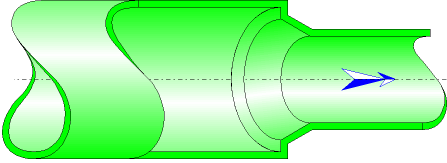




Sudden Contraction Bevelled Circular Cross-Section (Pipe Flow - Guide)



Model description:

This model of component calculates the minor head loss (pressure drop) generated by the flow in a sudden contraction bevelled.

The head loss by friction in the inlet and outlet piping is not taken into account in this component.

Model formulation:

Ratio of small to large diameter:

$$\beta = \frac{d_2}{d_1}$$

Top angle of cone (°):

$$\alpha = 2 \cdot \tan^{-1} \left(\frac{d_0 - d_2}{2 \cdot l} \right)$$

Major cross-sectional area (m²):

$$A_1 = \pi \cdot \frac{d_1^2}{4}$$

Minor cross-sectional area (m²):

$$A_2 = \pi \cdot \frac{d_2^2}{4}$$

Mean velocity in major diameter (m/s):

$$V_1 = \frac{Q}{A_1}$$

Mean velocity in minor diameter (m/s):

$$V_2 = \frac{Q}{A_2}$$

Mass flow rate (kg/s):

$$G = Q \cdot \rho$$

Reynolds number in major diameter:

$$N_{Re_1} = \frac{V_1 \cdot d_1}{\nu}$$

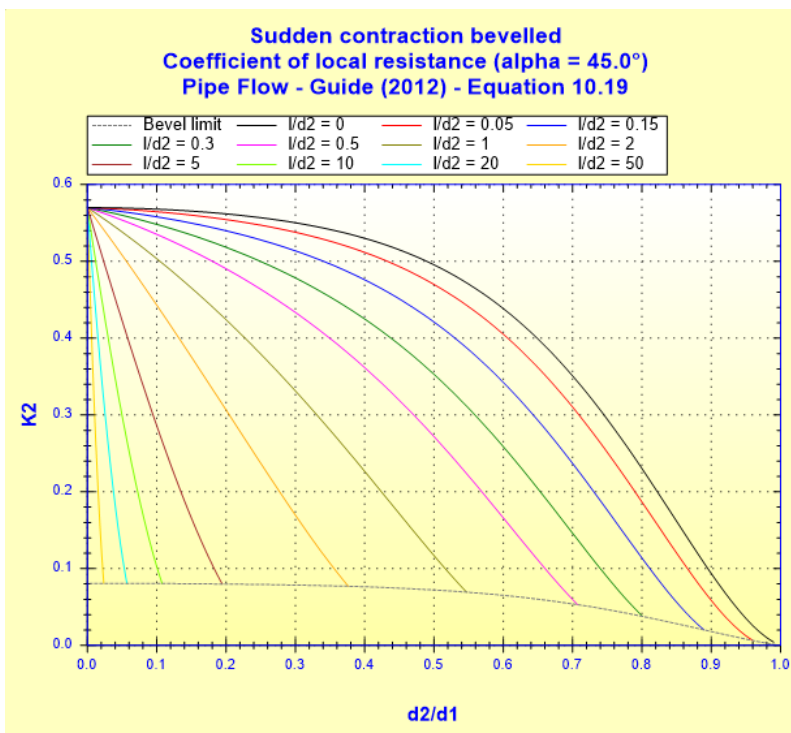
Reynolds number in minor diameter:

$$N_{Re_2} = \frac{V_2 \cdot d_2}{\nu}$$

Local resistance coefficient ($N_{Re} \geq 10^4$):

$$K_2 = 0.0696 \cdot \left[1 + C_B \cdot \left(\sin\left(\frac{\alpha}{2}\right) - 1 \right) \right] \cdot (1 - \beta^5) \cdot \lambda^2 + (\lambda - 1)^2$$

