FLUID POWER Design Data Sheet

Revised Sheet 57 - Womack 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 pages 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: $\Delta P = 0.0668\ \mu v \div D^2$, in which: ΔP is pressure loss per 100 feet of pipe:

μ is viscosity in centipoises (not SSU);
v is flow 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†
3	1/8	624	17
	1/4	187	9.3
	3/8	55	5.0
	1/2	22	3.2
	3/4	7.1	1.8
6	1/4	373	19
	3/8	111	10
	1/2	44	6.3
	3/4	14	3.6
	1	5.4	2.2
10	3/8	185	17
	1/2	73	11
	3/4	24	6.0
	1	9.0	3.7
	1¼	3.0	2.2
15	1/2	109	16
	3/4	36	9.0
	1	14	5.6
	1¼	4.5	3.2
	1½	2.4	2.4
20	1/2	146	21
	3/4	47	12
	1	18	7.4
	1¼	6.0	4.3
	1½	3.2	3.2
25	1/2	180	26
	3/4	59	15
	1	23	9.3
	1¼	7.6	5.4
	1½	4.0	3.9
30	1/2	214	31
	3/4	71	18
	1	27	11
	1¼	9.0	6.4
	1½	4.8	4.7

GPM	Pipe Size*	Pres. Drop**	Flow Veloc†
35	1/2	249	36
	3/4	83	21
	1	32	13
	1¼	11	7.5
	1½	5.7	5.5
40	3/4	95	24
	1	36	15
	1¼	12	8.6
	1½	6.5	6.3
	2	2.4	3.8
45	3/4	106	27
	1	41	17
	1¼	14	9.7
	1½	4.4	7.1
	2	2.7	4.3
50	3/4	122	31
	1	46	19
	1¼	15	11
	1½	8.1	7.9
	2	3.0	4.8
60	3/4	142	36
	1	53	22
	1¼	18	13
	1½	9.8	9.5
	2	3.6	5.7
70	3/4	205	42
	1	63	26
	1¼	21	15
	1½	11	11
	2	4.2	6.7
80	1	75	31
	1¼	24	17
	1½	13	13
	2	4.8	7.7
	2½	2.3	5.4

GPM	Pipe Size*	Pres. Drop**	Flow Veloc†
90	1	80	33
	1¼	27	19
	1½	15	14
	2	5.4	8.6
	2½	2.6	6.0
100	1	92	38
	1¼	30	22
	1½	16	16
	2	6.0	9.6
	2½	2.9	6.7
125	1	114	47
	1¼	38	27
	1½	20	20
	2	7.5	12
	2½	9.8	8.4
150	1¼	44	31
	1½	24	24
	2	8.9	14
	2½	4.4	10
	3	1.8	6.4
175	1¼	53	38
	1½	29	28
	2	10	17
	2½	5.1	12
	3	2.2	7.6
200	1¼	60	43
	1½	32	31
	2	12	19
	2½	5.9	13
	3	2.5	8.7
225	1¼	69	49
	1½	37	36
	2	13	22
	2½	6.6	15
	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″ O.D. with 0.095 wall, use the 1¼″ pipe size under 50 GPM in **Table 1**. This shows a 15 PSI loss per 100 feet. Multiply this times 0.981 from **Table 2** = 14.71 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	Tube O.D.	Wall Thick.	Tube I.D.	Use NPT	Mult. by	Tube O.D.	Wall Thick.	Tube I.D.	Use NPT	Mult. by
3/16	0.032	0.124	1/4	8.69		0.049	0.652	1/2	0.910		0.072	1.106	1	0.901
	0.035	0.180	1/4	4.09		0.058	0.634	1/2	0.962		0.083	1.084	1	0.938
	0.042	0.166	1/4	4.81		0.065	0.620	1/2	1.01	1¼	0.095	1.060	1	0.981
1/4	0.049	0.152	1/4	5.73	3/4	0.072	0.606	1/2	1.08		0.109	1.032	1	1.03
	0.058	0.134	1/4	7.38		0.083	0.584	1/2	1.13		0.120	1.010	1	1.08
	0.065	0.120	1/4	9.20		0.095	0.560	1/2	1.23		0.065	1.370	1¼	1.01
	0.035	0.305	1/4	1.42		0.109	0.532	1/2	1.37		0.072	1.356	1¼	1.04
	0.042	0.291	1/4	1.56		0.049	0.902	3/4	0.835	1½	0.083	1.334	1¼	1.07
3/8	0.049	0.277	1/4	1.73		0.058	0.884	3/4	0.869		0.095	1.310	1¼	1.11
	0.058	0.259	1/4	1.97		0.065	0.870	3/4	0.897		0.109	1.282	1¼	1.16
	0.065	0.245	1/4	2.21	1	0.072	0.856	3/4	0.927		0.120	1.260	1¼	1.20
	0.035	0.430	3/8	1.31		0.083	0.834	3/4	0.976		0.065	1.870	2	1.22
	0.042	0.416	3/8	1.40		0.095	0.810	3/4	1.03		0.072	1.856	2	1.24
	0.049	0.402	3/8	1.50		0.109	0.782	3/4	1.11		0.083	1.834	2	1.27
1/2	0.058	0.384	3/8	1.65		0.120	0.760	3/4	1.18	2	0.095	1.810	2	1.30
	0.065	0.370	3/8	1.78		0.049	1.152	1	0.830		0.109	1.782	2	1.35
	0.072	0.356	3/8	2.01	1¼	0.058	1.134	1	0.857		0.120	1.760	2	1.38
	0.083	0.334	3/8	2.18		0.065	1.120	1	0.878		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 × 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**.

Table 3.

SSU Vis.	Centi-stokes	Factor
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
1,000	220	4.95
2,000	420	9.46
3,000	630	14.2
4,000	850	19.1

Water is a special case. For straight water, pressure loss will be approximately half the values shown in **Table 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).

Table 4. *Pressure loss through fittings*

	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° Elbow	¾	1	1¼	1¾	2	2½	3	3¾	4½
90° Elbow	1½	2	2¾	3¼	4¼	5	6	8	9½

Published by:
WOMACK EDUCATIONAL PUBLICATIONS
Womack Machine Supply Co.
13835 Senlac Dr.
Farmers Branch, TX 75234
Tel: 800-859-9801
Fax: 214-630-5314
www.womack-educational.com