Program: ERASMUS-EDU-2022-CBHE-STRAND-2
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LOCAL LOSSES

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- Local energy losses are those that occur locally on the elbows, valves, contractions, expansion, etc.
- It is customary to express local losses in relation to the velocity altitude

$$h_L = K(v^2/2g)$$

SUDDEN ENLARGEMENT

- When a fluid flows from a smaller tube to a larger tube (sudden enlargement), its velocity decreases sharply, causing turbulence, leading to a loss of energy.
- The energy loss depends on the ratio of the size of the two pipes to the flow velocity in the smaller pipe.

$$h_L = K(v_1^2/2g)$$

FIGURE 10.2 Sudden enlargement.

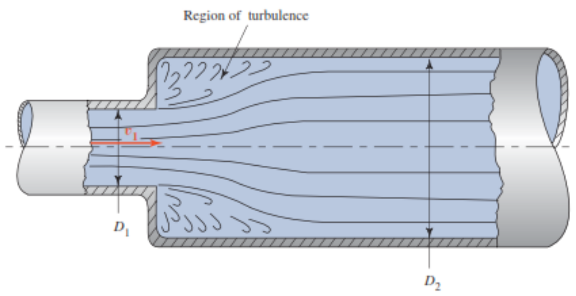

FIGURE 10.3 Resistance coefficient—sudden enlargement.

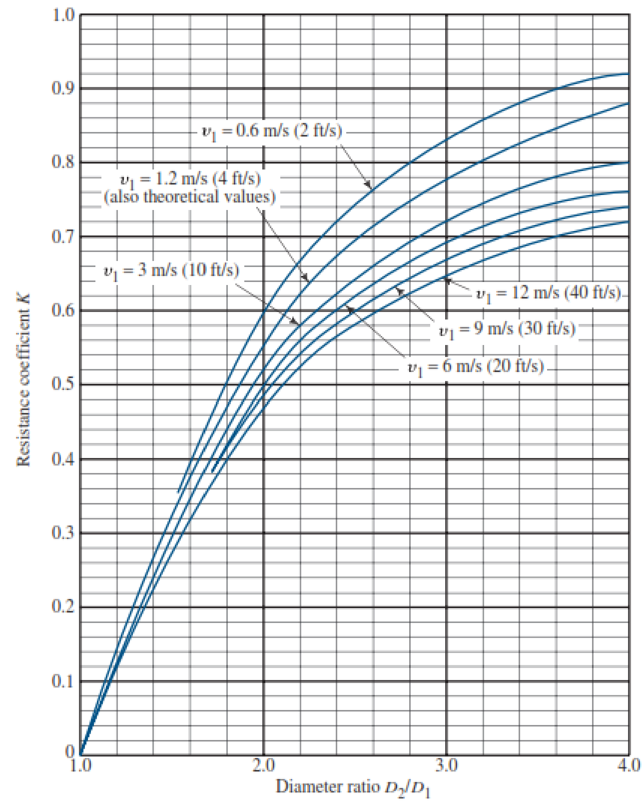

TABLE 10.1B Resistance coefficient—sudden enlargement—Metric data

	Velocity v_1, m/s										
D_2/D_1	0.5	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
1.2	0.11	0.10	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
1.4	0.26	0.26	0.24	0.23	0.23	0.22	0.22	0.22	0.21	0.21	0.21
1.6	0.40	0.39	0.36	0.35	0.35	0.34	0.33	0.33	0.32	0.32	0.32
1.8	0.51	0.49	0.46	0.45	0.44	0.43	0.42	0.42	0.41	0.41	0.41
2.0	0.60	0.58	0.54	0.52	0.52	0.51	0.50	0.50	0.49	0.48	0.48
2.5	0.74	0.72	0.67	0.65	0.64	0.63	0.62	0.62	0.61	0.60	0.59
3.0	0.84	0.80	0.75	0.73	0.71	0.70	0.69	0.68	0.67	0.67	0.66
4.0	0.93	0.89	0.83	0.80	0.79	0.77	0.76	0.75	0.74	0.74	0.73
5.0	0.97	0.93	0.87	0.84	0.83	0.81	0.80	0.79	0.78	0.77	0.76
10.0	1.00	0.98	0.92	0.89	0.87	0.85	0.84	0.83	0.82	0.82	0.81
∞	1.00	1.00	0.94	0.91	0.89	0.87	0.86	0.85	0.84	0.83	0.82

