Viscous Losses in Fittings

Loss coefficients for a selection of other common fittings and components are presented in Figures 1 to 5. Figure 1 presents typical loss coefficients for a sudden expansion and a sudden contraction as a function of the ratio of the internal diameters of the two adjoining pipes. These results exemplify two characteristics of loss coefficients. First an expansion which implies a deceleration of the flow tends to induce more viscous loss than a contraction which, conversely, implies an acceleration of the flow. As will be seen in the pages dealing with boundary layers, deceleration tends to promote separation of the boundary layer and therefore lossy recirculating regions; in addition deceleration tends to promote transition from laminar to turbulent flow and this also enhances the viscous losses. The second characteristic is that sudden changes in the flow also tend to promote separation and/or transition. This was also seen in the loss coefficients presented for conical diffusers where the larger the cone angle, the more sudden the flow change and the larger the loss coefficients.

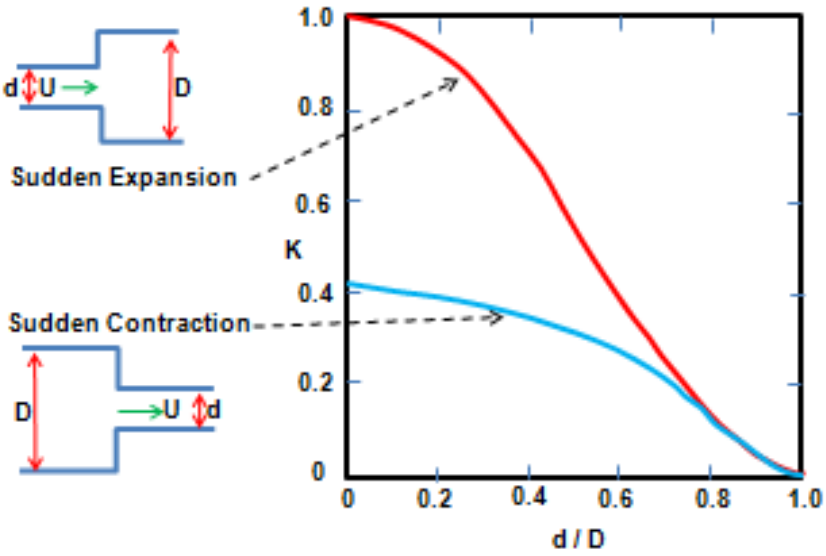

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Figure 1: Typical loss coefficients for sudden expansions and contractions as functions of the diameter ratio.

Figure 2 presents typical loss coefficients for right-angle bends as a function of the radius to diameter ratio, r/d, and the roughness to diameter ratio, ϵ/d. Note again that the more abrupt the bend (the smaller the radius, r) the greater the loss, except at large radii where the extreme length of the bend begins to increase the loss.

The viscous loss coefficients for some other common fittings are listed in Figure 3. This information is often given for convenience in terms of the equivalent length of the connecting pipe that would produce the same head loss. This length is usually quoted in numbers of diameters of the connecting pipe. Figure 3 lists some common fittings and the length of connecting pipe (in diameters) that yields the same viscous loss. In the case of valves, the loss coefficient will clearly depend on whether the valve is fully open or partially closed. Figure 5 presents some typical data for gate and globe valves and the ratio of the loss coefficient in partially open condition to that in fully open condition.

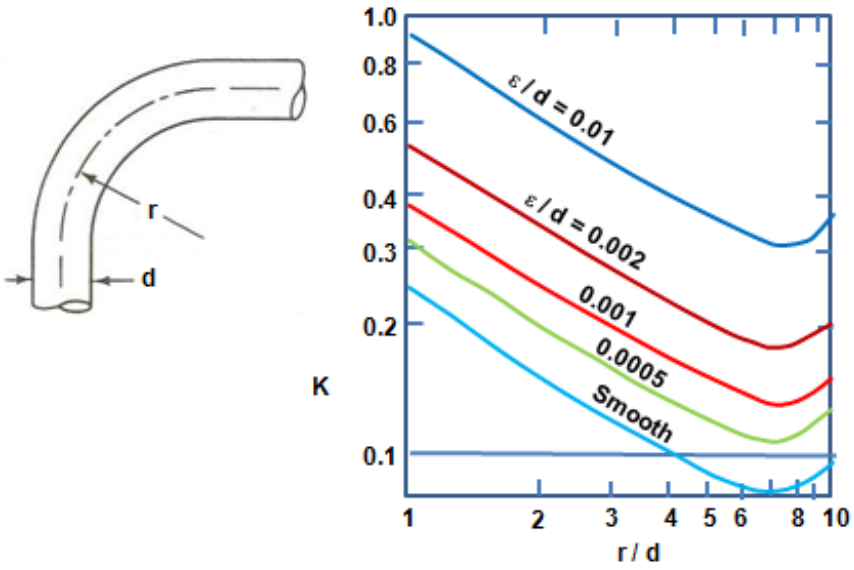

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Figure 2: Loss coefficients for right-angle bends as functions of the radius to diameter ratio, r/d, and the roughness to diameter ratio, ϵ/d. Note that the straight pipe loss for the same length of pipe needs to be added to the above.

Nominal Diameter (in.):	Screwed Joints 1/2	1	2	4	Flanged Joints 1	2	4	8	20
Valves (open):									
Globe	14	8.2	6.9	5.7	13	8.5	6.0	5.8	5.5
Gate	0.30	0.24	0.16	0.11	0.80	0.35	0.16	0.07	0.03
Swing check	5.1	2.9	2.1	2.0	2.0	2.0	2.0	2.0	2.0
Angle	9.0	4.7	2.0	1.0	4.5	2.4	2.0	2.0	2.0
Elbows:									
45° regular	0.39	0.32	0.30	0.29					
45° long radius					0.21	0.20	0.19	0.16	0.14
90° regular	2.0	1.5	0.95	0.64	0.50	0.39	0.30	0.26	0.21
90° long rad.	1.0	0.72	0.41	0.23	0.40	0.30	0.19	0.15	0.10
180° regular	2.0	1.5	0.95	0.64	0.41	0.35	0.30	0.25	0.20
180° long radius					0.40	0.30	0.21	0.15	0.10
Tees:									
Line Flow	0.90	0.90	0.90	0.90	0.24	0.19	0.14	0.10	0.07
Branch Flow	2.4	1.8	1.4	1.1	1.0	0.80	0.64	0.58	0.41

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Figure 3: The viscous loss coefficients for some common fittings with data for both screw-jointed and flange-jointed fittings.

Fitting or component	Range of equivalent pipe diameters
Conventional Globe Valve (fully open)	340-450
Conventional Angle Valve (fully open)	145-200
Conventional Gate Valve (fully open)	13
Conventional Check Valve (fully open)	135-150
Butterfly Valve (fully open)	20
90° Standard Elbow	30
45° Standard Elbow	16
90° Long Radius Elbow	20
90° Street Elbow	50
45° Street Elbow	26
Square Corner Elbow	57
Straight flow through standard tee	20
Branch flow through standard tee	60

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Figure 4: Some common fittings and the lengths of connecting pipe (in diameters) that yield the same viscous head loss.

Ratios of loss coefficient / fully open loss coefficient

Percent Open	Gate Valve	Globe Valve
100%	1.0	1.0
75%	3.0 – 5.0	1.5 – 2.0
50%	12 – 22	2.0 – 3.0
25%	70 – 120	6.0 – 8.0

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Figure 5: Ratios of the loss coefficients in partially open conditions to that in fully open condition for gate and globe valves.