

FLUID POWER DATA

FORMULAS



Basic Fluid Power Formulas:

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

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	$V_A = \frac{\text{PRESSURE (PSI)} \times \text{VOLUME}}{250,000 \text{ (approx.)}} = \frac{\text{PSI} \times \text{VOL}}{250,000}$
Expansion	ADDITIONAL OIL GENERATED ABOVE ORIGINAL VOLUME DUE TO THERMAL EXPANSION	$V_A = \frac{\text{TEMP. CHANGE (°F)} \times \text{VOLUME}}{2000 \text{ (approx.)}} = \frac{\Delta T \times \text{VOL}}{2000}$
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.	$C_v = \frac{\text{FLOW RATE (GPM)} \times \sqrt{\text{SPEC. GRAVITY}}}{\sqrt{\text{PRESSURE DROP (PSI)}}} = \frac{\text{GPM} \times \sqrt{S_G}}{\sqrt{\Delta P}}$
Viscosity	FOR VISCOSITIES OF 32 TO 100 SAYBOLT UNIVERSAL SECONDS: FOR VISCOSITIES OF 100 TO 240 SAYBOLT UNIVERSAL SECONDS: FOR VISCOSITIES ABOVE 240 SAYBOLT UNIVERSAL SECONDS:	$CS = .2253 \times \text{SUS} - \frac{194.4}{\text{SUS}}$ $CS = .2193 \times \text{SUS} - \frac{134.6}{\text{SUS}}$ $CS = \frac{\text{SUS}}{4.635}$

APPROXIMATE VISCOSITIES AT 100°F:
AW32- 150 SUS
AW46- 205 SUS
AW68- 310 SUS

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	$F = \text{PRESSURE (PSI)} \times \text{AREA (Sq-In)} = P \times A$
Speed	EXPRESSED IN INCHES/ SEC	$S = \frac{3.85 \times \text{FLOW (GPM)}}{\text{CYL. EFFECTIVE AREA (Sq-In)}} = \frac{3.85 \times Q}{A}$
Flow Rate	FLOW EXPRESSED IN GPM. NOTE: DEDUCT ROD AREA FOR CYL. RETRACT.	$Q = .26 \times \text{CYL. AREA (Sq-In)} \times \text{SPEED (In-Sec)} = .26 \times A \times S$

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Pump & Motor Formulas:

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

Thermal Formulas:

Heat Exchanger	BASIC FORMULA- HEAT INTO SYSTEM DUE TO INEFFICIENCY.	BTU/HR= $216.2 \times \Delta T \times Q$ (System Flow GPM)	= $216.2 \times \Delta T \times Q$ <small>$\Delta T = \text{Oil Temp In- Oil Temp Out } ^\circ\text{F}$</small>
Reservoir	COOLING CAPACITY OF STEEL TANK. ASSUMES ADEQUATE AIR CIRCULATION.	HP= $.001 \times \Delta T (^\circ\text{F}) \times \text{RESERVOIR AREA (Sq Ft)}$	= $.001 \times \Delta T \times A$ <small>$\Delta T = \text{Reservoir Oil Temp- Ambient Air Temp } ^\circ\text{F}$</small>

Flow Data

Pipe							Hose					
PIPE SIZE	FLOW- GPM @ 15 FT/SEC			PRESSURE (PSI, 4:1 SAFETY FACTOR)			HOSE SIZE	FLOW- GPM @ 15 FT/SEC	PRESSURE (PSI, 4:1 SAFETY FACTOR)			
	SCH40	SCH80	SCH160	SCH40	SCH80	SCH160			1 WIRE	2 WIRE	4 WIRE	6WIRE
1/8	2.7	1.7		3500	4800		1/4	2.3	2750	5000		11250
1/4	4.9	3.4		2100	4350		3/8	5.2	2250	4000	4000	10000
3/8	9.0	6.6		1700	4800		1/2	9.2	2000	3500	4000	7500
1/2	12.0	11.0	8.0	2300	4100	7300	3/4	20.7	1250	2250	4000	6250
3/4	25.1	20.3	12.7	2000	3500	6500	1	36.7	1000	2000	4000	5000
1	40.6	33.8	24.5	2100	3500	5700	1-1/4	57.4	625	1625	3000	3500
1-1/4	70.3	60.2	49.7	1800	3000	4400	1-1/2	82.7		1250	2500	3000
1-1/2	95.6	83.0	66.1	1700	2800	4500	2	147		1125	2500	3000
2	157	139	105	1500	2500	4600						
2-1/2	225	199	164	1900	2800	4200						
3	347	310	254	1600	2600	4100						

Tubing

TUBE SIZE	FLOW- GPM @ 15 FT/SEC							PRESSURE (PSI, 4:1 SAFETY FACTOR)						
	WALL THICKNESS:							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

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