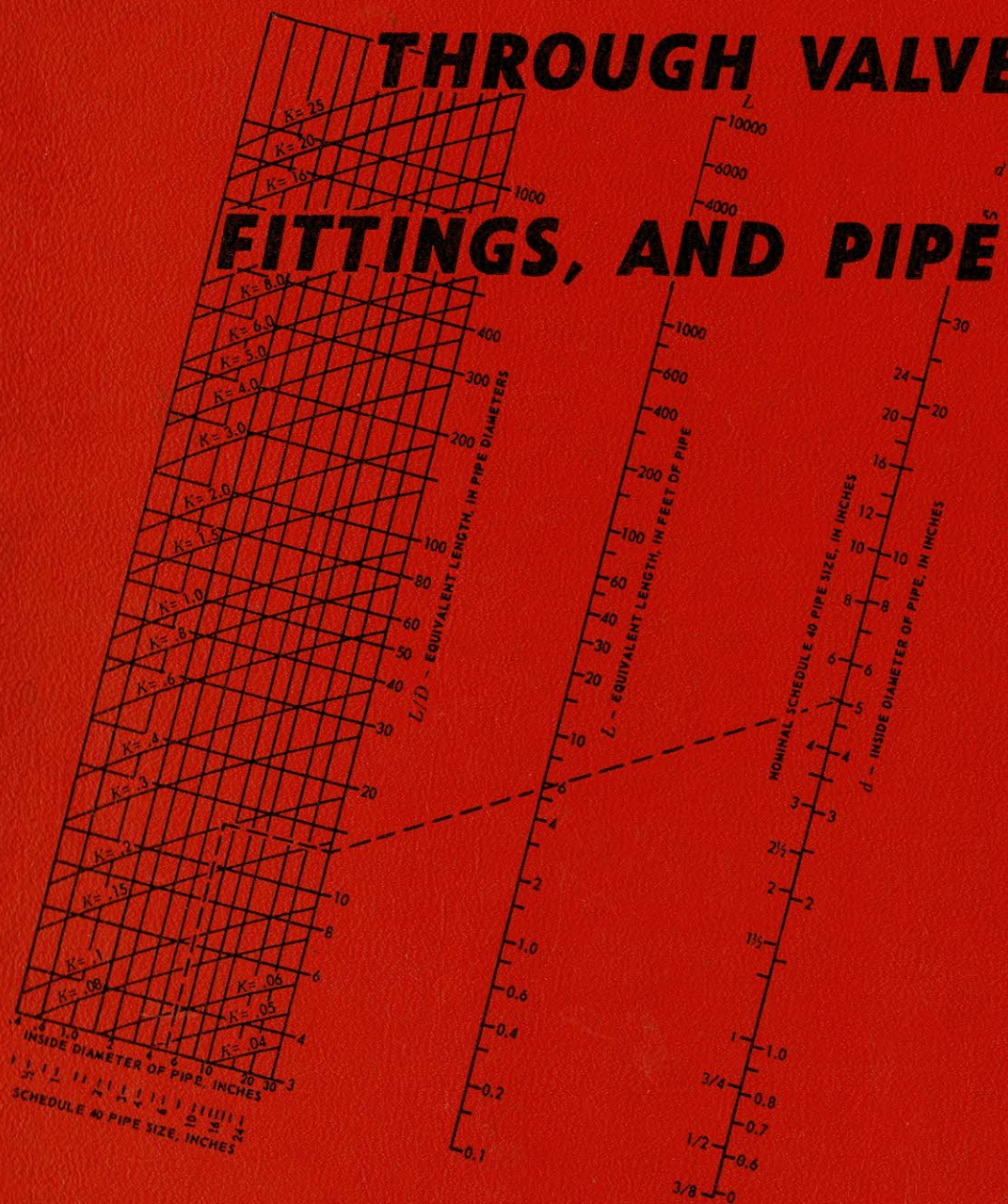
FLOW OF FLUIDS

THROUGH VALVES, FITTINGS, AND PIPE

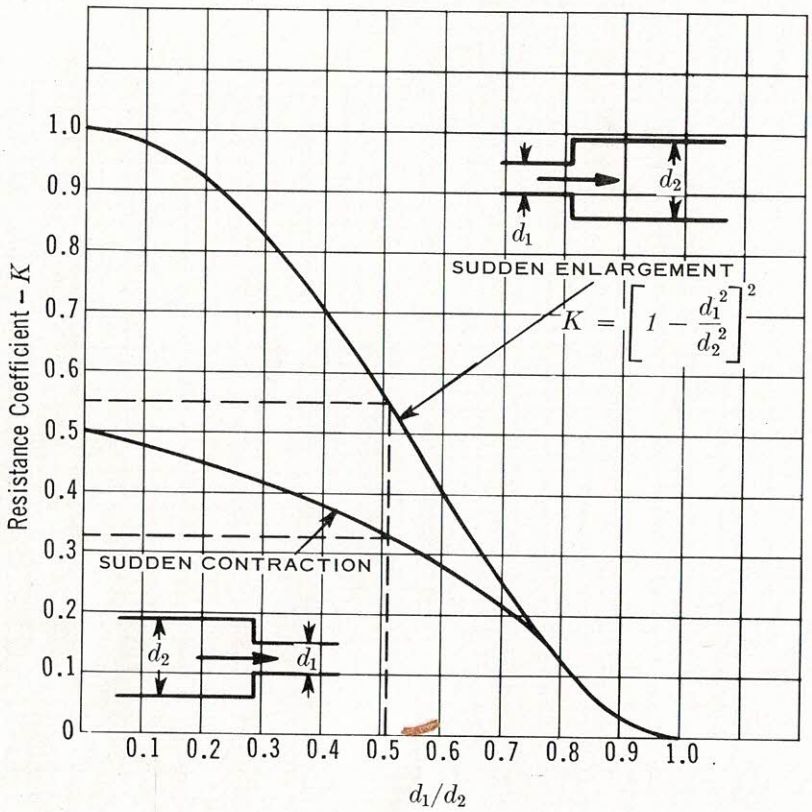


CRANE

Technical Paper No. 410

Resistance in Pipe

Resistance Due to Sudden Enlargements and Contractions[20]



Sudden enlargement: The resistance coefficient K for a sudden enlargement from 6-inch Schedule 40 pipe to 12-inch Schedule 40 pipe is **0.55,** based on the 6-inch pipe size.

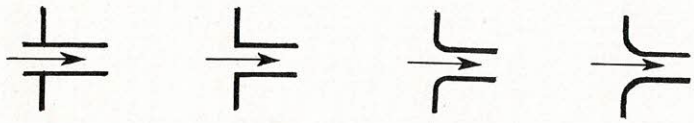
$$\frac{d_1}{d_2} = \frac{6.065}{11.938} = 0.51$$

Sudden contraction: The resistance coefficient K for a sudden contraction from 12-inch Schedule 40 pipe to 6-inch Schedule 40 pipe is **0.33,** based on the 6-inch pipe size.

$$\frac{d_1}{d_2} = \frac{6.065}{11.938} = 0.51$$

Note: The values for the resistance coefficient, K, are based on velocity in the small pipe. To determine K values in terms of the greater diameter, multiply the chart values by $(d_2/d_1)^4$.

Resistance Due to Pipe Entrance and Exit



K = 0.78 Inward Projecting Pipe Entrance

K = 0.50 Sharp Edged Entrance

K = 0.23 Slightly Rounded Entrance

K = 0.04 Well Rounded Entrance

K = 1.0 Projecting Pipe Exit

K = 1.0 Sharp Edged Exit

K = 1.0 Rounded Exit

Problem: Determine the total resistance coefficient for a pipe one diameter long having a sharp edged entrance and a sharp edged exit.

