TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE CASPER, WYOMING SOIL CONSERVATION SERVICE

Engineering No. 10 (Revised) May 23, 1975

Friction Head Loss and Pipeline Properties

Plastic -- Welded Steel -- Asbestos Cement

Two procedures are presented to determine friction head loss in pipelines.

If angles, valves, etc., are involved, additional computations will be required to determine head loss in these obstructions. These losses and entrance losses may be obtained from the Engineering Field Manual, Chapter 3, Hydraulics.

Procedure #1 $H_f = (F)\ (Q)^2\ (L)/1000 = (S)(L)/1000$

H_f = Friction Head Loss in Feet.
Q = Capacity of Pipeline in cfs.
L = Length of Pipeline in Feet.
S = $(F)(Q)^2$ = Friction Slope of Pipeline in Feet/1000 ft.
F = Friction Loss Factor from table.

$$F = \left(\frac{n}{.463\ (d)^{8/3}}\right)^2 1000$$

n = roughness coefficient.
n = 0.009 - Plastic Pipe.
n = 0.012 - Welded Steel Pipe (W.S.).
n = 0.010 - Asbestos Cement Pipe (A.C.).
d = Inside Diameter of Pipe in "Feet".

Sample Problem:

Given: 10" diameter, 12 gage welded steel pipelines, 1300 feet long. Capacity = 3.5 cfs.

Find: Total friction loss using F factor.

1. Select (F) factor from Table. F = 1.9882.
2. Total Friction Loss = H_f

$$H_f = (F)(Q)^2(L)/1000 = (1.9882)(3.5)^2(1300)/1000 = 31.66 \text{ feet.}$$

Procedure #2 $H_f = (V^2/2_g)\ (K_p)\ (L)$

H_f = Friction Head Loss in Feet.
$V^2/2_g$ = Velocity Head in Feet.
L = Length of Pipeline in Feet.
K_p = Friction Loss Factor from table.

$$K_p = \frac{5087\ (n)^2}{(d)\ 4/3}$$

n = roughness coefficient.
n = 0.009 - Plastic Pipe.
n = 0.012 - Welded Steel Pipe (W.S.).
n = 0.010 - Asbestos Cement Pipe (A.C.).
d = Inside Diameter of Pipe in "Inches".

Sample Problem:

Given: 10" diameter, 12 gage welded steel pipeline, 1300 feet long. Capacity = 3.5 cfs.

Find: Total Friction Loss using K_p factor.

1. Area of pipeline = 0.5228 feet^2 - Table.
2. V = Q/A = 3.5/0.5228 = 6.695 feet/second.
3. Select (K_p) factor from Table = 0.034973.

$$H_f = \frac{V^2}{2g} (K_p)(L)$$

$$H_f = \frac{(6.695)^2}{64.4} (0.034973)\ 1300$$

$$H_f = 31.64 \text{ feet.}$$

PLASTIC PIPELINE PROPERTIES

(6" thru 12" dia.; n = 0.009)

Pipe Diameter Type	PSI Rating	O.D. Inches	I.D. Inches	Area Sq.Ft.	F	K_p	Wt./Ft. Lbs.
6" Nominal	---	---	6.00	0.1963	15.23408	0.037793	----
6" PIP, SDR-51	80	6.14	5.90	0.1899	16.66271	0.038650	1.45
6" PIP, SDR-41	100	6.14	5.84	0.1860	17.59629	0.039180	1.80
6" IPS, SDR-41	100	6.625	6.301	0.2165	11.73381	0.035405	2.08*
6" IPS, SDR-32.5	125	6.625	6.217	0.2108	12.60448	0.036044	2.74
6" IPS, SDR-26	160	6.625	6.115	0.2039	13.76204	0.036848	3.31
6" IPS, SDR-21	200	6.625	5.993	0.1959	15.32923	0.037852	4.07
8" Nominal	---	---	8.00	0.3491	3.28455	0.025753	----
8" PIP, SDR-51	80	8.16	7.84	0.3352	3.65823	0.026456	2.60
8" PIP, SDR-41	100	8.16	7.76	0.3284	3.86391	0.026820	3.20
8" IPS, SDR-41	100	8.625	8.205	0.3672	2.86993	0.024899	3.65*
8" IPS, SDR-32.5	125	8.625	8.095	0.3574	3.08413	0.025351	4.55
8" IPS, SDR-26	160	8.625	7.961	0.3457	3.37129	0.025921	5.66
8" IPS, SDR-21	200	8.625	7.805	0.3323	3.74657	0.026614	6.95
10" Nominal	---	---	10.00	0.5454	0.99913	0.019126	----
10" PIP, SDR-51	80	10.20	9.80	0.5238	1.11280	0.019648	4.05
10" PIP, SDR-41	100	10.20	9.70	0.5132	1.17537	0.019918	5.00
10" IPS, SDR-41	100	10.750	10.226	0.5703	0.88687	0.018564	5.45*
10" IPS, SDR-32.5	125	10.750	10.088	0.5551	0.95352	0.018903	6.85
10" IPS, SDR-26	160	10.750	9.924	0.5372	1.04062	0.019321	8.47
10" IPS, SDR-21	200	10.750	9.728	0.5161	1.15744	0.019842	10.38
12" Nominal	---	---	12.00	0.7854	0.37785	0.014998	----
12" PIP, SDR-51	80	12.24	11.76	0.7543	0.42084	0.015408	5.85
12" PIP, SDR-41	100	12.24	11.64	0.7390	0.44450	0.015620	7.25
12" IPS, SDR-41	100	12.750	12.128	0.8022	0.35707	0.014787	7.72*
12" IPS, SDR-32.5	125	12.750	11.966	0.7810	0.38362	0.015055	9.68*
12" IPS, SDR-26	160	12.750	11.770	0.7556	0.41894	0.015390	11.96*
12" IPS, SDR-21	200	12.750	11.538	0.7261	0.46587	0.015804	14.70*