D_2/D_1—ratio of diameter of larger pipe to diameter of smaller pipe; v_1—velocity in smaller pipe.
Source: Brater, Ernest F, et al. © 1996. *Handbook of Hydraulics*, 7th ed. New York: McGraw-Hill, Table 6–5.

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- Analitical determination of factor K:

$$K = [1 - (A_1/A_2)]^2 = [1 - (D_1/D_2)^2]^2$$

Exit loss

- When fluid flows from a pipe into a large reservoir, as shown in Figure 10.4 its velocity decreases to almost zero. In this process, the kinetic energy possessed by the fluid in the tube, indicated as the velocity height, dissipated. Therefore, the loss of en[ergy for this] condition is: $h_L = 1.0(v_1^2/2g)$

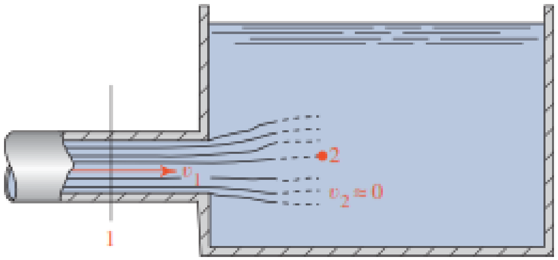

FIGURE 10.4 Exit loss as fluid flows from a pipe into a static reservoir.

GRADUAL ENLARGEMENT

- If the transition from a smaller to a larger tube can be carried out gradually, the loss of energy is reduced.
- It is usually achieved by placing a conical shape between two pipes.
- It is calculated according to the following expression:

$$h_L = K(v_1^2/2g)$$

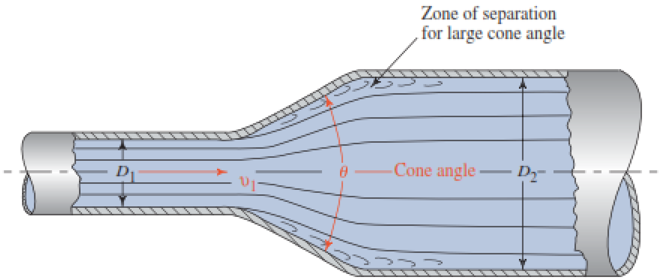

FIGURE 10.5 Gradual enlargement.

FIGURE 10.6 Resistance coefficient—gradual enlargement.