Solution: The resistance of pipe one diameter long is small and can be neglected ($K = f\,L/D$).

From the diagrams, note:

Resistance for a sharp edged entrance = 0.5
Resistance for a sharp edged exit = 1.0

Then,
the total resistance, K, for the pipe = **1.5**

Resistance of Bends

Resistance of 90 Degree Bends[21]

The chart at the right shows the resistance of 90 degree bends to the flow of fluids in terms of equivalent lengths of straight pipe.

Resistance of bends greater than 90 degrees is found using the formula:

$$\frac{L}{D} = R_t + (n-1)\left(R_l + \frac{R_b}{2}\right)$$

n = total number of 90° bends in coil
R_t = total resistance due to one 90° bend, in L/D
R_l = resistance due to length of one 90° bend, in L/D
R_b = bend resistance due to one 90° bend, in L/D

Problem: Determine the equivalent lengths in pipe diameters of a 90 degree bend and a 270 degree bend having a relative radius of 12.

Solution: Referring to the "Total Resistance" curve, the equivalent length for a 90 degree bend is **34.5** pipe diameters.

The equivalent length of a 270 degree bend is:

$L/D = 34.5 + (3-1)\,[18.7 + (15.8 \div 2)]$
$L/D =$ **87.7** pipe diameters

Note: This loss is less than the sum of losses through three 90 degree bends separated by tangents. For "resistance of bends theory", see page 2-12.