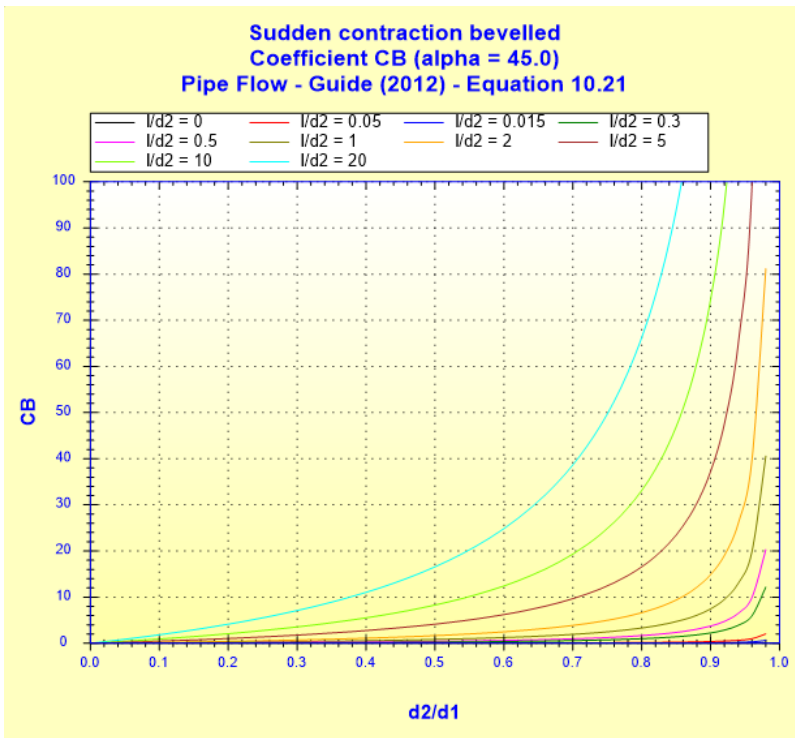
([1] equation 10.19)



With:

$$C_B = \frac{l}{d_2} \cdot \frac{2 \cdot \beta \cdot \tan\left(\frac{\alpha}{2}\right)}{1 - \beta}$$

([1] equation 10.21)

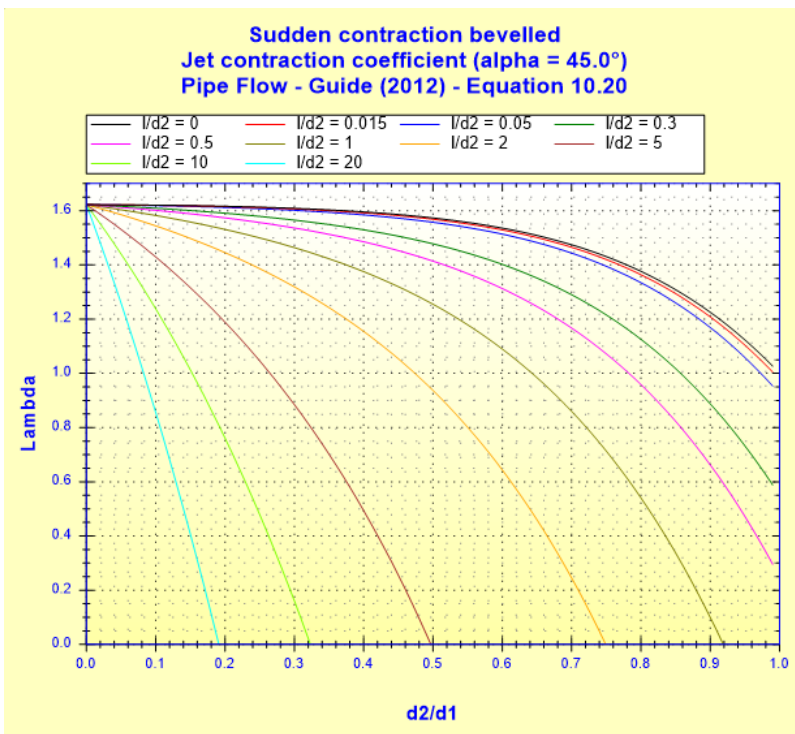


And:

$$\lambda = 1 + 0.622 \cdot \left[1 + C_B \cdot \left(\left(\frac{\alpha}{180} \right)^{4/5} - 1 \right) \right] \cdot \left(1 - 0.215 \cdot \beta^2 - 0.785 \cdot \beta^5 \right)$$