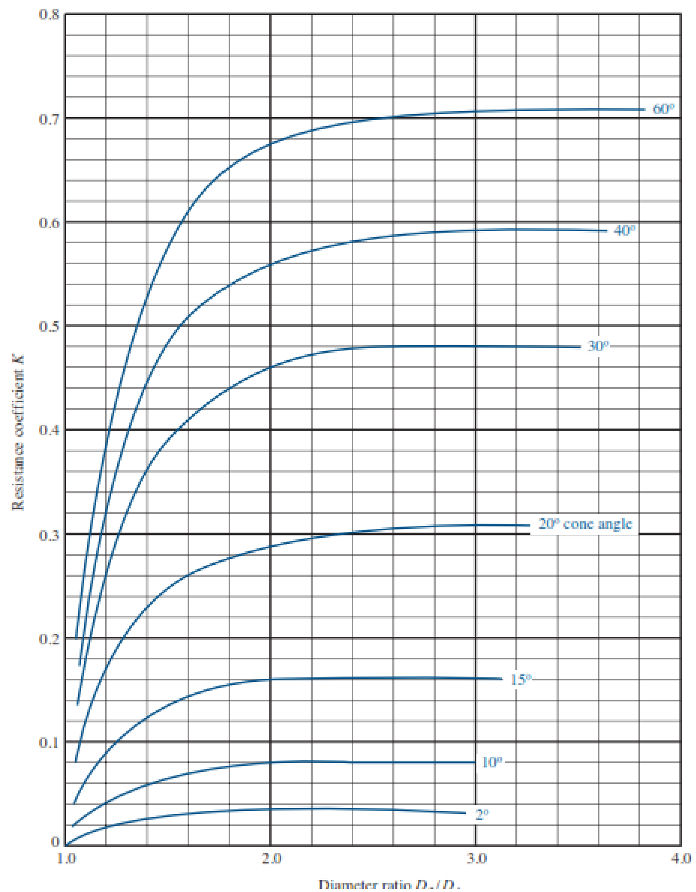

TABLE 10.2 Resistance coefficient—gradual enlargement

	Angle of Cone θ											
D_2/D_1	2°	6°	10°	15°	20°	25°	30°	35°	40°	45°	50°	60°
1.1	0.01	0.01	0.03	0.05	0.10	0.13	0.16	0.18	0.19	0.20	0.21	0.23
1.2	0.02	0.02	0.04	0.09	0.16	0.21	0.25	0.29	0.31	0.33	0.35	0.37
1.4	0.02	0.03	0.06	0.12	0.23	0.30	0.36	0.41	0.44	0.47	0.50	0.53
1.6	0.03	0.04	0.07	0.14	0.26	0.35	0.42	0.47	0.51	0.54	0.57	0.61
1.8	0.03	0.04	0.07	0.15	0.28	0.37	0.44	0.50	0.54	0.58	0.61	0.65
2.0	0.03	0.04	0.07	0.16	0.29	0.38	0.46	0.52	0.56	0.60	0.63	0.68
2.5	0.03	0.04	0.08	0.16	0.30	0.39	0.48	0.54	0.58	0.62	0.65	0.70
3.0	0.03	0.04	0.08	0.16	0.31	0.40	0.48	0.55	0.59	0.63	0.66	0.71
∞	0.03	0.05	0.08	0.16	0.31	0.40	0.49	0.56	0.60	0.64	0.67	0.72

Source: Brater, Ernest F, Horace W. King, James E. Lindell, and C. Y. Wei. 1996. *Handbook of Hydraulics*, 7th ed. New York: McGraw-Hill, Table 6–6.

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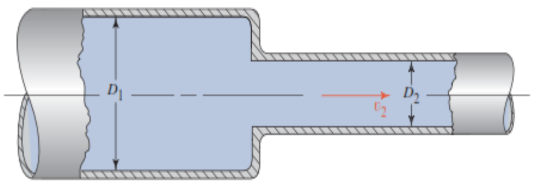
Sudden contraction

- The loss of energy in a sudden narrowing, shown in the figure, is calculated according to the following expression:

FIGURE 10.7 Sudden contraction.



