Fluid Power Design Data Sheet

Evolution MOTION SOLUTIONS

REVISED SHEET 57 - EVOLUTION DESIGN DATA FILE

PRESSURE LOSS DUE TO FLUID FLOW THROUGH PIPES

This table has been calculated from a formula published by the Crane Co. on Page 3-12 of Technical Paper 410. It shows the approximate pressure loss per 100 feet of Schedule 40 pipe with hydraulic oil of known specific gravity and known viscosity flowing through it. The formula used is: $\Delta P = 0.0668\ uv \div D^2$, in which: ΔP is pressure loss per 100 feet of pipe: u is viscosity in centipoises (not SSU); v is flow of velocity in feet per second; D is inside diameter of pipe, in inches.

Note: Absolute viscosity in centipoises must be used in the formula. For any fluid this is the kinematic viscosity in centistokes times the specific gravity. An absolute viscosity of 40 centipoises was used for calculating the table. This corresponds approximately to a hydraulic oil with 0.9 specific gravity and a viscosity of 220 SSU (or 44.4 centicentipoises stokes). See back side of sheet for other fluids.

TABLE 1. PRESSURE LOSS PER 100 FEET SCHEDULE 40 PIPE WITH OIL OF 220 SSU AND 0.9 SPECIFIC GRAVITY

GPM	Pipe Size*	Pres. Drop**	Flow Veloc†	GPM	Pipe Size*	Pres. Drop**	Flow Veloc†	GPM	Pipe Size*	Pres. Drop**	Flow Veloc†
3	1/8	624	17	35	1/2	249	36	90	1	80	33
	1/4	187	9.3		3/4	83	21		1¼	27	19
	3/8	55	5.0		1	32	13		1½	15	14
	1/2	22	3.2		1¼	11	7.5		2	5.4	8.6
	3/4	7.1	1.8		1½	5.7	5.5		2½	2.6	6.0
6	1/4	373	19	40	3/4	95	24	100	1	92	38
	3/8	111	10		1	36	15		1¼	30	22
	1/2	44	6.3		1¼	12	8.6		1½	16	16
	3/4	14	3.6		1½	6.5	6.3		2	6.0	9.6
	1	5.4	2.2		2	2.4	3.8		2½	2.9	6.7
10	3/8	185	17	45	3/4	106	27	125	1	114	47
	1/2	73	11		1	41	17		1¼	38	27
	3/4	24	6.0		1¼	14	9.7		1½	20	20
	1	9.0	3.7		1½	4.4	7.1		2	7.5	12
	1¼	3.0	2.2		2	2.7	4.3		2½	9.8	8.4
15	1/2	109	16	50	3/4	122	31	150	1¼	44	31
	3/4	36	9.0		1	46	19		1½	24	24
	1	14	5.6		1¼	15	11		2	8.9	14
	1¼	4.5	3.2		1½	8.1	7.9		2½	4.4	10
	1½	2.4	2.4		2	3.0	4.8		3	1.8	6.4
20	1/2	146	21	60	3/4	142	36	175	1¼	53	38
	3/4	47	12		1	53	22		1½	29	28
	1	18	7.4		1¼	18	13		2	10	17
	1¼	6.0	4.3		1½	9.8	9.5		2½	5.1	12
	1½	3.2	3.2		2	3.6	5.7		3	2.2	7.6
25	1/2	180	26	70	3/4	205	42	200	1¼	60	43
	3/4	59	15		1	63	26		1½	32	31
	1	23	9.3		1¼	21	15		2	12	19
	1¼	7.6	5.4		1½	11	11		2½	5.9	13
	1½	4.0	3.9		2	4.2	6.7		3	2.5	8.7
30	1/2	214	31	80	1	75	31	225	1¼	69	49
	3/4	71	18		1¼	24	17		1½	37	36
	1	27	11		1½	13	13		2	13	22
	1¼	9.0	6.4		2	4.8	7.7		2½	6.6	15
	1½	4.8	4.7		2½	2.3	5.4		3	2.8	9.8
*Standard Schedule 40 pipe.				**Pressure loss per 100 feet of pipe				†Oil flow velocity in feet per second			

For pressure loss per 100 feet of steel tubing, use the nearest NPT size shown in this table. Find pressure loss from **Table 1** on front side of this sheet. Then, multiply this loss times the factor shown in the last column of this table.

Example: For a flow of 50 GPM through a tube of 1½" OD with .095 wall, use the 114" pipe size under 50 GPM in **Table 1**. This shows a 265 PSI loss per 100 feet. Multiply this times 1.11 from Table 2 = 295 PSI per 100 feet loss.

