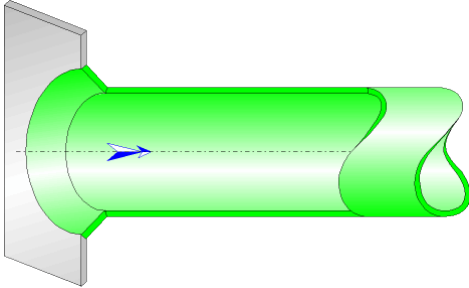




## Flush-mounted bevelled entrance Circular Cross-Section (Pipe Flow - Guide)



### Model description:

This model of component calculates the minor head loss (pressure drop) generated by the flow in a flush-mounted bevelled entrance of piping.

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

### Model formulation:

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Hydraulic diameter (m):

$$d_h = d$$

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Pipe cross-sectional area (m<sup>2</sup>):

$$A = \pi \cdot \frac{d^2}{4}$$

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Mean velocity in pipe (m/s):

$$V = \frac{Q}{A}$$

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Mass flow rate (kg/s):

$$G = Q \cdot \rho_m$$

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Reynolds number in pipe:

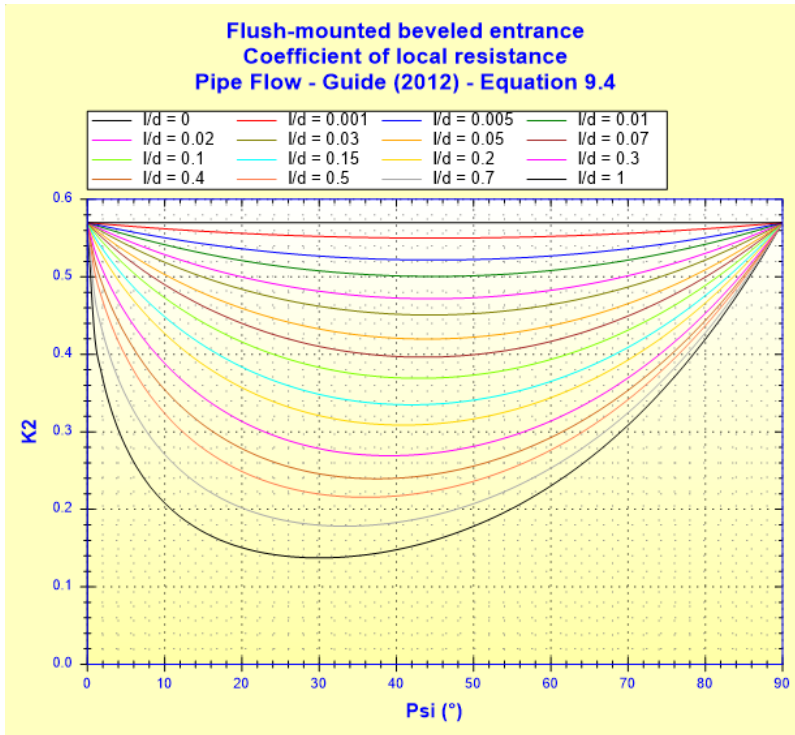
$$N_{Re} = \frac{V \cdot d}{\nu}$$

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

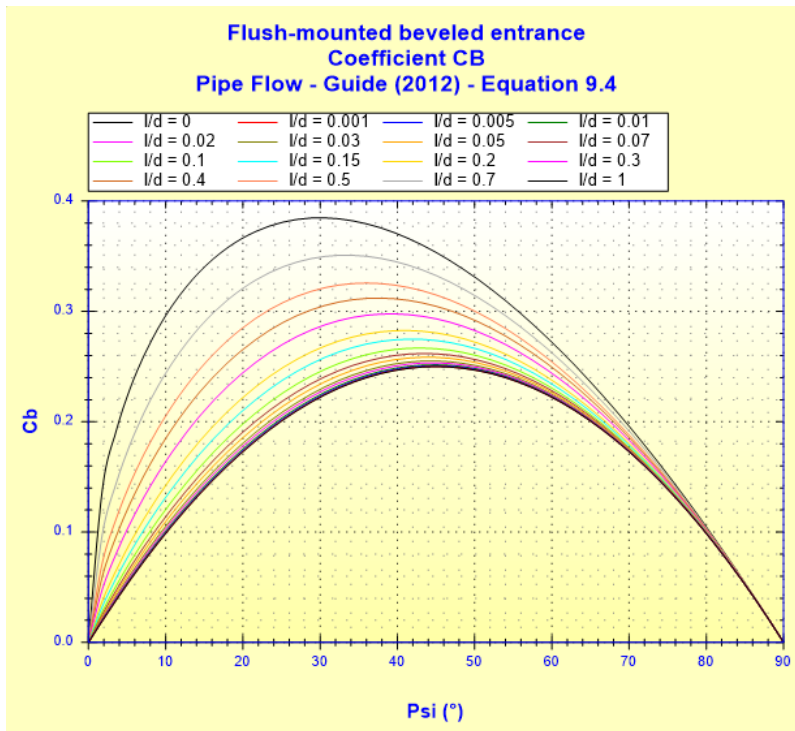
$$K_2 = 0.0696 \cdot \left[ 1 - C_b \cdot \frac{l}{d} \right] \cdot \lambda^2 + (\lambda - 1)^2$$

([1] equation 9.4)



