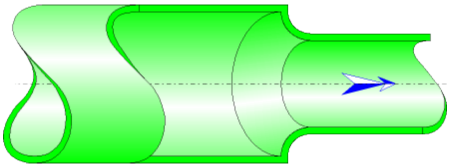
Sudden Contraction Rounded
Circular Cross-Section
(Pipe Flow - Guide)



Model description:

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

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:

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

Major cross-sectional area (m^2):

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

Minor cross-sectional area (m^2):

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

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:

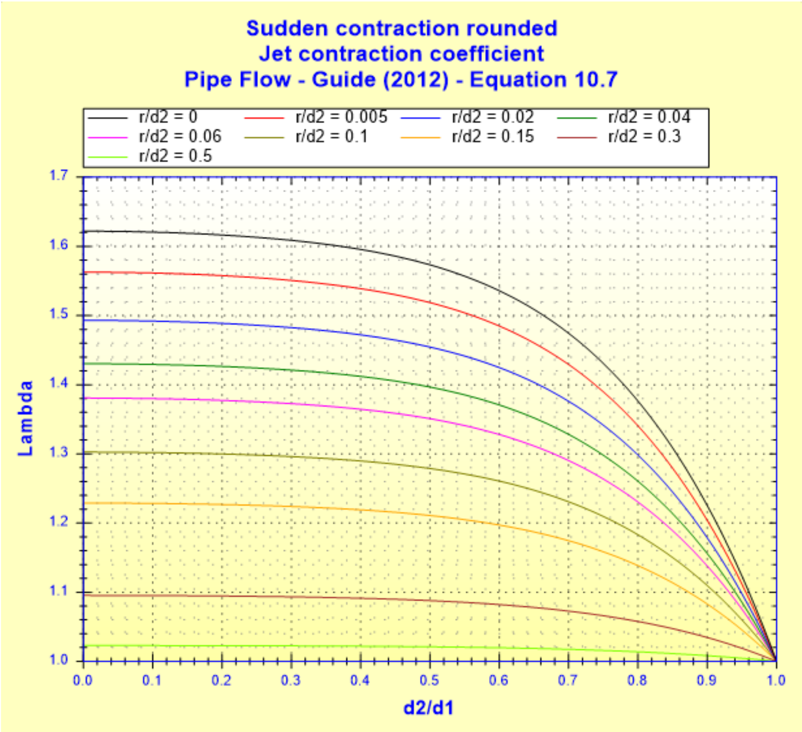
$$N_{Re_2} = \frac{V_2 \cdot d_2}{\nu}$$

Jet contraction coefficient:

- $0 \le r/d_2 \le 1$:

$$\lambda = 1 + 0.622 \cdot \left(1 - 0.30 \cdot \sqrt{\frac{r}{d_2}} - 0.70 \cdot \frac{r}{d_2}\right)^4 \cdot \left(1 - 0.215 \cdot \beta^2 - 0.785 \cdot \beta^5\right)$$

([1] equation 10.7)



- $r/d_2 > 1$:

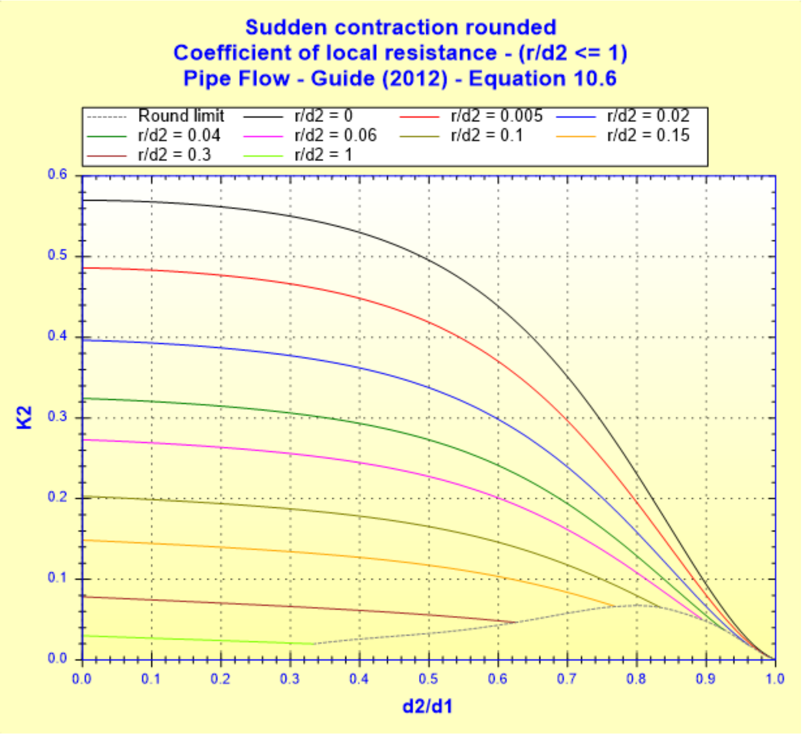
$$\lambda = 1$$

Local resistance coefficient ($NRe_2 \ge 10^4$):

- $0 \le r/d_2 \le 1$:

$$K_2 = 0.0696 \cdot \left(1 - 0.569 \cdot \frac{r}{d_2}\right) \cdot \left(1 - \sqrt{\frac{r}{d_2}} \cdot \beta\right) \cdot \left(1 - \beta^5\right) \cdot \lambda^2 + (\lambda - 1)^2$$

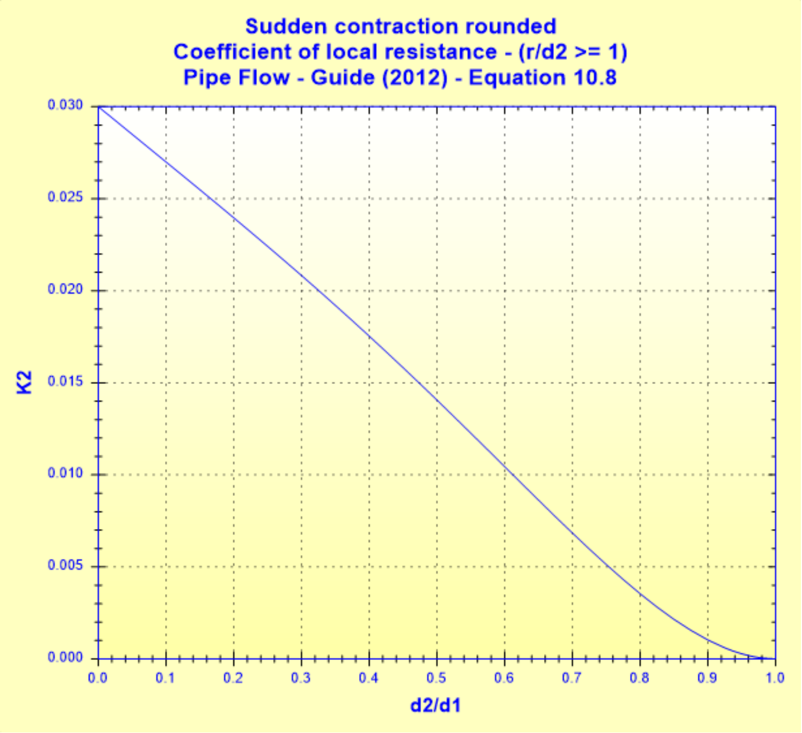
([1] equation 10.6)



- $r/d_2 > 1$:

$$K_2 = 0.030 \cdot (1-\beta) \cdot \left(1-\beta^4\right)$$

([1] equation 10.8)



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):

