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TECHNICAL INFORMATION
Bulletin

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FINDING EQUIVALENT PIPE LENGTHS
…Of Valves, section changes, and miter bends

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BECAUSE obtaining complete test data on the pressure drop of every available size and type of valve and pipe fitting is impossible, a practical method for extending available information is useful. This technique, known as the equivalent-length method for calculating pressure losses, applies only to singlephase, noncompressible, nonflashing liquids.

In this method, of determining total pressure loss in a system, the pressure drop through a valve; fitting, miter elbow, or any pressure-reducing component is equated with the length of straight, round pipe that will have the same pressure loss under the same flow conditions. The values shown in Table I apply only to turbulent flow, the most prevalent condition in general piping systems.

TABLE I. EQUIVALENT LENGTHS OF VALVES, SUDDEN CROSS-SECTIONAL CHANGES, AND MITER BENDS, FT

Nominal pipe size, in.	Globe valve	Angle valve / Ball check	Return bend / Swing check	Standard tee / Square elbow	Standard elbow / Reduced tee ½	Medium elbow / Reduced tee ¼	Long elbow / Run of standard tee	45 deg elbow	Gate valve	Ball valve	Plug cock straight way Full port
1½	40	21	10	7	4	4	3	2	1	1	2
2	50	27	13	10	5	5	3	2.5	1	2	3
2½	60	33	15	12	6	6	4	3	1.5	2	4
3	80	40	18	15	8	7	5	4	2	2	5
4	115	55	23	20	11	9	6	5	2.5	3	6
6	160	80	36	30	16	14	9	7.5	3.5	4	9
8	225	110	50	40	20	18	14	10	4.5	5	12
10	290	135	60	50	25	22	18	13	7	7	16
12	350	160	70	60	30	25	20	16	8	8	18
14	400	190	85	66	35	30	23	18	9	9	20
16	450	220	100	76	40	35	27	21	10	10	23
18	500	250	110	86	45	40	30	24	12	11	26
20	550	280	125	96	50	45	35	26	13	13	29
22	600	300	155	105	55	50	38	29	15	15	32
24	660	335	190	116	60	56	45	32	18	16	35
30	–	–	–	146	75	–	50	40	21	20	–
36	–	–	–	176	90	–	60	48	25	24	–
42	–	–	–	205	105	–	70	56	30	27	–
48	–	–	–	235	120	–	80	64	35	31	–
54	–	–	–	265	135	–	90	72	40	35	–
60	–	–	–	295	150	–	100	80	45	40	–

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When laminar flow exists, calculations are required. Standard texts should be consulted for empirical relationships covering laminar flow conditions.

Resistance to flow includes the pressure drop from valves, fittings, sudden changes in'the pipe cross-section, and miter elbows. 'Values for pressure loss through system components are expressed as equivalent feet of round, straight pipe, in Table I. Pressure losses also result from flow measurement devices and fluid entry into and exit from a pipe. These losses represent special cases and are not included in the tables.

Pipe characteristics vary considerably, and Table I applies only to ordinary commercial steel and iron pipe. For pipe of other materials, Table II lists values based on the coefficient of roughness *c*. If possible, this coefficient should be obtained from the manufacturer.

The effect of pressure drop through valves and fittings is negligible when the ratio of pipeline length to pipe, diameter is equal to or greater than 1000 to 1, as is usually the case for long water and oil pipelines with the usual number of fittings and valves.

Example: Crude oil is flowing through a 20 mile long, 12 in. diameter pipeline. Should the effect of valves and fittings in the line be considered in the determination of pressure drop?

Solution:

$$\frac{20 \times 5280}{\frac{12}{12}} = 105,600$$

Because the result is greater than 1000, the pressure drop through valves and fittings in this pipeline can be ignored.

