Program: ERASMUS-EDU-2022-CBHE-STRAND-2
Project number: 101082860

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LOKALNI GUBICI

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Primjenjena Mehanika fluida/ 08.04.2025

Partnership for Promotion and Popularization of Electrical Mobility through Transformation and Modernization of WB HEIs Study Programs/PELMOB
Call: ERASMUS-EDU-2022-CBHE-STRAND-2
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Lokalni gubici energije su oni koji nastaju lokalno na koljenima, ventilima, suženju, proširenju i sl.

Uobičajeno je lokalne gubitke izražavati u odnosu na brzinsku visinu

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

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Kad fluid teče iz manje cijevi u veću cijev (iznenadno proširenje), njegova brzina se naglo smanjuje, uzrokujući turbulencije, što dovodi do gubitka energije.

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

Gubitak energije zavisi od odnosa veličina dvije cijevi i brzine toka u manjoj cijevi.

FIGURE 10.2 Sudden enlargement.

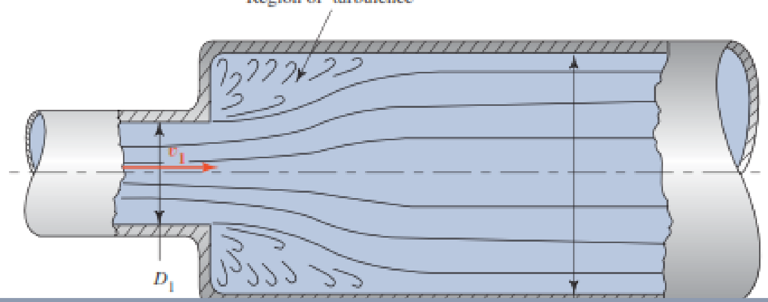

FIGURE 10.3 Resistance coefficient—sudden enlargement.

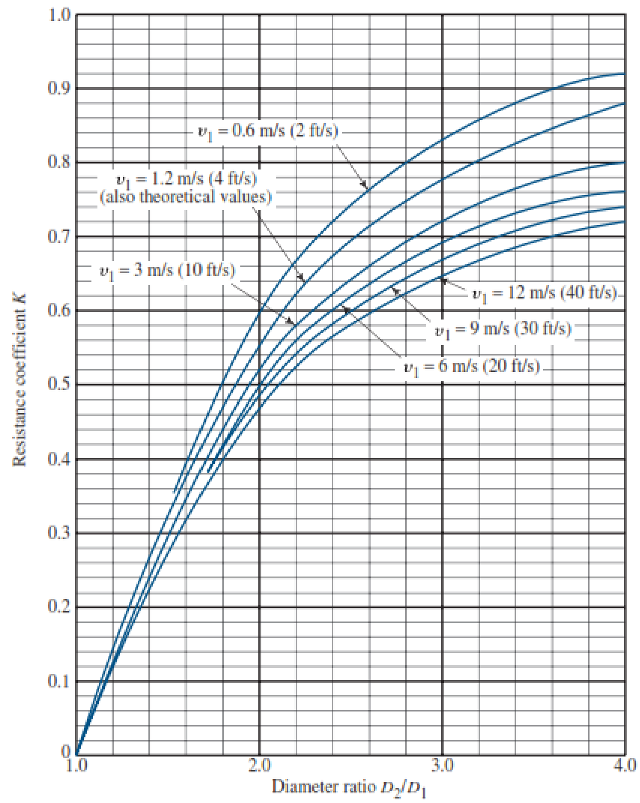

TABLE 10.1B Resistance coefficient—sudden enlargement—Metric data

	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.

Određivanje faktora K analitčki:

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

Kada fluid teče iz cijevi u veliki rezervoar, kao što je prikazano na slici 10.4 njegova brzina se smanjuje na gotovo nula.

U tom procesu kinetička energija koju je posjedovo fluid u cijevi,naznačena kao brzinska visina se raspršila.

Stoga je gubitak energije za ovo stanje:

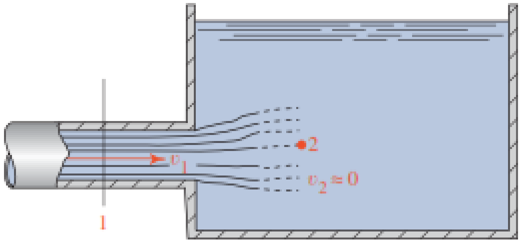

FIGURE 10.4 Exit loss as fluid flows from a pipe into a static reservoir.

$$h_L = 1.0(v_1^2/2g)$$

Ako se prelaz sa manje na veću cijev može izvršiti postepeno smanjuje se gubitak energije.

