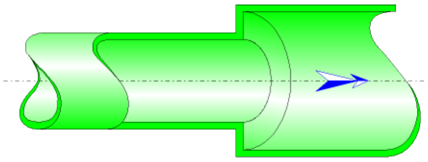
Sudden Expansion
Circular Cross-Section
(Pipe Flow - Guide)



Model description:

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

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:

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

Minor cross-sectional area (m^2):

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

Major cross-sectional area (m^2):

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

Mean velocity in minor diameter (m/s):

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

Mean velocity in major diameter (m/s):

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

Mass flow rate (kg/s):

$$G = Q \cdot \rho$$

Reynolds number in minor diameter:

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

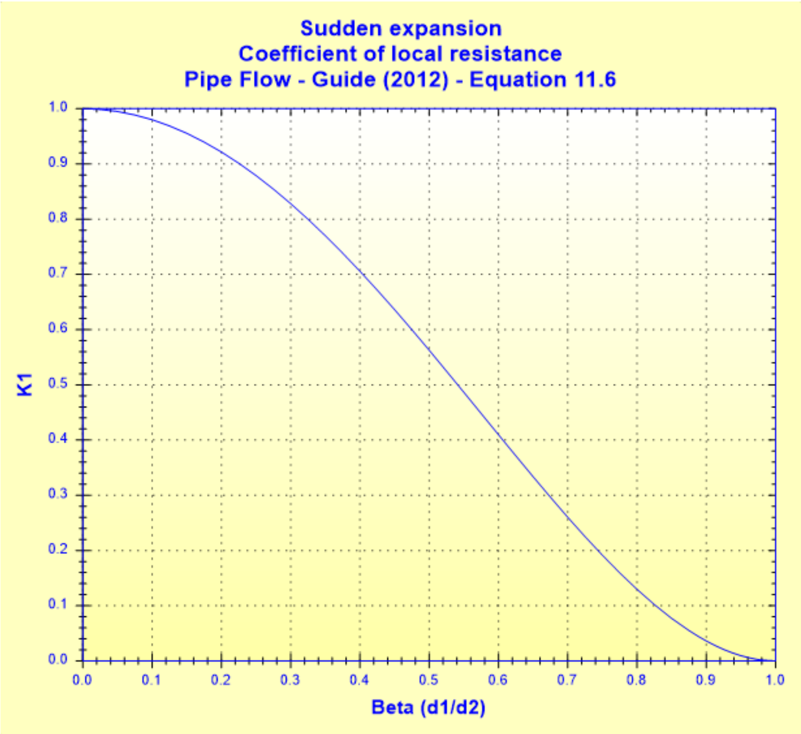
Reynolds number in major diameter:

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

Local resistance coefficient ($Re_1 \geq 10^4$):

$$K_1 = \left(1 - \beta^2\right)^2$$

([1] equation 11.6) (Borda-Carnot equation)



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

$$K = K_1$$

Total pressure loss (Pa):

$$\Delta P = K \cdot \frac{\rho_m \cdot V_1^2}{2}$$

Total head loss of fluid (m):

$$\Delta H = K \cdot \frac{V_1^2}{2 \cdot g}$$

Hydraulic power loss (W):