$$h_L = K(v_2^2/2g)$$

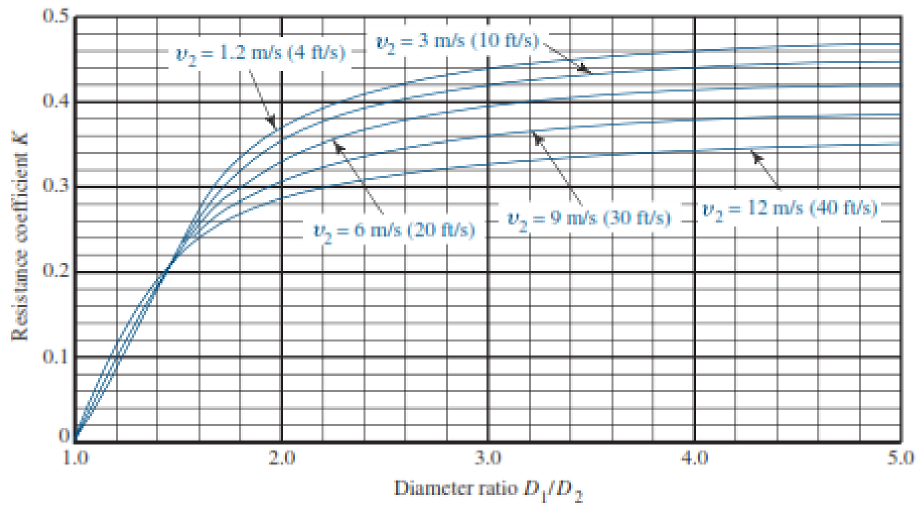


FIGURE 10.8 Resistance coefficient—sudden contraction.

TABLE 10.3B Resistance coefficient—sudden contraction—Metric data

	Velocity v_2, m/s										
D_1/D_2	0.5	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
1.1	0.03	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05
1.2	0.07	0.07	0.07	0.08	0.08	0.08	0.09	0.09	0.10	0.10	0.10
1.4	0.17	0.17	0.17	0.18	0.18	0.18	0.18	0.19	0.19	0.19	0.19
1.6	0.26	0.26	0.26	0.26	0.26	0.26	0.25	0.25	0.25	0.25	0.24
1.8	0.34	0.34	0.34	0.33	0.32	0.31	0.31	0.30	0.29	0.29	0.28
2.0	0.38	0.38	0.37	0.36	0.35	0.34	0.33	0.33	0.32	0.31	0.30
2.2	0.40	0.40	0.39	0.38	0.37	0.36	0.35	0.35	0.34	0.33	0.32
2.5	0.42	0.42	0.41	0.40	0.39	0.38	0.37	0.36	0.35	0.34	0.33
3.0	0.44	0.44	0.43	0.42	0.41	0.40	0.39	0.38	0.37	0.36	0.35
4.0	0.47	0.46	0.45	0.44	0.43	0.42	0.41	0.40	0.38	0.37	0.36
5.0	0.48	0.48	0.46	0.45	0.45	0.44	0.42	0.41	0.39	0.38	0.37
10.0	0.49	0.48	0.47	0.46	0.46	0.44	0.43	0.42	0.41	0.40	0.39
∞	0.49	0.49	0.47	0.47	0.46	0.45	0.44	0.43	0.42	0.41	0.40

D_1/D_2—ratio of diameter of larger pipe to diameter of smaller pipe; v_2—velocity in smaller pipe.

Source: Brater, Ernest F, Horace W. King, James E. Lindell, and C. Y. Wei. 1996. *Handbook of Hydraulics*, 7th ed. New York: McGraw-Hill, Table 6–7.

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Gradual conraction

- The loss of energy in constriction can be reduced by achieving a gradual constriction.

Gradual contraction.

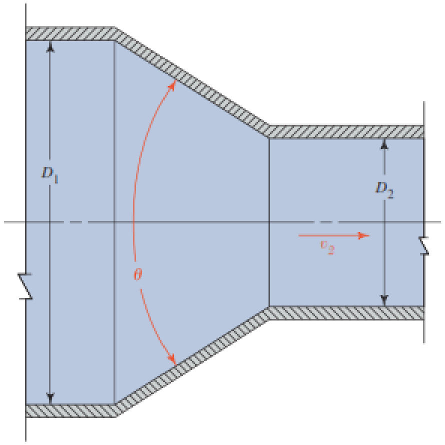

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FIGURE 10.11 Resistance coefficient—gradual contraction with $\theta \geq 15°$.