* Data not available, weight computed.

PIP - Plastic Irrigation Pipe.

IPS - Plastic Pipe based on Iron Pipe Size.

SDR - Standard Demension Ratio and is obtained by dividing the outside pipe diameter by the pipe wall thickness.

ASBESTOS - CEMENT PIPELINE PROPERTIES

PIPE DIAMETER Inches	NON PRESSURE - ASTM SPEC. C-428 WEIGHT LBS./FT. (Including Couplings and 2 Rings) Class 1500	Class 2400	Class 3300	Class 4000	Class 5000	PRESSURE - ASTM SPEC. C-296 CLASS 100 Pipe Weight Lbs./Ft.	CLASS 150 Pipe Weight Lbs./Ft.	CLASS 200 Pipe Weight Lbs./Ft.	AREA $(FT.)^2$	F Factor	K_p Factor
4	--	--	--	--	--	6.1	7.2	8.8	0.0873	163.48	0.0801
6	--	--	--	--	--	11.1	12.3	14.5	0.1964	18.807	0.0467
8	12.8	12.8	14.5	--	--	16.5	18.7	22.2	0.3491	4.0550	0.0318
10	17.1	17.7	20.5	22.7	25.8	22.7	29.9	34.5	0.5454	1.2335	0.0236
12	22.2	22.9	27.0	29.6	33.6	32.1	41.0	48.2	0.7854	0.4665	0.0185
14	27.7	28.9	34.0	37.3	42.0	39.2	55.0	64.7	1.0690	0.2050	0.0151
16	33.3	35.3	41.1	45.4	51.0	50.0	68.3	83.7	1.3963	0.1007	0.0126
18	--	42.0	48.9	54.2	60.6	66.3	90.9	129.5	1.7671	0.0537	0.0108
20	--	48.9	57.1	63.0	70.6	80.5	111.1	160.0	2.1817	0.0306	0.00937
24	--	64.3	74.5	82.3	92.2	112.5	158.5	228.7	3.1416	0.0116	0.00735
27	--	--	89.3	98.6	110.4	--	--	--	3.9761	0.00618	0.00628
30	--	--	104.8	115.9	128.9	172.7	248.6	359.1	4.9088	0.00352	0.00546
33	--	--	--	133.5	148.7	--	--	--	5.9396	0.00211	0.00481
36	--	--	--	152.2	169.8	242.6	356.4	516.3	7.0686	0.00133	0.00428

Weight includes pipe, coupling and 2 rings.