Obično se postiže postavljanjem koničnog oblika između dvije cijevi.

Računa se prema sljedećem izrazu:

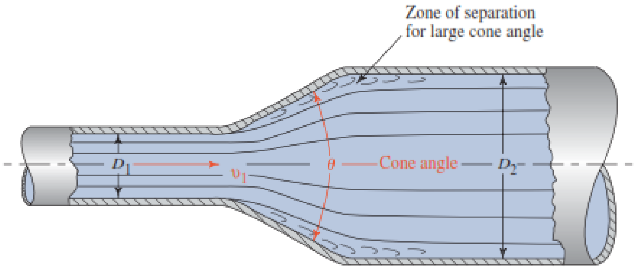

FIGURE 10.5 Gradual enlargement.

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

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FIGURE 10.6 Resistance coefficient—gradual enlargement.

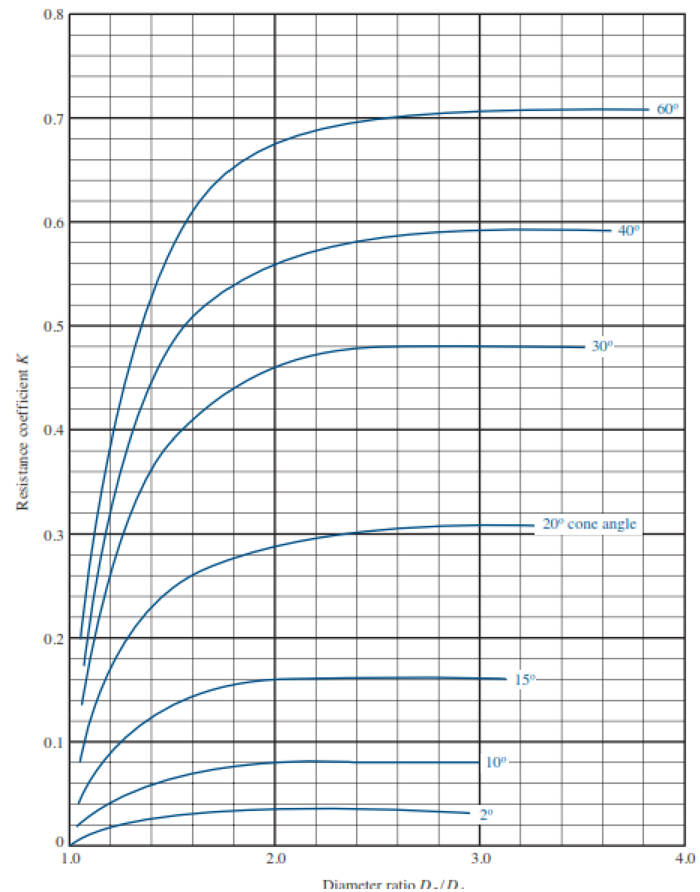

TABLE 10.2 Resistance coefficient—gradual enlargement

	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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Gubitak energije pri iznenadnom suženju, prikazanom na slici, se računa prema sljedećem izrazu:

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

FIGURE 10.7 Sudden contraction.

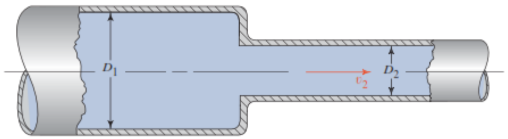
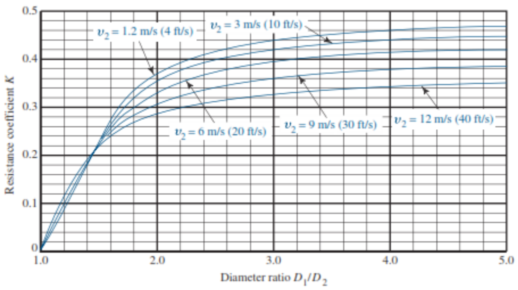


FIGURE 10.8 Resistance coefficient—sudden contraction.



