FLUID POWER
Design Data Sheet

Womack ™
Machine Supply Co.

Revised Sheet 74 - Womack Design Data File

WORKING WITH ISO METRIC CYLINDERS- PART 1

Sometime in the future, cylinders and other fluid power components will be built to ISO (International Standards Organization) dimensions in which metric measurements are used. Conversion to international standards has been slow in the United States, and at the time this sheet was prepared the availability of metric dimension cylinders was quite limited, but complete conversion will come in due time.

Cylinder force charts in this sheet cover standardized bore and rod combinations from 25mm through 200mm bore and with standard and maximum size piston rods. Intermediate size piston rods will no doubt be offered by most manufacturers. ISO standard sizes also include bore sizes of 8, 10, 12, 16, 20, 250, 320, and 400mm.

Calculations of cylinder force and velocity are not quite as straightforward as in the U. S. system because of extra conversions between units which become necessary. The ISO units which will be used in cylinder calculations are these:

FORCE. Force values are in Newtons (N). One Newton is equal to about 1/4 pound (0.2248 lb. to be exact), or 1 pound is equal to about 4½ N (4.448 N to be exact). This unit should serve for most cylinder calculations except where very large forces are involved in which the kilo Newton (kN) equal to 1,000 N may be used.

PISTON AREA. Piston bore is cataloged in units of millimeters (mm) as shown in the charts. For area, the mm² is too small for convenient calculations, so the unit for piston surface area will be the square centimeter (cm²). To calculate piston area, change bore diameter to em by dividing by 10. Then, find cm² piston area with the formula: $A = \pi r^2$ in the usual manner.

METRIC HYDRAULIC CYLINDERS - FORCE CHART - 25 TO 175 BARS PRESSURE

Bars			25	50	75	100	125	150	175
Kilo Pascals			2,500	5,000	7,500	10,000	12,500	15,000	17,500
PSI			363	725	1,088	1,450	1,813	2,175	2,538
Bore mm.	Bore cm.	Area sq. cm.	Theoretical Cylinder Force in Newtons						
25	2.5	4.91	1,227	2,454	3,680	4,907	6,138	7,361	8,587
32	3.2	8.04	2,011	4,021	6,032	8,042	10,053	10,053	12,063
40	4.0	12.57	3,142	6,283	9,425	12,566	15,708	18,849	21,991
50	5.0	19.63	4,909	9,817	14,726	19,634	24,543	29,451	34,360
63	6.3	31.17	7,793	15,585	23,378	31,170	38,963	46,755	54,548
80	8.0	50.27	12,566	25,133	37,699	50,265	62,831	75,398	87,964
100	10.0	78.54	19,935	39,270	58,904	78,539	98,174	117,809	137,443
125	12.5	122.72	30,679	61,358	92,037	122,716	153,395	184,074	214,753
160	16.0	201.06	50,265	100,531	150,796	201,061	251,326	301,592	351,857
200	20.0	314.16	78,540	157,080	235,619	314,159	392,699	471,239	549,778

METRIC HYDRAULIC CYLINDERS - FORCE CHART - 200 TO 350 BARS PRESSURE

Bars			200	225	250	275	300	325	350
Kilo Pascals			20,000	22,500	25,000	27,500	30,000	32,500	35,000
PSI			2,900	3,263	3,625	3,988	4,350	4,713	5,075
Bore mm.	Bore cm.	Area sq. cm.	Theoretical Cylinder Force in Newtons						
25	2.5	4.91	9,814	11,041	12,268	13,494	14,721	15,948	17,175
32	3.2	8.04	16,084	18,095	20,105	22,116	24,126	26,137	28,147
40	4.0	12.57	25,132	28,274	31,415	34,557	37,698	40,840	43,981
50	5.0	19.63	39,268	44,177	49,805	53,994	58,902	63,811	68,719
63	6.3	31.17	62,340	70,133	77,925	85,718	93,510	101,303	109,095
80	8.0	50.27	100,530	113,096	125,663	138,229	150,795	163,361	175,928
100	10.0	78.54	157,078	176,713	196,348	215,982	235,617	255,252	274,887
125	12.5	122.72	245,432	276,111	306,790	337,469	368,148	398,827	429,506
160	16.0	201.06	402,122	452,387	502,653	552,918	603,183	653,448	703,714
200	20.0	314.16	628,318	706,858	785,398	863,937	942,477	1,021,017	1,099,557

PRESSURE. Fluid pressure will usually be expressed in kilo Pascals (kPa) because the Pascal, which is defined as one Newton of force per square meter, is such a small unit that it is hard to work with in making calculations. One kPa = 1,000 Pa.

