FUNDAMENTAL INFORMATION ON OIL HYDRAULICS

PUSHING AND PULLING FORCE OF HYDRAULIC CYLINDERS

Cylinder Diameter, Inches	1	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6	6 1/2
Cylinder Area, Square Inch	.7854	1.767	3.142	4.909	7.065	9.621	12.57	15.90	19.64	23.76	28.27	33.18
Pushing Force, Lbs @ 1000 PSI	780	1767	3142	4909	7065	9621	12750	15900	19640	23760	28270	33180
Pulling Force, Lbs @ 1000 PSI	343	1325	2034	3801	5951	8513	11460	14790	18530	22650	27160	32070

FORMULAS AND ABBREVIATIONS

HP- Horsepower
GPS - Gallons per Second
1 Gallon - 231 Cubic Inches
PSI x Cylinder area Force
GPM - Gallons per Minute
PSI - Pounds per square inch
RPM - Revolutions per Minute
Horsepower = GPM x PSI ÷ 1714
Horsepower = Torque(foot lbs.) x RPM ÷ 5252

PUMP CAPACITY OR OUTPUT REQUIRED

To determine gallon capacity or output of the pump required to operate a cylinder or cylinders at a predetermined or required speed, proceed as follows:

(1) Establish in seconds the time required to extend the cylinder to its full length.
(2) Determine cubic inch capacity of cylinder (area x length of stroke.)
(3) Convert cubic inches capacity of cylinders to gallons. (Cubic inches ÷ 231 = cylinder capacity in gallons.)
(4) Cylinder capacity in gallons ÷ required speed in seconds = Gallons per second (GPS).
(5) GPS x 60 = Gallons per minute (GPM).

Example: If it has been determined that a 3” x 50” stroke cylinder must extend the full length in 4 seconds, proceed as follows:

Find cylinder area from table above.
Area of a 3” cylinder is 7.065 square inches.
Capacity of cylinder is 7.065 x 50 = 353.25 cubic inches.
353.25 cubic inches ÷ 231 = 1.530 gallons.
1.530 gallons ÷ 4 seconds = .3825 gallons per second.
.3825 gallons per second x 60 = 22.90 gallons per minute.

Therefore, the pump required must have output of 22.95 gallons per minute.

HORSEPOWER REQUIREMENTS

A practical formula for determining horsepower requirements for pumps is as follows:

Gallons per minute x PSI Required ÷ 1714 = Horsepower.

Example: If a pump delivers 12 GPM and assuming that the required operating pressure is 1,000 PSI.
Then multiply 12 GPM x 1,000 PSI = 12,000.
12,000 ÷ 1714 = 7.0 horsepower.
Therefore, it takes 7.0 horsepower to operate the pump.

HYDRAULIC CYLINDER FORCE

To determine the force exerted by hydraulic cylinder:
Multiply the hydraulic pressure by the cylinder area.

Example: Find force for a 3” cylinder at 1,000 PSI.
Find cylinder area from table above.
Area of a 3” cylinder is 7.065 square inches.
7,065 square inches x 1,000 PSI = 7065 lbs. pushing force. If pulling power is desired, find the area of piston rod.
For 1-3/16” rod, 1.1875 x 1.1875 x .785 = 1.114 square inch.
This is subtracted from the cylinder area.
7.065 minus 1.114 = 5.951 square inches.
5.951 square inches x 1,000 PSI = 5951 lbs. pulling force.

HYDRAULIC CYLINDER CUBIC DISPLACEMENT

To determine the cubic displacement of hydraulic cylinder:
Multiply the cylinder area by the length of the cylinder stroke.

Example: A 3” cylinder with 50” stroke.
Find cylinder area from table above.
Area of a 3” cylinder = 7.065 square inches.
7.065 square inches x 50” = 353.45 cubic inches.
To convert to gallons, divide by 231.
353.45 ÷ 231 = 1.530 gallons displacement.

CYLINDER PRESSURE CHART

PUSH With Various Pressures Cylinder Power in Pounds At Various Pressure

Pump Pressure →	3,000	2,500	2,000	1,500	1,250	1,000	750	500
5" Bore	58,899	49,083	39,267	29,451	24,543	19,635	14,724	9,816
4" Bore	37,694	31,412	25,130	18,848	15,707	12,566	9,423	6,282
3-1/2" Bore	28,861	24,051	19,241	14,431	12,026	9,621	7,215	4,810
3" Bore	21,204	17,670	14,136	10,602	8,835	7,068	5,301	3,534
2-1/2" Bore	14,724	12,270	9,816	7,362	6,136	4,908	3,681	2,454
2" Bore	9,421	7,851	6,281	4,711	3,926	3,141	2,355	1,570
1-1/2" Bore	5,295	4,413	3,531	2,649	2,208	1,767	1,323	882

PULL With Various Pressures

Pump Pressure →	3,000	2,500	2,000	1,500	1,250	1,000	750	500
5" Bore, 2" Shaft	49,478	41,232	32,986	24,740	20,617	16,494	12,369	8,246
5" Bore, 1-1/2" Shaft	53,604	44,670	35,736	26,802	22,335	17,868	13,401	8,934
4" Bore, 2" Shaft	28,273	23,561	18,849	14,137	11,781	9,425	7,068	4,712
4" Bore, 1-1/2" Shaft	32,391	26,993	21,595	16,197	13,498	10,799	8,097	5,398
4" Bore, 1-1/4" Shaft	34,011	28,343	22,675	17,007	14,173	11,339	8,502	5,668
3-1/2" Bore, 2" Shaft	19,440	16,200	12,960	9,720	8,100	6,480	4,860	3,240
3-1/2" Bore, 1-1/2" Shaft	23,558	19,632	15,706	11,780	9,817	7,854	5,889	3,926
3-1/2" Bore, 1-1/4" Shaft	25,178	20,982	16,786	12,590	10,492	8,394	6,294	4,196
3" Bore, 1-1/2" Shaft	15,901	13,251	10,601	7,951	6,626	5,301	3,975	2,650
3" Bore, 1-1/4" Shaft	17,521	14,601	11,681	8,761	7,301	5,841	4,380	2,920
3" Bore, 1-1/8" Shaft	18,218	15,182	12,146	9,110	7,592	6,074	4,554	3,036
2-1/2" Bore, 1-1/16" Shaft	12,062	10,052	8,042	6,032	5,027	4,022	3,015	2,010
2" Bore, 1-1/16" Shaft	6,759	5,633	4,507	3,381	2,818	2,255	1,689	1,126
1-1/2" Bore, 3/4" Shaft	3,974	3,312	2,650	1,988	1,657	1,326	993	662

NOTE: - The Pull at a given pressure will change according to shaft size.