([1] equation

10.20)



Total pressure loss coefficient (based on mean velocity in minor diameter):

$$K = K_2$$

Total pressure loss (Pa):

$$\Delta P = K \cdot \frac{\rho_m \cdot V_2^2}{2}$$

Total head loss of fluid (m):

$$\Delta H = K \cdot \frac{V_2^2}{2 \cdot g}$$

Hydraulic power loss (W):

$$Wh = \Delta P \cdot Q$$

Symbols, Definitions, SI Units:

d_1	Major diameter (m)
d_2	Minor diameter (m)
d_0	Base diameter of the cone (m)
β	Ratio of small to large diameter ()
A_1	Major cross-sectional area (m ²)
A_2	Minor cross-sectional area (m ²)
Q	Volume flow rate (m ³ /s)
G	Mass flow rate (kg/s)
V_1	Mean velocity in major diameter (m/s)
V_2	Mean velocity in minor diameter (m/s)
NRe_1	Reynolds number in major diameter ()
NRe_2	Reynolds number in minor diameter ()
K_2	Local resistance coefficient ()
C_B	Ratio of bevel length l to the length of a conical contraction of corresponding diameter ratio and included angle ()
λ	Jet contraction coefficient ()
K	Total pressure loss coefficient (based on mean velocity in minor diameter) ()
ΔP	Total pressure loss (Pa)
ΔH	Total head loss of fluid (m)
Wh	Hydraulic power loss (W)
ρ_m	Fluid density (kg/m ³)
ν	Fluid kinematic viscosity (m ² /s)
g	Gravitational acceleration (m/s ²)

Validity range:

- turbulent flow regime in minor diameter ($NRe_2 \geq 10^4$)

Example of application:

HydrauCalc 2020a - [Sudden contraction bevelled - Pipe Flow - Guide (2012)]

File Edit Preferences Calculation method Database Tools Help

Fluid characteristics

Fluid : Water @ 1 atm [HC]
Ref.: IAPWS IF97

Temperature : T 20 °C
Pressure : P 1.013 bar

Density : ρ 998.2061 kg/m³
Dynamic Viscosity : μ 0.00100159 N.s/m²
Kinematic Viscosity : ν 1.00340E-06 m²/s

Density Dyn. Visc. Kin. Visc.

Density (kg/m³) vs Temperature (°C)

logY

Geometrical characteristics

Help Info Calculate

Pressure loss ΔP 0.01437072 bar
 ΔH 0.1468 m of fluid

Complementary results

Designation	Symbol	Value	Unit
Diameters ratio (d2/d1)	β	0.6130868	
Major cross-section area	A1	0.003881508	m ²
Minor cross-section area	A2	0.001458963	m ²
Cross-sections area ratio	A2/A1	0.3758754	
Ratio 'Bevel length / small diameter'	l/d2	0.2320186	
Major diameter Reynolds number	NRe1	90251	
Minor diameter Reynolds number	NRe2	147207.5	
Jet velocity ratio (Equation 10.20)	λ	1.386837	
Coefficient (Equation 10.21)	CB	0.5	
Coefficient of local resistance (Equation 10.19)	K2	0.2451529	
Pressure loss coefficient (based on velocity in minor diameter)	K	0.2451529	
Hydraulic power loss	Wh	7.185358	W

References:

[1] Pipe Flow: A Practical and Comprehensive Guide. Donald C. Rennels and Hobart M. Hudson. (2012)