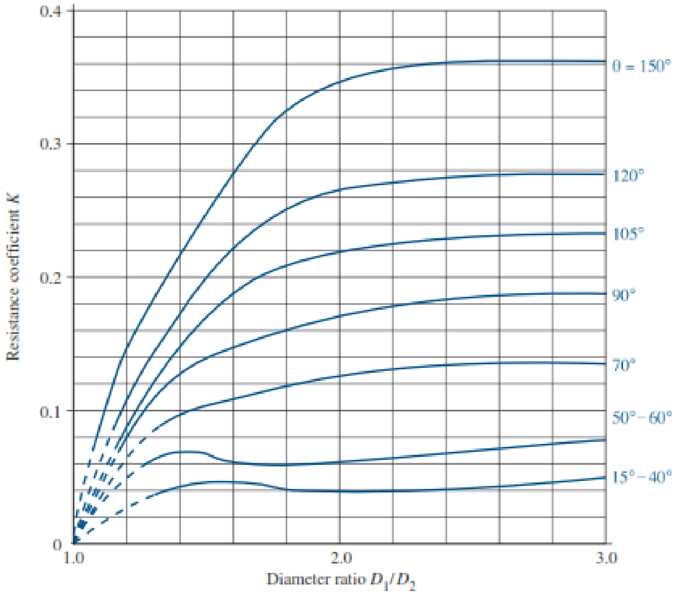
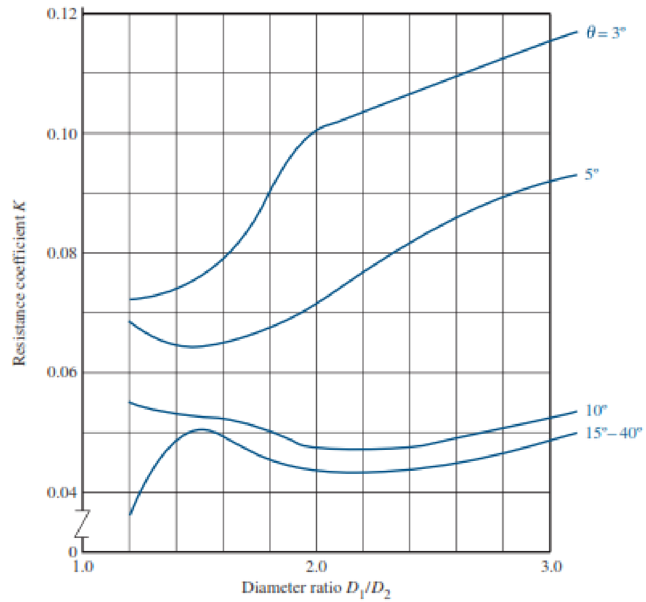
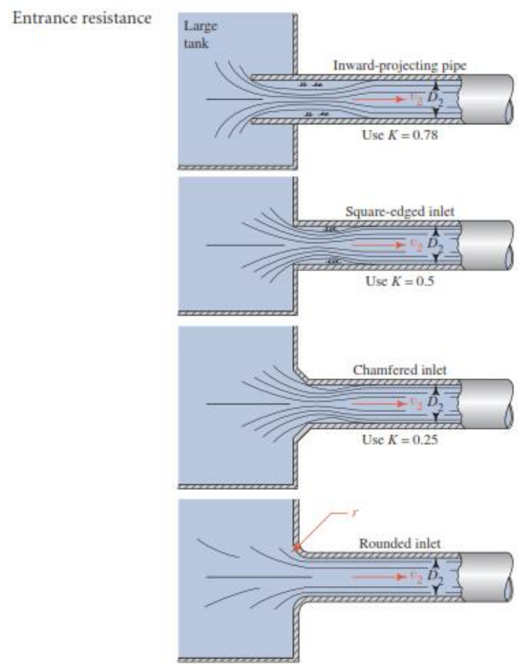


FIGURE 10.12 Resistance coefficient—gradual contraction with $\theta < 15°$.