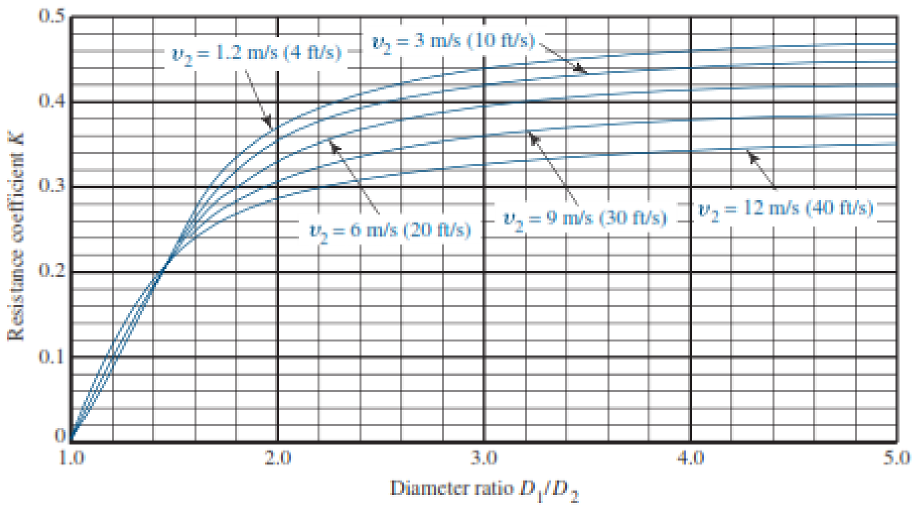


FIGURE 10.8 Resistance coefficient—sudden contraction.

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.

Gubitak energije kod suženja se može smanjiti postizanjem postepenog suženja.

Gradual contraction.

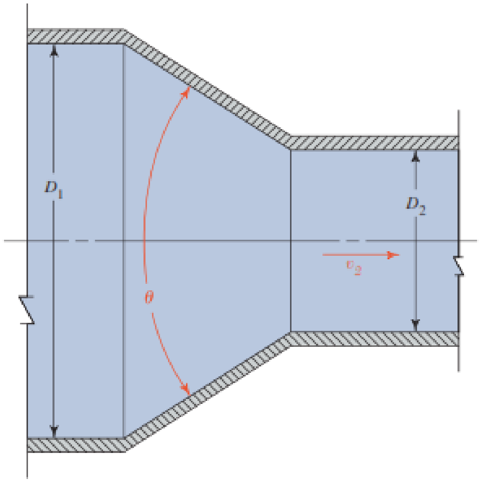


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FIGURE 10.11 Resistance coefficient—gradual contraction with $\theta \geq 15°$.

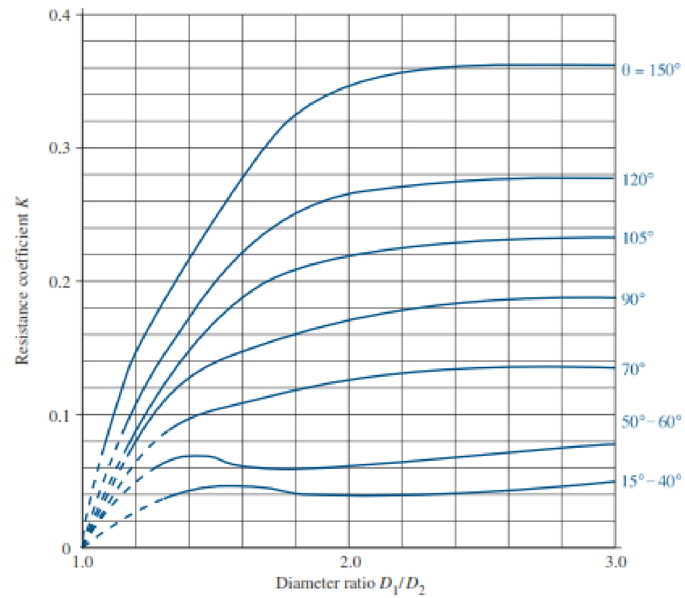
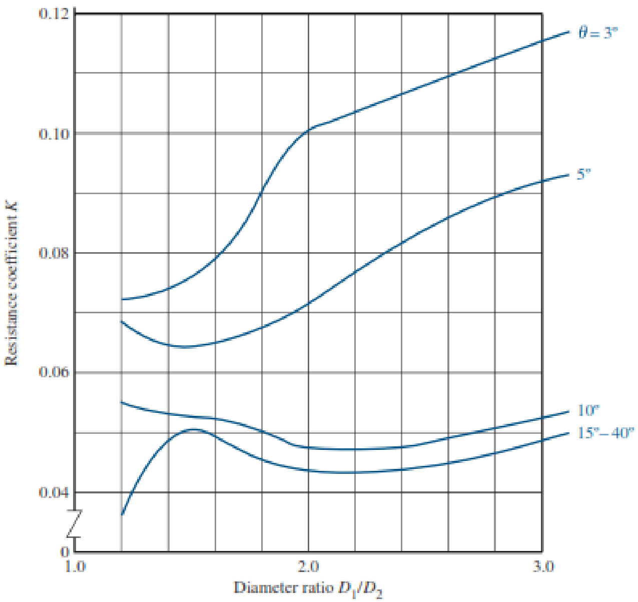