Sudden enlargement, Equivalent L's in terms of d: d/D=¼	d/D=½	d/D=¾	Borda entrance	Ordinary entrance	Sudden contraction, Equivalent L's in terms of d: d/D=¼	d/D=½	d/D=¾	Two-miter bend	Three-miter bend	Four-miter bend	Six-miter bend
4.5	3	1	4	2.5	2	1.5	1				
5	3.5	1	5	3	2.5	2	1				
6	4.5	1.5	6	3.5	3	2.5	1.5				
8	5	2	8	4.5	4	3	2				
11	7	2.5	11	6	5	4	2.5				
16	10	3.5	15	9	7.5	5.5	3.5				
20	14	4.5	19	12	10	7.5	4.5				
25	18	7	25	15	13	10	7				
30	20	8	30	17.5	16	12	8	28	21	20	12
35	23	9	35	20	18	13.5	9	32	24	22	18
42	27	10	40	23	21	15	10	38	27	24	20
48	30	12	45	25	24	17	12	42	30	28	22
52	35	13	50	29	26	18.5	13	46	33	32	24
58	38	15	55	31	29	20	15	52	36	34	26
65	42	18	60	35	32	21.5	18	56	39	36	28
75	50	21	–	–	40	26	21	70	51	44	36
100	60	25	–	–	48	28	25	84	60	52	42
110	65	30	–	–	56	40	30	98	69	64	48
140	80	35	–	–	64	45	35	112	81	72	54
150	90	40	–	–	72	50	40	126	90	80	60
160	100	45	–	–	80	60	45	140	99	92	66

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Table III lists factors for calculating pressure drop when c is some value other than 100.

Example: Pressure drop in a water pipeline with turbulent flow is 25 psi for ordinary steel pipe. What would the pressure drop be if copper pipe were used?

Solution: Table II lists the coefficient of roughness for copper pipe as 130; from Table III, the multiplier factor for c is found to be 0.6152. Therefore, the pressure drop for copper pipe is 25 X 0.6152 = 15.38 psi.

Example: A piping run consists of 37 ft of 4 in. diameter straight pipe, three short-radius elbows, two wide- open gate valves, and one wide-open globe valve. What total equivalent length of straight pipe is used to calculate head loss?

Solution: Equivalent lengths are found in Table I.

Straight pipe	37 ft
3 elbows X 11 ft	33 ft
2 gate valves X 2.5 ft	5 ft
1 globe valve X 115 ft	115 ft
Total	190 ft

Note: Calculations are normally made on the basis of wide-open valve position and apply to check valves, foot valves, butterfly valves, and cocks. An orifice meter inserted in the pipeline presents a special case. This restriction causes a permanent loss of pressure across the orifice, measured as a percentage of the manometer differential. The loss may be from 50 to 95 percent of the meter differential, varying inversely with the orifice-to-pipe inside diameter. In a venturi meter, the permanent loss is much less (10 to 20 percent of meter differential), because of static pressure regain in the gradual configuration of the venturi throat and after section.

"Calculations are normally made on the basis of wide-open valve position and apply to check valves, foot valves, butterfly valves, and cocks. An orifice meter inserted in the pipeline presents a special case."

TABLE II. ROUGHNESS VALUES FOR PIPE OF VARIOUS MATERIALS

Type of Pipe	Coefficient of Roughness *c*
Cast Iron (properly installed)	
Time Since Installation, Years	
Less than 4	130
4 to 6	120
10 to 12	110
13 to 20	100
21 to 35	80
Asbestos Cement	140
Cement Lined	
Hand applied	120
Applied by centrifuge	140
Riveted Steel (66 to 144 in. dia)	
Time Since Installation, Years	
Less than 1	140
1 to 10	100
More than 10	90
Fiber	140
Bitumastic-Lined Iron or Steel	140
Copper, Brass, Lead	130
Tin or Glass	130
Wood Stave	110
Welded and Seamless Steel	100
Wrought Iron	100
Ordinary Commercial Steel and Iron	100
Concrete	100
Vitrified	100
Corrugated Steel	60
Tile	110
Brick (Sewers)	100
Fire Hose	
Extremely smooth	143
Rubber lined	125 to 140
Mill hose	100 to 120
Unlined linen	85 to 95

TABLE III. CONVERSION FACTORS FOR VALUES OF ROUGHNESS

Coefficient *c*	Multiplier Factor
60	2.575
70	1.936
80	1.512
90	1.215
100	1.000
110	0.8382
120	0.7135
130	0.6152
140	0.5363
150	0.4683

Interpolate as required.