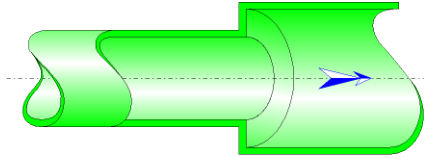




Sudden Expansion Circular Cross-Section (CRANE)



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:

$$\beta = \frac{D_1}{D_2}$$

Minor cross-sectional area (m²):

$$A_1 = \pi \cdot \frac{D_1^2}{4}$$

Major cross-sectional area (m²):

$$A_2 = \pi \cdot \frac{D_2^2}{4}$$

Mean velocity in minor diameter (m/s):

$$v_1 = \frac{q}{A_1}$$

Mean velocity in major diameter (m/s):

$$v_2 = \frac{q}{A_2}$$

Mass flow rate (kg/s):

$$G = q \cdot \rho$$

Reynolds number in minor diameter:

$$Re_1 = \frac{v_1 \cdot D_1}{\nu}$$

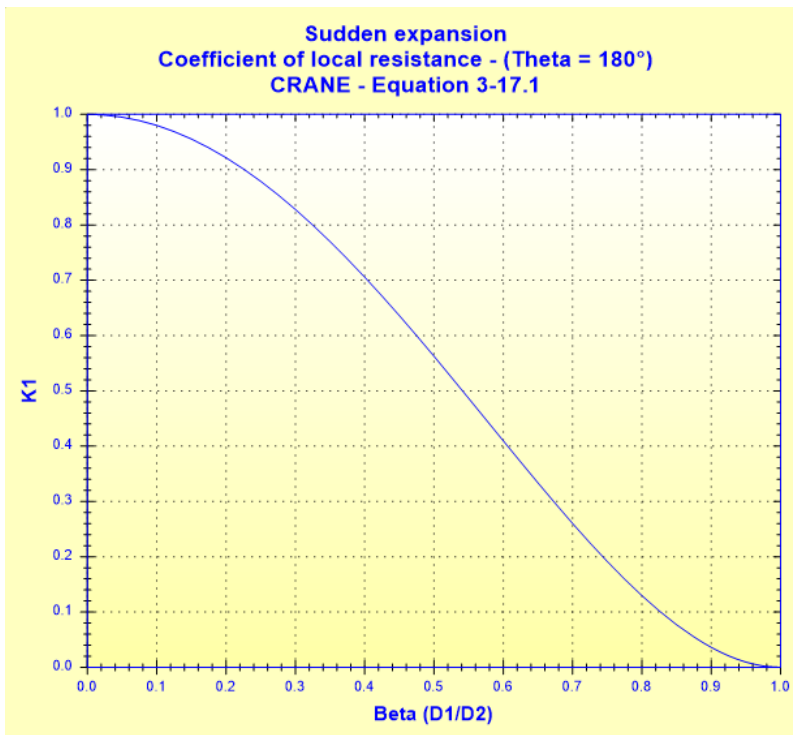
Reynolds number in major diameter:

$$Re_2 = \frac{v_2 \cdot D_2}{\nu}$$

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

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

([1] equation 3-17.1 with $\theta=180^\circ$ or equation 2-9.1)



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

$$K = K_1$$

Total pressure loss (Pa):

$$\Delta P = K \cdot \frac{\rho \cdot v_1^2}{2}$$

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)
Re_1	Reynolds number in minor diameter ()
Re_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	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 ($Re_1 \geq 10^4$)

Example of application:

HydrauCalc 2018a - [Sudden expansion - CRANE (1999)]

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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.

Geometrical characteristics

Help Info Calculate

Pressure loss ΔP 0.0228341 bar
 ΔH 0.2333 m of fluid

Complementary results

Designation	Symbol	Value	Unit
Diameters ratio (D1/D2)	β	0.6130868	
Minor diameter cross-section area	A1	0.001458963	m ²
Major diameter cross-section area	A2	0.003881508	m ²
Cross-sections area ratio	A1/A2	0.3758754	
Minor diameter Reynolds number	Re1	147207.5	
Major diameter Reynolds number	Re2	90251	
<input checked="" type="checkbox"/> Coefficient of local resistance (Equation 3-17.1)	K1	0.3895316	
Pressure loss coefficient (based on velocity in minor diameter)	K	0.3895316	
Hydraulic power loss	Wh	11.41705	W

References:

[1] CRANE - Flow of Fluids Through Valves, Fitting and Pipe - Technical Paper No. 410 - Edition 1999