ASBESTOS - CEMENT PIPELINE PROPERTIES
TRANSMISSION PIPE

ASTM Specification 668 n = 0.010

PIPE DIAMETER Inches	WEIGHTS - LBS./FT. (INCLUDING COUPLINGS)									AREA $(FT.)^2$	F Factor	K_p Factor
	Class 30	Class 35	Class 40	Class 45	Class 50	Class 60	Class 70	Class 80	Class 90			
6	----	----	8.9	9.3	10.9	15.8	16.1	13.5	14.8	0.1964	18.807	0.046658
8	12.4	12.4	12.9	13.8	16.4	19.0	19.0	21.4	23.2	0.3491	4.0550	0.031794
10	17.2	17.6	19.2	22.7	23.2	29.9	30.3	35.2	37.4	0.5454	1.2335	0.023612
12	22.5	23.0	24.9	31.0	32.6	40.9	43.0	49.1	54.4	0.7854	0.46649	0.018516
14	28.1	29.0	30.8	37.8	41.4	54.8	57.0	65.6	75.6	1.0690	0.20502	0.015076
15	30.9	33.8	35.3	44.5	47.1	60.2	67.3	80.2	92.3	1.2272	0.14190	0.013751
16	35.3	37.9	41.7	49.0	53.2	68.6	76.3	85.1	98.0	1.3963	0.10058	0.012617
18	40.9	44.3	58.4	60.0	65.4	79.8	95.6	111.5	131.9	1.7671	0.05366	0.010784
20	50.0	55.8	71.4	73.6	79.5	99.9	117.6	137.4	162.5	2.1817	0.03059	0.0093703
21	55.0	60.0	80.0	80.8	87.7	108.0	129.6	150.9	178.9	2.4053	0.02358	0.0087802
24	71.4	76.4	98.6	103.9	112.9	140.9	168.9	197.1	233.3	3.1416	0.01157	0.0073482
27	90.8	97.1	129.2	132.9	144.3	179.7	215.6	251.3	297.3	3.9761	0.006173	0.0062802
30	111.6	119.6	153.6	162.2	177.2	221.7	264.9	309.7	367.8	4.9088	0.003520	0.0054572
33	134.0	144.6	189.3	197.6	214.3	267.5	320.7	374.2	442.4	5.9396	0.002117	0.0048059
36	157.9	171.7	220.5	232.7	254.6	318.2	381.9	445.1	528.6	7.0686	0.001331	0.0042795

ASBESTOS - CEMENT PIPELINE PROPERTIES
IRRIGATION PIPE

SCS Specification 432-B n = 0.010

PIPE DIAMETER Inches	WEIGHTS LBS/FT. (INCLUDING COUPLINGS)				AREA $(FT.)^2$	F Factor	K_p Factor
	50' HEAD	25 PSI	75 PSI	125 PSI			
4	4.7	7.5	8.0	8.0	0.0873	163.48	0.080115
5	5.7	---	---	---	0.1364	49.731	0.059498
6	6.7	9.5	10.0	11.6	0.1964	18.807	0.046658
8	12.5	11.5	12.2	17.8	0.3491	4.0550	0.031794
10	17.3	17.2	17.2	29.1	0.5454	1.2335	0.023612
12	22.7	22.2	22.2	38.0	0.7854	0.46649	0.018516
14	28.5	27.0	27.0	45.2	1.0690	0.20502	0.015076
15	31.2	29.2	29.2	50.3	1.2272	0.14190	0.013751
16	34.4	34.4	34.4	64.0	1.3963	0.10058	0.012617
18	---	40.7	40.7	87.9	1.7671	0.05366	0.010784
20	---	46.8	46.8	108.0	2.1817	0.03059	0.0093703
21	---	52.0	52.0	130.2	2.4053	0.02358	0.0087802
24	---	63.4	63.4	154.0	3.1416	0.01157	0.0073482

WELDED STEEL PIPE PROPERTIES

n = 0.012

NOMINAL DIAMETER Inches	THICKNESS Gage Fraction	THICKNESS Inches	WEIGHT Lbs./Ft.	I.D. Inches	AREA Sq.Ft.	F	K_p
8"	14	0.0747	6.5	7.8506	0.3362	6.4568	0.046948
	12	0.1046	9.0	7.7908	0.3310	6.7255	0.047429
	ID			8.0000	0.3491	5.8391	0.045783
10"	12	0.1046	11.3	9.7908	0.5228	1.9882	0.034973
	10	0.1345	14.5	9.7310	0.5165	2.0543	0.035260
	3/16	0.1875	20.2	9.6250	0.5053	2.1779	0.035779
	ID			10.0000	0.5454	1.7762	0.034001
12"	12	0.1046	13.6	11.7908	0.7582	0.73780	0.027296
	10	0.1345	17.5	11.7310	0.7506	0.75808	0.027482
	3/16	0.1875	24.3	11.6250	0.7371	0.79568	0.027816
	ID			12.0000	0.7854	0.67174	0.026663
14"	12	0.1046	15.9	13.7908	1.0373	0.31991	0.022150
	10	0.1345	20.4	13.7310	1.0283	0.32741	0.022279
	3/16	0.1875	28.4	13.6250	1.0125	0.34122	0.022510
	ID			14.0000	1.0690	0.29522	0.021710
16"	12	0.1046	18.5	15.7908	1.3600	0.15536	0.018491
	10	0.1345	23.4	15.7310	1.3497	0.15854	0.018584
	3/16	0.1875	32.4	15.6250	1.3316	0.16436	0.018753
	1/4	0.2500	43	15.5000	1.3104	0.17155	0.018955
	ID			16.0000	1.3963	0.14483	0.018169
18"	12	0.1046	20.7	17.7908	1.7263	0.08225	0.015772
	10	0.1345	26.3	17.7310	1.7147	0.08374	0.015843
	3/16	0.1875	36.4	17.6250	1.6943	0.08646	0.015971
	1/4	0.2500	47.4	17.5000	1.6703	0.08980	0.016123
	ID			18.0000	1.7671	0.07728	0.015528
20"	10	0.1345	29.2	19.7310	2.1234	0.04736	0.013739
	3/16	0.1875	40.5	19.6250	2.1006	0.04874	0.013838
	1/4	0.2500	52.7	19.5000	2.0739	0.05043	0.013957
	5/16	0.3125	65.7	19.3750	2.0474	0.05218	0.014077
	ID			20.0000	2.1817	0.04406	0.013493

