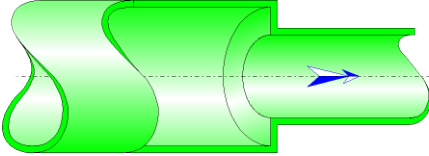




## Sudden Contraction Sharp Circular Cross-Section (CRANE)



### Model description:

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

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 (m<sup>2</sup>):

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

---

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

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

---

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 ( $Re_1 \geq 10^4$ ):

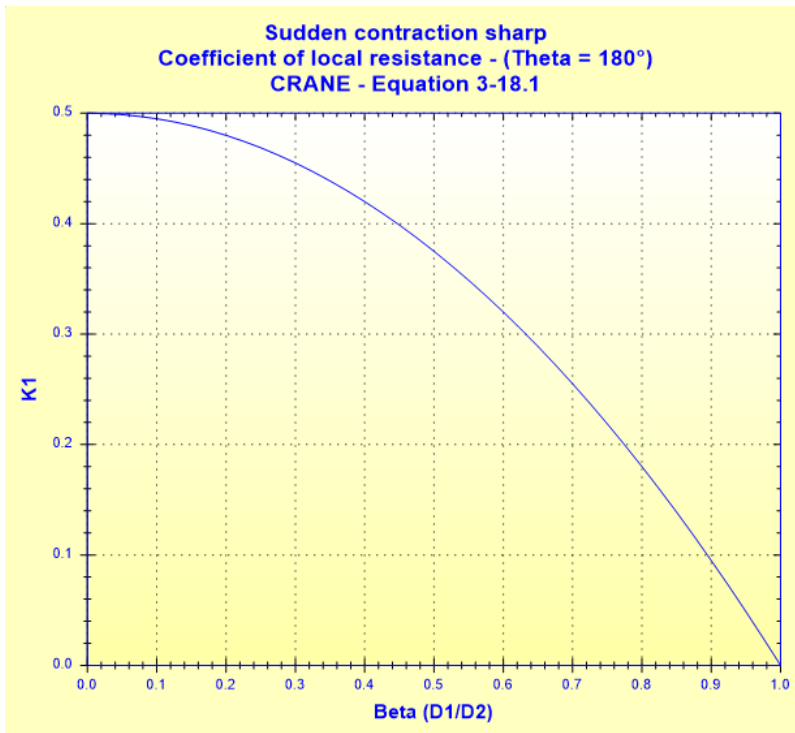
$$K_1 = 0.5 \cdot (1 - \beta^2)$$

([1] equation 2-10.1)

or

$$K_1 = 0.5 \sqrt{\sin\left(\frac{\theta}{2}\right)} (1 - \beta^2)$$

([1] equation 3-18.1 with  $\theta=180^\circ$ )



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)
$\beta$	Ratio of small to large diameter ( )
$A_1$	Minor cross-sectional area (m <sup>2</sup> )
$A_2$	Major cross-sectional area (m <sup>2</sup> )
$q$	Volume flow rate (m <sup>3</sup> /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) ( )
$\Delta P$	Total pressure loss (Pa)
$\Delta H$	Total head loss of fluid (m)
$Wh$	Hydraulic power loss (W)
$\rho$	Fluid density (kg/m <sup>3</sup> )
$\nu$	Fluid kinematic viscosity (m <sup>2</sup> /s)
$g$	Gravitational acceleration (m/s <sup>2</sup> )

---

**Validity range:**

- turbulent flow regime in minor diameter ( $Re_1 \geq 10^4$ )

---

**Example of application:**

HydrauCalc 2018a - [Sudden contraction sharp - CRANE (1999)]

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:  $\rho$  998.2061 kg/m<sup>3</sup>  
Dynamic Viscosity:  $\mu$  0.00100159 N.s/m<sup>2</sup>  
Kinematic Viscosity:  $\nu$  1.00340E-06 m<sup>2</sup>/s

Density  Dyn. Visc.  Kn. Visc.

HC

**Geometrical characteristics**

Help Info Calculate

Pressure loss  $\Delta P$  0.01829291 bar  
 $\Delta H$  0.1869 m of fluid

**Complementary results**

Designation	Symbol	Value	Unit
Diameters ratio (D1/D2)	$\beta$	0.6130868	
Minor diameter cross-section area	$A1$	0.001458963	m <sup>2</sup>
Major diameter cross-section area	$A2$	0.003881508	m <sup>2</sup>
Cross-sections area ratio	$A1/A2$	0.3758754	
Minor diameter Reynolds number	$Re1$	147207.5	
Major diameter Reynolds number	$Re2$	90251	
Coefficient of local resistance (Equation 3-18.1)	$K1$	0.3120623	
Pressure loss coefficient (based on velocity in minor diameter)	$K$	0.3120623	
Hydraulic power loss	$Wh$	9.146453	W

## References:

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