TABLE 2. CONVERSION FACTORS FOR USING TABLE 1 FOR STEEL TUBING

Tube O.D.	Wall Thick.	Tube I.D.	Use NPT	Mult. by
3/16	0.032	0.124	1/4	8.69
1/4	0.035	0.180	1/4	4.09
	0.042	0.166	1/4	4.81
	0.049	0.152	1/4	5.73
	0.058	0.134	1/4	7.38
	0.065	0.120	1/4	9.20
3/8	0.035	0.305	1/4	1.42
	0.042	0.291	1/4	1.56
	0.049	0.277	1/4	1.73
	0.058	0.259	1/4	1.97
	0.065	0.245	1/4	2.21
1/2	0.035	0.430	3/8	1.31
	0.042	0.416	3/8	1.40
	0.049	0.402	3/8	1.50
	0.058	0.384	3/8	1.65
	0.065	0.370	3/8	1.78
	0.072	0.356	3/8	2.01
	0.083	0.334	3/8	2.18
3/4	0.049	0.652	1/2	0.910
	0.058	0.634	1/2	0.962
	0.065	0.620	1/2	1.01
	0.072	0.606	1/2	1.08
	0.083	0.584	1/2	1.13
	0.095	0.560	1/2	1.23
	0.109	0.532	1/2	1.37
1	0.049	0.902	3/4	0.835
	0.058	0.884	3/4	0.869
	0.065	0.870	3/4	0.897
	0.072	0.856	3/4	0.927
	0.083	0.834	3/4	0.976
	0.095	0.810	3/4	1.03
	0.109	0.782	3/4	1.11
	0.120	0.760	3/4	1.18
1¼	0.049	1.152	1	0.830
	0.058	1.134	1	0.857
	0.065	1.120	1	0.878
1¼	0.072	1.106	1	0.901
	0.083	1.084	1	0.938
	0.095	1.060	1	0.981
	0.109	1.032	1	1.03
	0.120	1.010	1	1.08
1½	0.065	1.370	1¼	1.01
	0.072	1.356	1¼	1.04
	0.083	1.334	1¼	1.07
	0.095	1.310	1¼	1.11
	0.109	1.282	1¼	1.16
	0.120	1.260	1¼	1.20
2	0.065	1.870	2	1.22
	0.072	1.856	2	1.24
	0.083	1.834	2	1.27
	0.095	1.810	2	1.30
	0.109	1.782	2	1.35
	0.120	1.760	2	1.38
	0.134	1.732	2	1.42

HOW TO ADJUST FOR OTHER FLUIDS AND CONDITIONS

To use the information on this data sheet, first find the multiplying factor, if necessary, to convert from Schedule 40 to other schedules or to steel tubing. Follow instructions above **Table 2** to find the multiplying factor.

Next, use **Table 1**, regardless of the kind of fluid used, to find the pressure loss per 100 feet. If applicable, use conversion factor obtained from **Table 2**. Use **Table 3** to adjust for viscosities other than 220 SSU. If using a fluid other than oil, adjust for its gravity as explained in opposite column.

Generally, as shown by the formula on the front side of this sheet, pressure loss increases in direct proportion to an increase in velocity. This can be seen also in **Table 1**.

Always keep in mind that centistoke viscosity defines only the flow resistance to shear in the fluid. Centipoise viscosity defines the combined flow resistance including both shear in the fluid and specific gravity. Centipoises = Centistokes x specific gravity.

ADJUSTING FOR OTHER VISCOSITIES

Pressure loss through a pipe is directly proportional to viscosity in centistokes (for a given specific gravity). This table may be used with the chart on the front side to adjust pressure loss per 100 feet to oil with viscosity other than 220 SSU. **Example:** A hydraulic oil of 500 SSU will have a higher pressure loss than shown in the table by a factor of 2.48 for the same size pipe and the same flow. In using Table 3, multiply factor in 3rd column times the pressure loss shown in Table 1. Water is a special case. For straight water, pressure loss will be approximately half the values shown in **Table 1**.

TABLE 3

SSU Vis.	Centi-stokes	Fac-tor
80	15.8	0.356
100	20.8	0.468
150	33	0.743
300	65	1.46
400	87	1.96
500	110	2.48
750	163	3.67
1000	220	4.95
2000	420	9.46
3000	630	14..2
4000	850	19.1

ADJUSTING FOR OTHER GRAVITIES

Pressure loss through a pipe is directly proportional to specific gravity of the fluid. Other hydraulic fluids have a higher specific gravity than petroleum oil and (at the same viscosity) will have a higher pressure loss. Water/oil emulsions will have 7% higher, water/glycol will have 14% higher, and phosphate ester will have 22% higher pressure loss than petroleum hydraulic oil.

TABLE 4. PRESSURE LOSS THROUGH FITTINGS

Pressure loss through common fittings is shown in terms of the equivalent length of straight pipe of the same size. **Example:** The flow from the side outlet of a 1½" tee suffers the same pressure loss as if it were flowing through a 9 foot straight length of the same pipe. For pipe sizes less than 1/2", pressure loss through fittings is little more than for a straight section of the same length. (the Crane Company)

	NPT Pipe Size								
	1/2"	3/4"	1"	1¼"	1½"	2"	2½"	3"	3½"
Tee, Side	3½	4½	5½	7½	9	11½	14	16½	20
45° El	¾	1	1¼	1¾	2	2½	3	3¾	4½
90° El	1½	2	2¾	3¼	4¼	5	6	8	9½