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

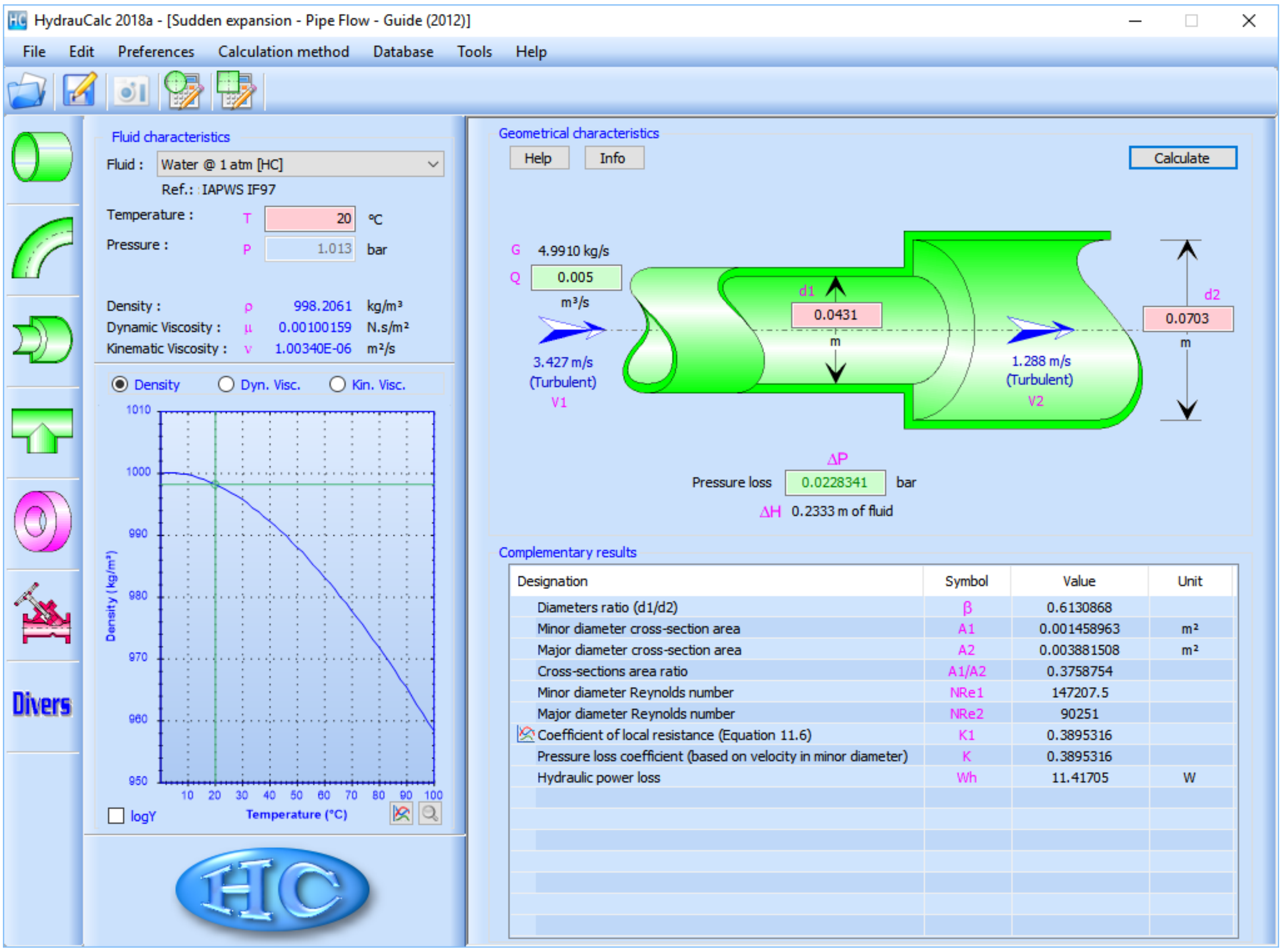
Symbols, Definitions, SI Units:

d_1	Minor diameter (m)
d_2	Major diameter (m)
β	Ratio of small to large diameter ()
A_1	Minor cross-sectional area (m^2)
A_2	Major cross-sectional area (m^2)
Q	Volume flow rate (m^3/s)
G	Mass flow rate (kg/s)
V_1	Mean velocity in minor diameter (m/s)
V_2	Mean velocity in major diameter (m/s)
NRe_1	Reynolds number in minor diameter ()
NRe_2	Reynolds number in major diameter ()
K_1	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 ($NRe_1 \geq 10^4$)

Example of application:



Designation	Symbol	Value	Unit
Diameters ratio (d1/d2)	β	0.6130868	
Minor diameter cross-section area	A1	0.001458963	m²
Major diameter cross-section area	A2	0.003881508	m²
Cross-sections area ratio	A1/A2	0.3758754	
Minor diameter Reynolds number	NRe1	147207.5	
Major diameter Reynolds number	NRe2	90251	
Coefficient of local resistance (Equation 11.6)	K1	0.3895316	
Pressure loss coefficient (based on velocity in minor diameter)	K	0.3895316	
Hydraulic power loss	Wh	11.41705	W

References:

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