Entrance losses

$$h_L = K(v_2^2/2g)$$



r/D_2	K
0	0.50
0.02	0.28
0.04	0.24
0.06	0.15
0.10	0.09
>0.15	0.04 (Well-rounded)

Drag coefficients for valves, elbows, T-joint

The drag coefficient for valves, elbows, T-joint is calculated according to the following expression:

$$K = (L_e/D)f_T$$

- where:
- $\frac{L_e}{D}$- ekvivalentnt lenght
- f_t- friction coefficient in region of full turbulence

TABLE 10.4 Resistance in valves and fittings expressed as equivalent length in pipe diameters, L_e/D

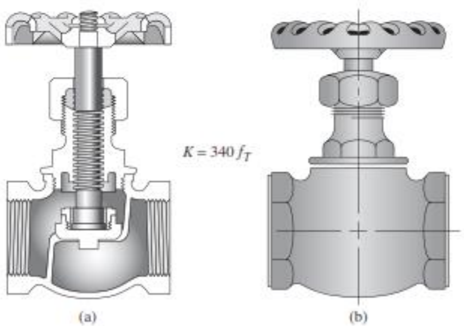
Type	Equivalent Length in Pipe Diameters L_e/D
Globe valve—fully open	340
Angle valve—fully open	150
Gate valve—fully open	8
—¾ open	35
—½ open	160
—¼ open	900
Check valve—swing type	100
Check valve—ball type	150
Butterfly valve—fully open, 2–8 in	45
—10–14 in	35
—16–24 in	25
Foot valve—poppet disc type	420
Foot valve—hinged disc type	75
90° standard elbow	30
90° long radius elbow	20
90° street elbow	50
45° standard elbow	16
45° street elbow	26
Close return bend	50
Standard tee—with flow through run	20
—with flow through branch	60

(Reprinted with permission from "Flow of Fluids Through Valves, Fittings and Pipe, Technical Paper 410" 2011. Crane Co. All Rights Reserved.)

TABLE 10.5 Friction factor in zone of complete turbulence for new, clean, commercial Schedule 40 steel pipe

Nominal Pipe Size		Friction factor, f_T	Nominal Pipe Size		Friction factor, f_T
U.S. (in)	Metric (mm)		U.S. (in)	Metric (mm)	
½	DN 15	0.026	3, 3½	DN 80, DN 90	0.017
¾	DN 20	0.024	4	DN 100	0.016
1	DN 25	0.022	5, 6	DN 125, DN 150	0.015
1¼	DN 32	0.021	8	DN 200	0.014
1½	DN 40	0.020	10–14	DN 250 to DN 350	0.013
2	DN 50	0.019	16–22	DN 400 to DN 550	0.012
2½	DN 65	0.018	24–36	DN 600 to DN 900	0.011

FIGURE 10.15 Globe valve. (Reprinted with permission from "Flow of Fluids Through Valves, Fittings and Pipe, Technical Paper 410" 2009. Crane Co. All Rights Reserved)



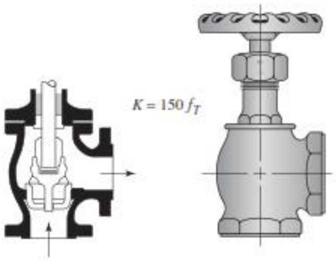


FIGURE 10.16 Angle valve. (Reprinted with permission from "Flow of Fluids Through Valves, Fittings and Pipe, Technical Paper 410" 2009. Crane Co. All Rights Reserved)

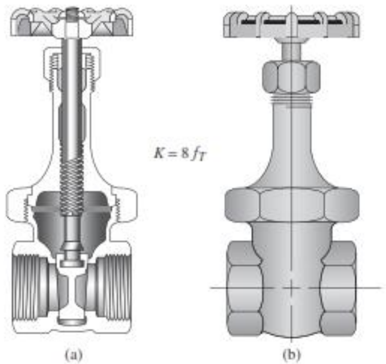


FIGURE 10.17 Gate valve. (Reprinted with permission from "Flow of Fluids Through Valves, Fittings and Pipe, Technical Paper 410" 2009. Crane Co. All Rights Reserved)