The bar is a more convenient unit for fluid pressure and will be allowed, at least for a limited time. The bar is related to the Pascal. One bar = 100,000 Pascals or 100 kPa. It is also equal to 14.5 PSI which is very close to one atmosphere. Pressure values in these charts are given in three pressure units, bars, kPa, and PSI, to help a person get a "feel" for the way metric pressure units compare with PSI units he has been using.

PUMP FLOW. Oil flow from a hydraulic pump is expressed in liters per minute (1/min). A litre is defined as one cubic decimeter (dm³), and is roughly ¼ gallon (0.2642 gallon to be exact). Or, 1 gal. = 3.785 liters. On very large flows, units of liters per second (lis) can be used.

FORCE CALCULATION. Cylinder force is calculated by multiplying piston surface area times fluid pressure:

$$F = A \times P \div 70, \text{ in which:}$$

F = force, in Newtons (N).
A = piston area in square centimeters (cm²).
P = differential pressure across ports in kPa.
10 is a necessary conversion between metric units.

When working with pressure in bars, the formula becomes:

$$F = A \times P \times 10, \text{ in which:}$$

P is differential pressure, in bars.

METRIC AIR CYLINDERS - FORCE CHART - 3 TO 6 BARS PRESSURE

Bars			3	3½	4	4½	5	5½	6
Kilo Pascals			300	350	400	450	500	550	600
PSI			43.5	50.8	58.0	65.3	72.5	79.8	87.0
Bore mm.	Bore cm.	Area sq. cm.	Theoretical Cylinder Force in Newtons						
25	2.5	4.91	147	172	196	221	245	270	294
32	3.2	8.04	241	281	322	362	402	442	483
40	4.0	12.57	377	440	503	565	628	691	754
50	5.0	19.63	589	687	785	884	982	1,080	1,178
63	6.3	31.17	935	1,091	1,247	1,403	1,559	1,714	1,870
80	8.0	50.27	1,508	1,759	2,011	2,262	2,513	2,765	3,016
100	10.0	78.54	2,356	2,749	3,142	3,534	3,927	4,320	4,712
125	12.5	122.72	3,681	4,295	4,909	5,522	6,136	6,749	7,363
160	16.0	201.06	6,032	7,037	8,042	9,048	10,053	11,058	12,064
200	20.0	314.16	9,225	10,996	12,566	14,137	15,708	17,279	18,850

METRIC AIR CYLINDERS - FORCE CHART - 6½ TO 11 BARS PRESSURE

Bars			6½	7	7½	8	9	10	11
Kilo Pascals			650	700	750	800	900	1,000	1,100
PSI			94.3	102	109	116	131	145	160
Bore mm.	Bore cm.	Area sq. cm.	Theoretical Cylinder Force in Newtons						
25	2.5	4.91	319	343	368	393	442	491	540
32	3.2	8.04	523	563	603	643	724	804	885
40	4.0	12.57	817	880	942	1,005	1,131	1,257	1,382
50	5.0	19.63	1,276	1,374	1,473	1,571	1,767	1,963	2,160
63	6.3	31.17	2,026	2,182	2,338	2,494	2,805	3,117	3,429
80	8.0	50.27	3,267	3,519	3,770	4,021	4,524	5,027	5,529
100	10.0	78.54	5,105	5,498	5,890	6283	7,069	7,854	8,639
125	12.5	122.72	7,977	8,590	9,204	9,817	11,044	12,272	13,499
160	16.0	201.06	13,069	14,072	15,080	16,085	18,095	20,106	22,117
200	20.0	314.16	20,420	21,991	23,562	25,133	28,274	31,416	34,557

CROSSOVER - METRIC TO INCH BORE SIZES

Metric mm.	Exact Inches	App. Inches	Metric mm.	Exact Inches	App. Inches
25	0.984	1	80	3.150	3¼
32	1.260	1¼	100	3.937	4
40	1.575	1½	125	4.921	5
50	1.969	2	160	6.300	6½
63	2.362	2½	200	7.874	8