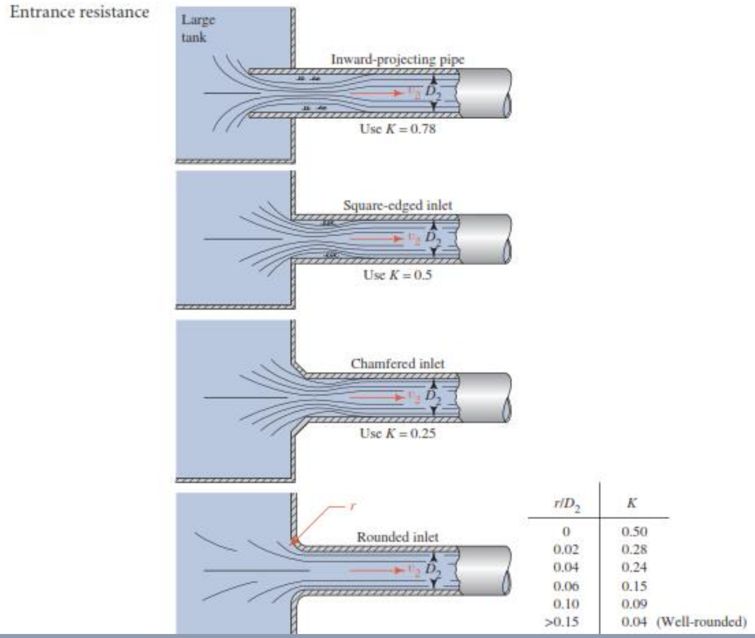
FIGURE 10.12 Resistance coefficient—gradual contraction with $\theta < 15°$.



GUBITAK NA ULASKU

Poseban slučaj kontrakcije događa se kada fluid teče iz relativno velikog rezervoara ili cisterne u cijev. Fluid mora ubrzavati od zanemarive brzine do brzine protoka u cijevi.

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



KOEFICIJENTI OTPORA ZA VENTILE, KOLJENA, T-KOMAD

Koeficijent otpora za ventile, koljena, T.komad se računa prema sljedećem izrazu:

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

gdje je:

$\frac{L_e}{D}$- ekvivalentna dužina

f_t- faktor trenja u području potpune turbulencije

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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

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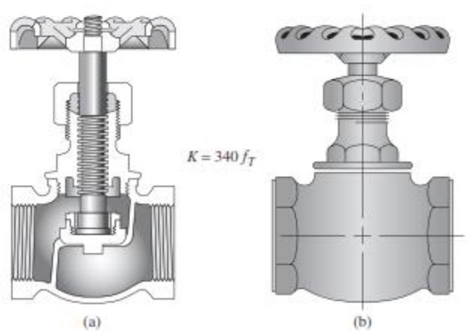


FIGURE 10.15 Globe valve. (Reprinted with permission from "Flow of Fluids Through Valves, Fittings and Pipe, Technical Paper 410" 2009. Crane Co. All Rights Reserved)

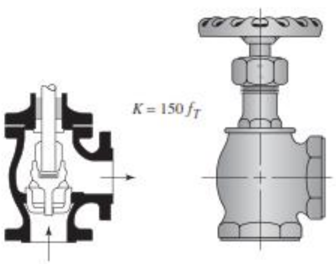


FIGURE 10.16 Angle valve. (Reprinted with permission from "Flow of Fluids Through Valves, Fittings and Pipe, Technical Paper 410" 2009. Crane Co. All Rights Reserved)