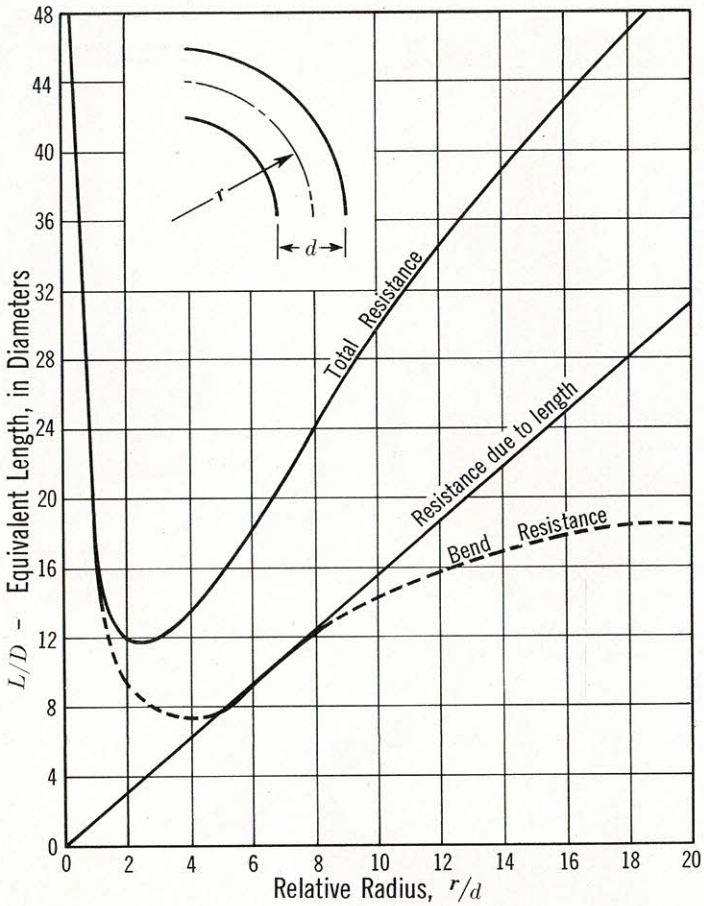


Chart for Resistance of 90 Degree Bends

From *Pressure Losses for Fluid Flow in 90 Degree Pipe Bends* by K. H. Beij. Courtesy of Journal of Research of National Bureau of Standards, Vol. 21, July, 1938.

Resistance of Miter Bends[4]

The chart at the lower right shows the resistance of miter bends to the flow of fluids. The chart is based on data published by the American Society of Mechanical Engineers (ASME).

Problem: Determine the equivalent length in pipe diameters of a 40 degree miter bend.

Solution: Referring to the "Total Resistance" curve in the chart, the equivalent length is **12** pipe diameters.

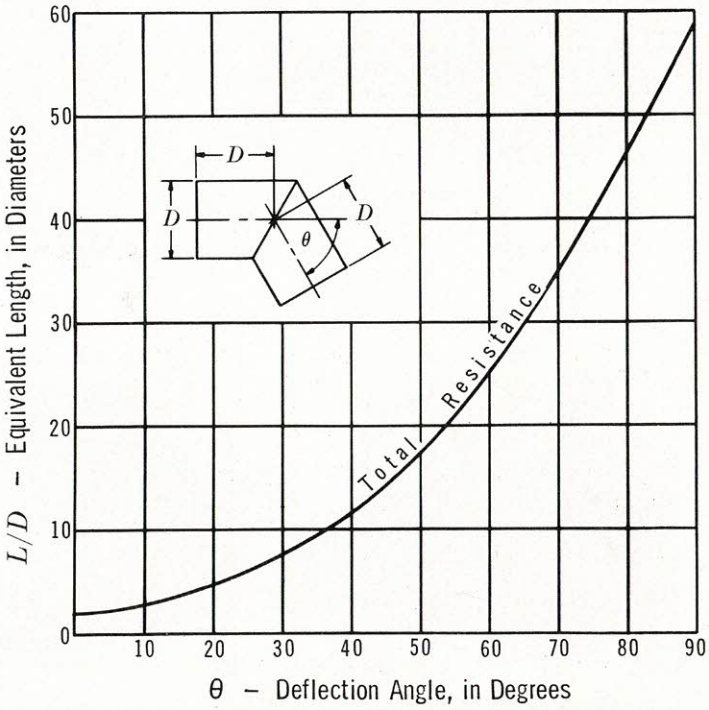


Chart for Resistance of Miter Bends