HAS BEEN BLED	$V_A = \frac{\text{PRESSURE (PSI) X VOLUME}}{\text{250,000 (approx.)}} = \frac{PSI \times VOL}{250{,}000}$	
Expansion	ADDITIONAL OIL GENERATED ABOVE ORIGINAL VOLUME DUE TO THERMAL EXPANSION	$V_A = \frac{\text{TEMP. CHANGE (°F) X VOLUME}}{\text{2000 (approx.)}} = \frac{\Delta T \times VOL}{2000}$	
Specific Gravity	EXPRESSED AS A COEFFICIENT (GENERALLY .86-.90 FOR MOST AW32 THRU AW68 OILS)	$S_G = \frac{\text{WEIGHT OF ONE CU-FT OF FLUID}}{\text{WEIGHT OF ONE CU-FT OF WATER}} = \frac{W}{62.4283}$	
Flow Coeff. C_v	COEFFICIENT OF FLOW - EXPRESSED IN GALLONS PER MINUTE OF 60° F WATER AT ONE PSI PRESSURE DROP ACROSS THE VALVE OR OTHER FLOW DEVICE.	$C_v = \frac{\text{FLOW RATE (GPM) X } \sqrt{\text{SPEC. GRAVITY}}}{\sqrt{\text{PRESSURE DROP (PSI)}}} = \frac{GPM \times \sqrt{S_G}}{\sqrt{\Delta P}}$	
Viscosity	FOR VISCOSITIES OF 32 TO 100 SAYBOLT UNIVERSAL SECONDS:	$CS = .2253 \times SUS - \frac{194.4}{SUS}$	APPROXIMATE VISCOSITIES AT 100°F: AW32- 150 SUS AW46- 205 SUS AW68- 310 SUS
	FOR VISCOSITIES OF 100 TO 240 SAYBOLT UNIVERSAL SECONDS:	$CS = .2193 \times SUS - \frac{134.6}{SUS}$	
	FOR VISCOSITIES ABOVE 240 SAYBOLT UNIVERSAL SECONDS:	$CS = \frac{SUS}{4.635}$	

Cylinder Formulas:

Area	OF A CIRCLE EXPRESSED AS SQUARE INCHES	$A = \pi \times \text{RADIUS}^2 \text{ (Inches)} = \pi \times r^2$	
		$A = \frac{\pi}{4} \times \text{DIAMETER}^2 \text{ (Inches)} = \frac{\pi D^2}{4} = .7854 \times D^2$	
Force	EXPRESSED IN POUNDS, IN FLUID GENERATED BY PRESSURE X AREA	$F = \text{PRESSURE (PSI) X AREA (Sq-In)} = P \times A$	
Speed	EXPRESSED IN INCHES/ SEC	$S = \frac{\text{3.85 X FLOW (GPM)}}{\text{CYL. EFFECTIVE AREA (Sq-In)}} = \frac{3.85 \times Q}{A}$	
Flow Rate	FLOW EXPRESSED IN GPM. NOTE: DEDUCT ROD AREA FOR CYL. RETRACT.	$Q = .26 \times \text{CYL. AREA (Sq-In)} \times \text{SPEED (In-Sec)} = .26 \times A \times S$	

Fluid Power Data

FORMULAS

Pump & Motor Formulas:

Flow	OUTLET FLOW OF PUMP- DISPLACEMENT VS. RPM	**GPM=** $\frac{\text{RPM X PUMP DISPLACEMENT (Cu-In)}}{231}$	= $\frac{\mathbf{n \times d}}{\mathbf{231}}$
Horsepower	INPUT HP REQUIRED TO OPERATE PUMPS	**HP=** $\frac{\text{PRESSURE (PSI) X FLOW (GPM)}}{\text{1714 X EFFICIENCY}}$	= $\frac{\mathbf{P \times Q}}{\mathbf{1714 \times EFF}}$
Torque	PRESSURE VS. HYD. MOTOR DISPLACEMENT (CU- IN). EXPRESSED IN INCH- LBS.	**T=** .159 X (PSI) X DISPLACEMENT (Cu-In)	= **.159 x P x d**
Horsepower	OUTPUT HP FROM HYD. MOTOR	**HP=** $\frac{\text{TORQUE (In-Lbs) X RPM X EFFICIENCY}}{63{,}025}$	= $\frac{\mathbf{T \times n \times EFF}}{\mathbf{63{,}025}}$

Thermal Formulas:

Heat Exchanger	BASIC FORMULA- HEAT INTO SYSTEM DUE TO INEFFICIENCY.	**BTU/HR=** 216.2 X ΔT X Q (System Flow GPM) ΔT= Oil Temp In- Oil Temp Out °F	= **216.2 x ΔT x Q**
Reservoir	COOLING CAPACITY OF STEEL TANK. ASSUMES ADEQUATE AIR CIRCULATION.	**HP=** .001 X ΔT (°F) X RESERVOIR AREA (Sq Ft) ΔT= Reservoir Oil Temp- Ambient Air Temp °F	= **.001 x ΔT x A**

Flow Data

Pipe

PIPE SIZE	FLOW- GPM @ 15 FT/SEC			PRESSURE (PSI, 4:1 SAFETY FACTOR)		
	SCH40	SCH80	SCH160	SCH40	SCH80	SCH160
1/8	2.7	1.7		3500	4800	
1/4	4.9	3.4		2100	4350	
3/8	9.0	6.6		1700	4800	
1/2	12.0	11.0	8.0	2300	4100	7300
3/4	25.1	20.3	12.7	2000	3500	6500
1	40.6	33.8	24.5	2100	3500	5700
1-1/4	70.3	60.2	49.7	1800	3000	4400
1-1/2	95.6	83.0	66.1	1700	2800	4500
2	157	139	105	1500	2500	4600
2-1/2	225	199	164	1900	2800	4200
3	347	310	254	1600	2600	4100

Hose

HOSE SIZE	FLOW- GPM @ 15 FT/SEC	PRESSURE (PSI, 4:1 SAFETY FACTOR)			
		1 WIRE	2 WIRE	4 WIRE	6WIRE
1/4	2.3	2750	5000		11250
3/8	5.2	2250	4000	4000	10000
1/2	9.2	2000	3500	4000	7500
3/4	20.7	1250	2250	4000	6250
1	36.7	1000	2000	4000	5000
1-1/4	57.4	625	1625	3000	3500
1-1/2	82.7		1250	2500	3000
2	147		1125	2500	3000

Tubing

TUBE SIZE	FLOW- GPM @ 15 FT/SEC WALL THICKNESS:							PRESSURE (PSI, 4:1 SAFETY FACTOR) WALL THICKNESS:						
	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.035	0.049	0.065	0.083	0.095	0.109	0.120
1/4	1.20	0.85						3850	5400					
3/8	3.44	2.84	2.21					2580	3600	4750				
1/2	6.83	5.97	5.06	4.11				1930	2700	3580	4560			
3/4		15.7	14.2	12.6	11.6	10.4			1800	2390	3050	3440	4000	
1		30	27.9	25.6	24.2	22.5	21.3		1350	1790	2280	2620	3000	3300
1-1/4				43.3	41.4	39.3	37.6				1830	2080	2400	2650
1-1/2					63.3	60.6	58.7					1740	2000	2200
2					120		114					1300		1650