WELDED STEEL PIPE PROPERTIES

n = 0.012

NOMINAL DIAMETER Inches	THICKNESS Gage Fraction	THICKNESS Inches	WEIGHT Lbs./Ft.	I.D. Inches	AREA Sq.Ft.	F	K_p
22"	10	0.1345	32.2	21.7310	2.5756	0.02830	0.012080
	3/16	0.1875	44.6	21.6250	2.5506	0.02904	0.012159
	1/4	0.2500	58.1	21.5000	2.5212	0.02996	0.012253
	5/16	0.3125	72.4	21.3750	2.4920	0.03090	0.012349
	ID			22.0000	2.6398	0.02650	0.011883
24"	10	0.1345	35.2	23.7310	3.0716	0.01769	0.010742
	3/16	0.1875	48.7	23.6250	3.0442	0.01812	0.010806
	1/4	0.2500	63.4	23.5000	3.0121	0.01864	0.010883
	5/16	0.3125	79.1	23.3750	2.9801	0.01918	0.010960
	ID			24.0000	3.1416	0.01666	0.010581
26"	3/16	0.1875	52.8	25.6250	3.5814	0.01175	0.0096963
	1/4	0.2500	71.6	25.5000	3.5466	0.01206	0.0097597
	5/16	0.3125	87	25.3750	3.5119	0.01238	0.0098339
	ID			26.0000	3.6870	0.01087	0.0095103
28"	3/16	0.1875	56.9	27.6250	4.1623	0.007868	0.0087718
	1/4	0.2500	79.1	27.5000	4.1247	0.008061	0.0088250
	5/16	0.3125	94	27.3750	4.0873	0.008259	0.0088788
	3/8	0.3750	113	27.2500	4.0501	0.008463	0.0089331
	ID			28.0000	2.3333	0.007322	0.0086155
30"	3/16	0.1875	61.0	29.6250	4.7868	0.005420	0.0079912
	1/4	0.2500	82.6	29.5000	4.7465	0.005543	0.0080364
	5/16	0.3125	101	29.3750	4.7063	0.005670	0.0080820
	3/8	0.3750	121	29.2500	4.6664	0.005801	0.0080364
	ID			30.0000	4.9088	0.005068	0.0078583
32"	3/16	0.1875	65.0	31.6250	5.4549	0.003825	0.0073246
	1/4	0.2500	91.7	31.5000	5.4119	0.003907	0.0073634
	5/16	0.3125	114	31.3750	5.3690	0.003991	0.0074025
	3/8	0.3750	137	31.2500	5.3263	0.004077	0.0074430
	ID			32.0000	5.5851	0.003592	0.0072104

WELDED STEEL PIPE PROPERTIES

n = 0.012

NOMINAL DIAMETER Inches	THICKNESS Gage Fraction	THICKNESS Inches	WEIGHT Lbs./Ft.	I.D. Inches	AREA Sq.Ft.	F	K_p
34"	3/16	0.1875	69.1	33.6250	6.1667	0.002758	0.0067495
	1/4	0.2500	97.8	33.5000	6.1209	0.002814	0.0067831
	5/16	0.3125	114	33.3750	6.0753	0.002870	0.0068170
	3/8	0.3750	137	33.2500	6.0299	0.002928	0.0068512
	ID			34.0000	6.3050	0.002600	0.0066505
36"	3/16	0.1875	73.1	35.6250	6.9221	0.002027	0.0062491
	1/4	0.2500	99.2	35.5000	6.8736	0.002065	0.0062785
	5/16	0.3125	119.1	35.3750	6.8253	0.002104	0.0063081
	3/8	0.3750	142.7	35.2500	6.7771	0.002144	0.0063379
	7/16	0.4375	166.2	35.1250	6.7292	0.002185	0.0063680
	ID			36.0000	7.0686	0.001917	0.0061625