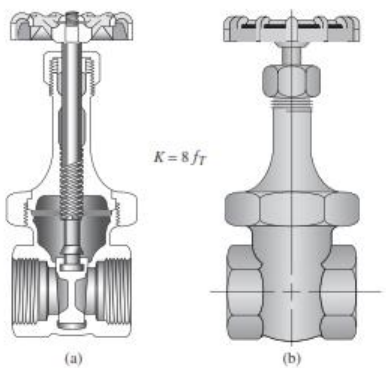


FIGURE 10.17 Gate valve. (Reprinted with permission from "Flow of Fluids Through Valves, Fittings and Pipe, Technical Paper 410" 2009. Crane Co. All Rights Reserved)

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)

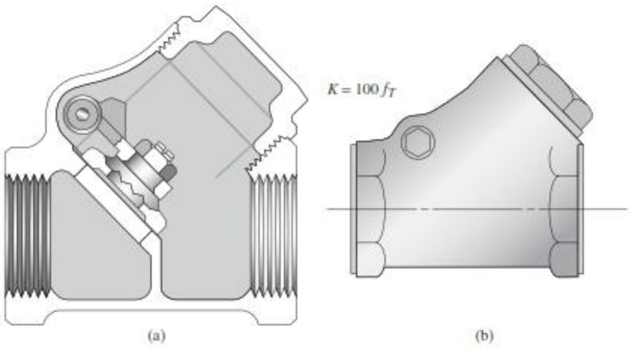
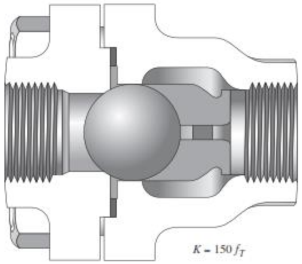


FIGURE 10.19 Check valve—ball type. (Reprinted with permission from "Flow of Fluids Through Valves, Fittings and Pipe, Technical Paper 410" 2009. Crane Co. All Rights Reserved)



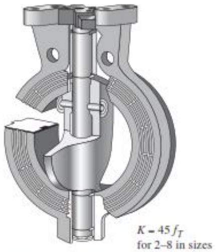


FIGURE 10.20 Butterfly valve. (Reprinted with permission from "Flow of Fluids Through Valves, Fittings and Pipe, Technical Paper 410" 2009. Crane Co. All Rights Reserved)

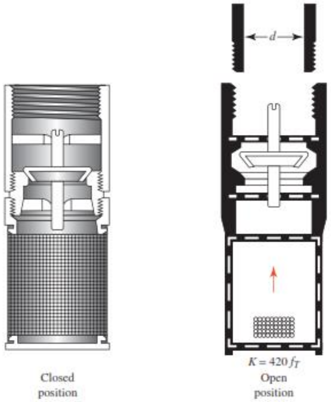
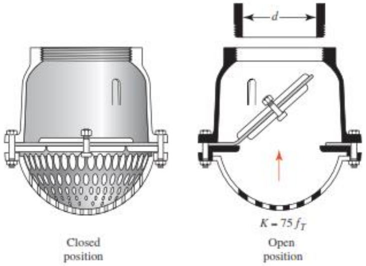


FIGURE 10.21 Foot valve with strainer—poppet disc type. (Reprinted with permission from "Flow of Fluids Through Valves, Fittings and Pipe, Technical Paper 410" 2009. Crane Co. All Rights Reserved)

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)



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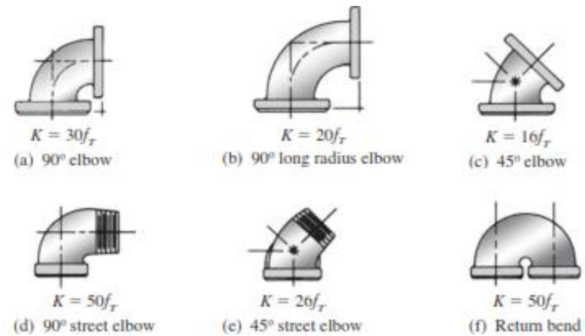
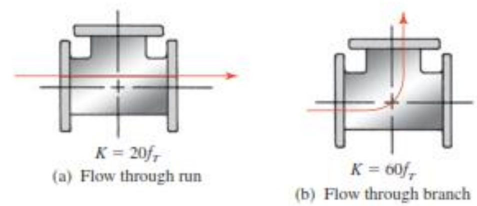


FIGURE 10.23 Pipe elbows. (Reprinted with permission from "Flow of Fluids Through Valves, Fittings and Pipe, Technical Paper 410" 2009 Crane Co. All Rights Reserved)

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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