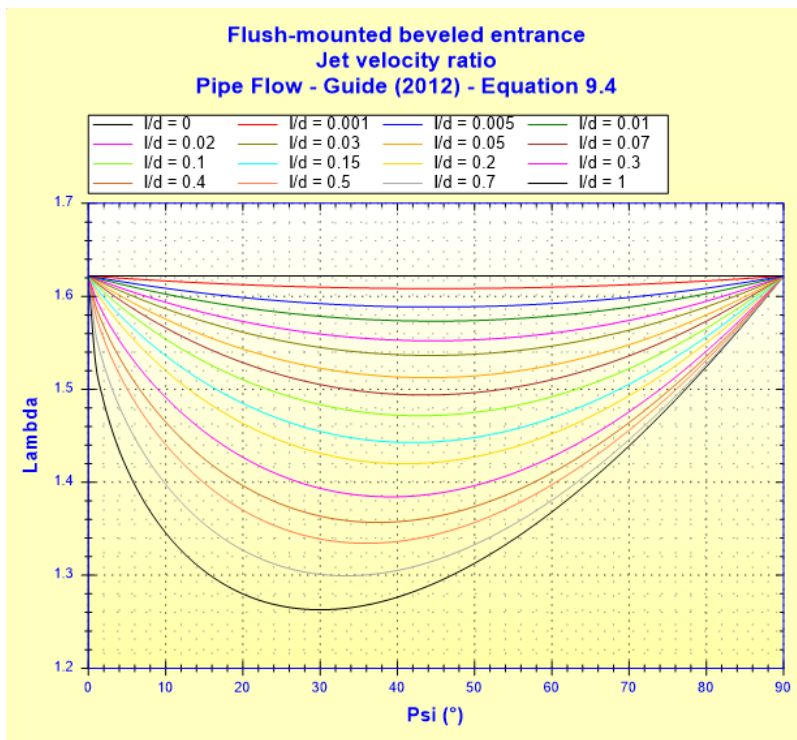
With:

$$C_b = \left( 1 - \frac{\Psi}{90} \right) \cdot \left( \frac{\Psi}{90} \right)^{1+l/d}$$



And:

$$\lambda = 1 + 0.622 \cdot \left[ 1 - 1.5 \cdot C_b \cdot \left( \frac{l}{d} \right)^{\frac{1-\sqrt{l/d}}{2}} \right]$$



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

$$K = K_2$$

Total pressure loss (Pa):

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

Total head loss of fluid (m):

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

Hydraulic power loss (W):

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

**Symbols, Definitions, SI Units:**

$d_h$	Hydraulic diameter (m)
$d$	Pipe diameter (m)
$A$	Pipe cross-sectional area (m <sup>2</sup> )
$Q$	Volume flow rate (m <sup>3</sup> /s)
$G$	Mass flow rate (kg/s)
$V$	Mean velocity in pipe (m/s)
$N_{Re}$	Reynolds number in pipe ( )
$\psi$	Bevel angle (°)
$l$	Bevel length ( )
$K_2$	Local resistance coefficient ( )
$K$	Total pressure loss coefficient (based on mean velocity in pipe) ( )
$\Delta P$	Total pressure loss (Pa)
$\Delta H$	Total head loss of fluid (m)

Wh Hydraulic power loss (W)

$\rho_m$  Fluid density ( $\text{kg/m}^3$ )

$\nu$  Fluid kinematic viscosity ( $\text{m}^2/\text{s}$ )

$g$  Gravitational acceleration ( $\text{m/s}^2$ )

### Validity range:

- turbulent flow regime in pipe ( $Re \geq 10^4$ )
- relative length of bevel ( $l/d$ ) equal to or lower than 1

### Example of application:

The screenshot shows the HydraulCalc 2019b interface. The 'Fluid characteristics' panel on the left is set to 'Water @ 1 atm [HC]' with a temperature of 20 °C and a pressure of 1.013 bar. It displays physical properties: Density  $\rho = 998.2061 \text{ kg/m}^3$ , Dynamic Viscosity  $\mu = 0.00100159 \text{ N.s/m}^2$ , and Kinematic Viscosity  $\nu = 1.00340E-06 \text{ m}^2/\text{s}$ . A graph shows density vs. temperature. The 'Geometrical characteristics' panel shows a 3D model of a pipe with a bevelled entrance. Parameters include: top angle  $\alpha = 45^\circ$ , bevel length  $l = 0.01 \text{ m}$ , pipe diameter  $d = 0.0703 \text{ m}$ , flow rate  $Q = 0.005 \text{ m}^3/\text{s}$ , mass flow  $\dot{m} = 4.9910 \text{ kg/s}$ , and mean velocity  $v = 1.288 \text{ m/s}$  (turbulent). The calculated pressure loss is  $\Delta P = 0.002819033 \text{ bar}$  ( $\Delta H = 0.0288 \text{ m}$  of fluid). The 'Complementary results' table is shown below.

Designation	Symbol	Value	Unit
Hydraulic diameter	$d$	0.0703	m
Pipe cross-section area	$A$	0.003881508	$\text{m}^2$
Relative length of the bevel	$l/d$	0.1422475	
Reynolds number	$Re$	90251	
Top angle of cone	$\alpha$	90	$^\circ$
Coefficient $C_b$ (Equation 9.4)	$C_b$	0.2725387	
Jet velocity ratio (Equation 9.4)	$\lambda$	1.447457	
Pressure loss coefficient (Equation 9.4)	$K_2$	0.3403854	
Pressure loss coefficient (based on the mean pipe velocity)	$K$	0.3403854	
Hydraulic power loss	$Wh$	1.409516	W

### References:

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