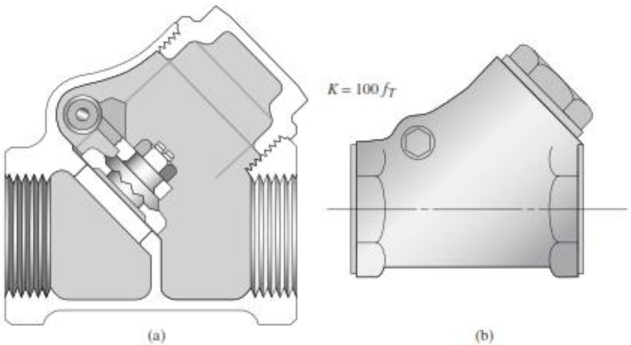
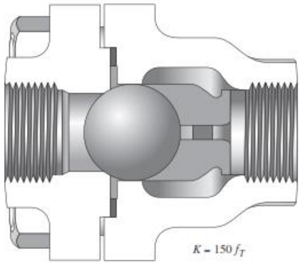


FIGURE 10.18 Check valve—swing type. (Reprinted with permission from "Flow of Fluids Through Valves, Fittings and Pipe, Technical Paper 410" 2009. Crane Co. All Rights Reserved)

FIGURE 10.19 Check valve—ball type. (Reprinted with permission from "Flow of Fluids Through Valves, Fittings and Pipe, Technical Paper 410" 2009. Crane Co. All Rights Reserved)



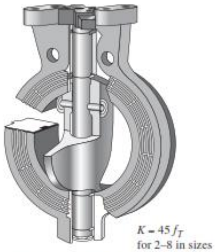


FIGURE 10.20 Butterfly valve. (Reprinted with permission from "Flow of Fluids Through Valves, Fittings and Pipe, Technical Paper 410" 2009. Crane Co. All Rights Reserved)

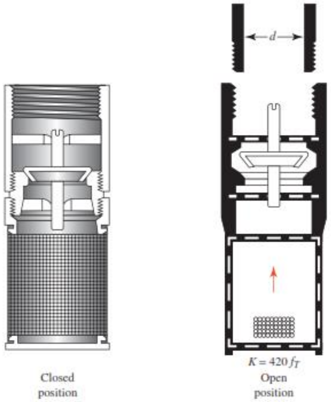
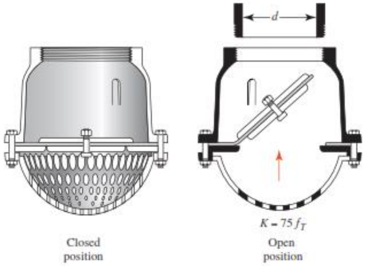


FIGURE 10.21 Foot valve with strainer—poppet disc type. (Reprinted with permission from "Flow of Fluids Through Valves, Fittings and Pipe, Technical Paper 410" 2009. Crane Co. All Rights Reserved)

FIGURE 10.22 Foot valve with strainer—hinged disc. (Reprinted with permission from "Flow of Fluids Through Valves, Fittings and Pipe, Technical Paper 410" 2009 Crane Co. All Rights Reserved)



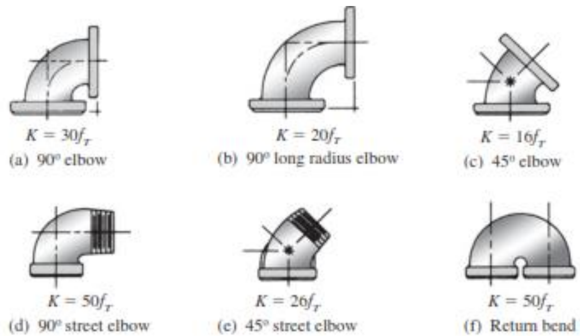
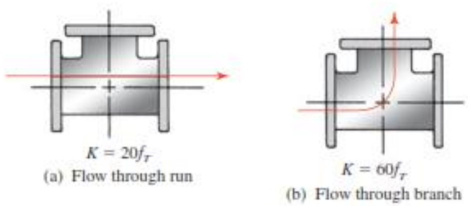


FIGURE 10.23 Pipe elbows. (Reprinted with permission from "Flow of Fluids Through Valves, Fittings and Pipe, Technical Paper 410" 2009 Crane Co. All Rights Reserved)

FIGURE 10.24 Standard tees. (Reprinted with permission from "Flow of Fluids Through Valves, Fittings and Pipe, Technical Paper 410" 2009 Crane Co. All Rights Reserved)