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

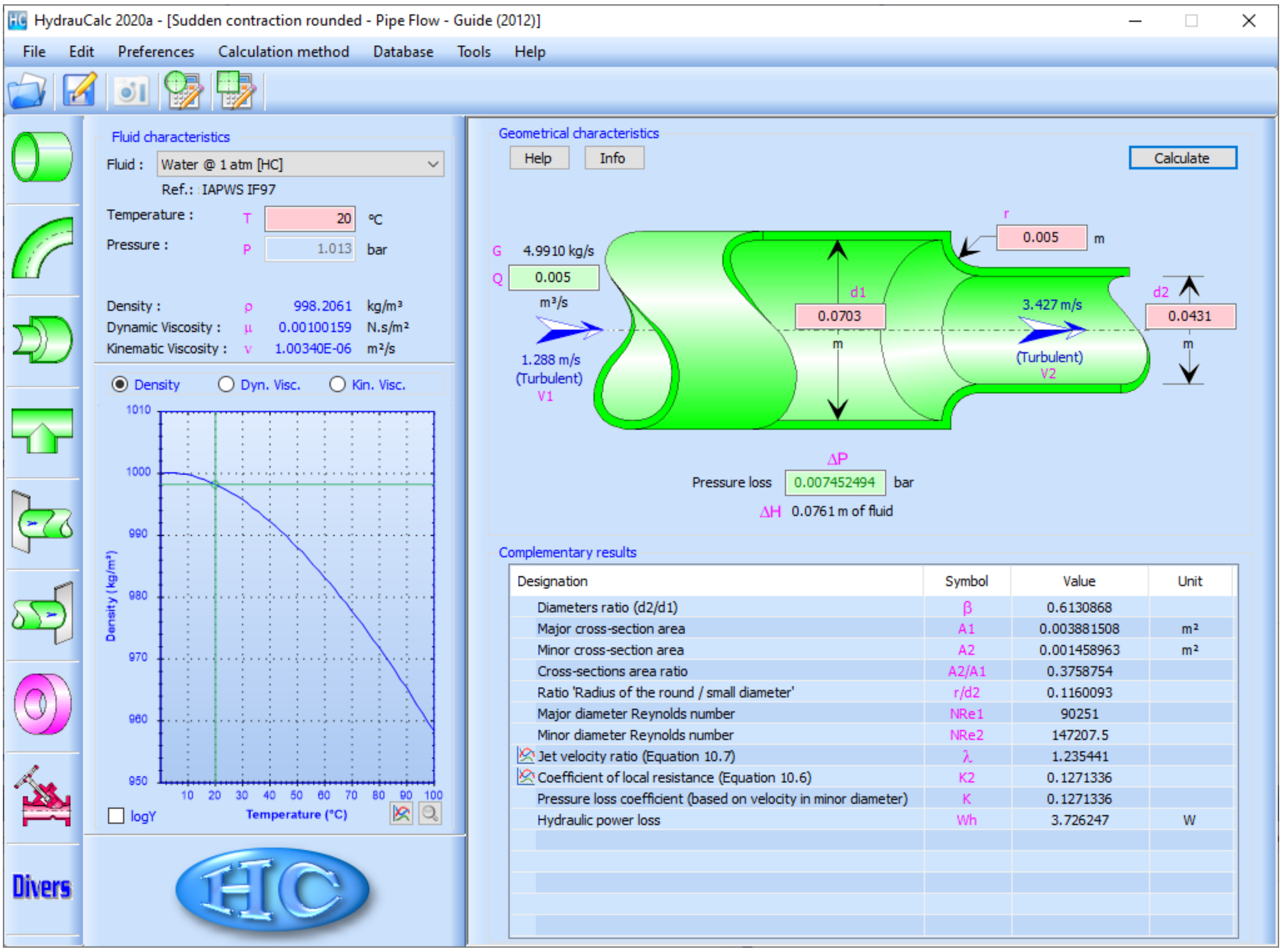
Symbols, Definitions, SI Units:

d_1	Major diameter (m)
d_2	Minor diameter (m)
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 ()
r	Radius of the round (m)
λ	Jet contraction coefficient ()
K_2	Local resistance 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 ($NRe_2 \geq 10^4$)
- round radius less than the radius difference ($r < (d_1/2 - d_2/2)$)

Example of application:



References:

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