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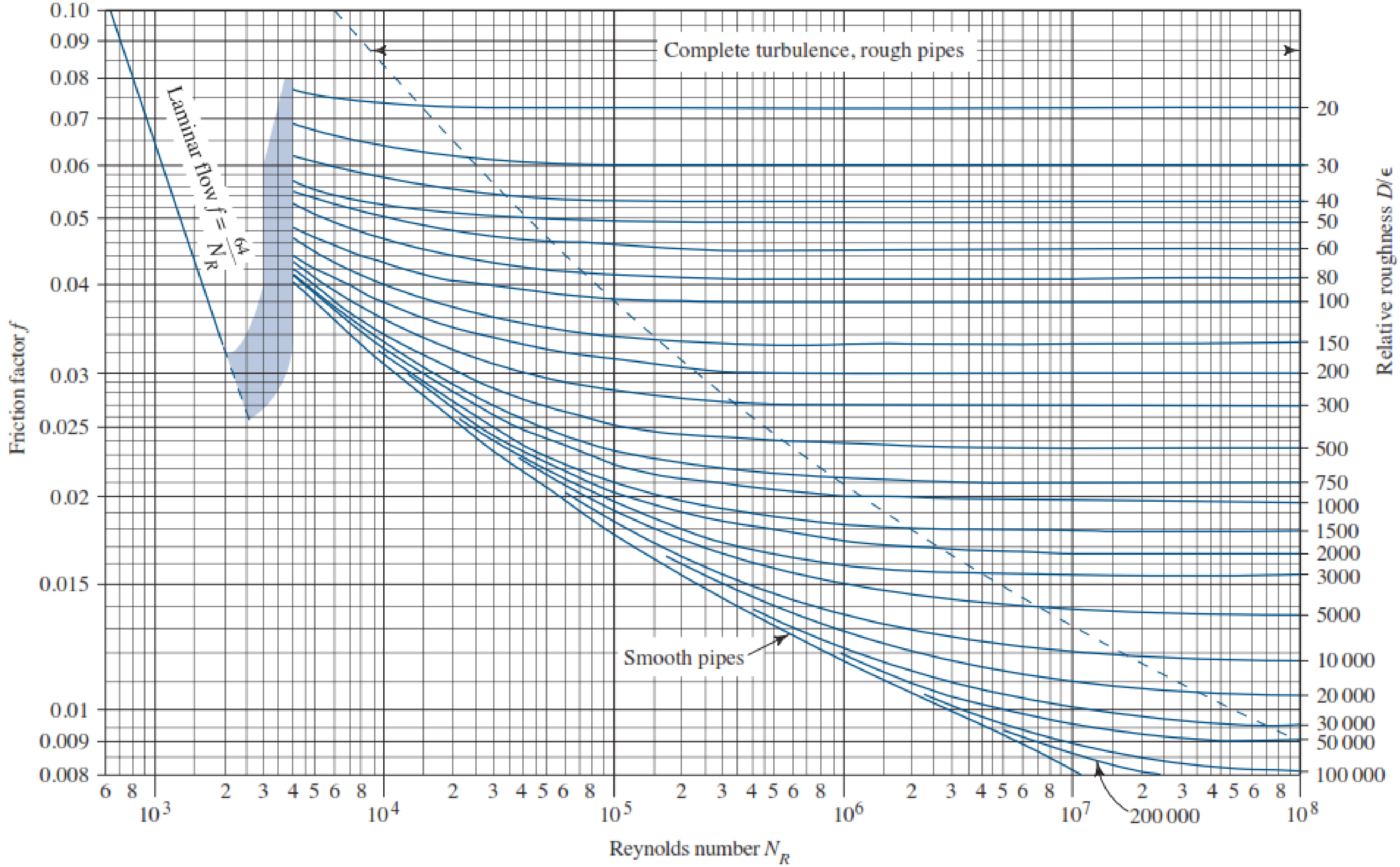

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