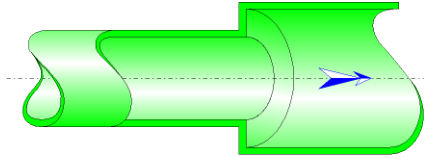




## Sudden Expansion Circular Cross-Section (Pipe Flow - Guide)



### 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:

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Ratio of small to large diameter:

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

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

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

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

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

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Mean velocity in minor diameter (m/s):

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

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Mean velocity in major diameter (m/s):

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

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Mass flow rate (kg/s):

$$G = Q \cdot \rho$$

Reynolds number in minor diameter:

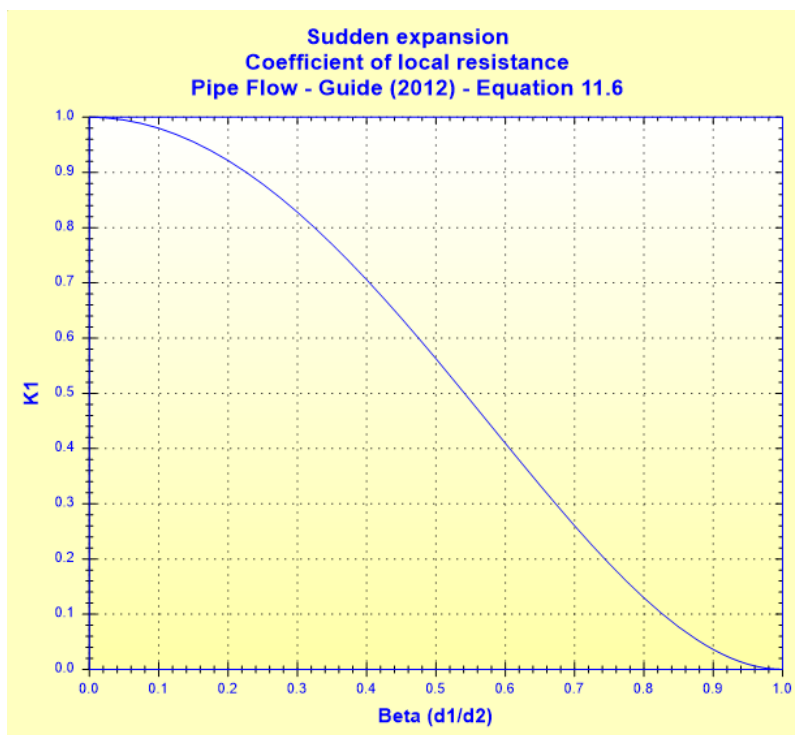
$$N_{Re_1} = \frac{V_1 \cdot d_1}{\nu}$$

Reynolds number in major diameter:

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

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

$$K_1 = (1 - \beta^2)^2 \quad ([1] \text{ equation 11.6}) \quad (\text{Borda-Carnot equation})$$



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)
$\beta$	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) ( )
$\Delta P$	Total pressure loss (Pa)
$\Delta H$	Total head loss of fluid (m)
$Wh$	Hydraulic power loss (W)
$\rho_m$	Fluid density ( $kg/m^3$ )
$\nu$	Fluid kinematic viscosity ( $m^2/s$ )
$g$	Gravitational acceleration ( $m/s^2$ )

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### Validity range:

- turbulent flow regime in minor diameter ( $NRe_1 \geq 10^4$ )

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### Example of application:

HydrauCalc 2018a - [Sudden expansion - Pipe Flow - Guide (2012)]

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**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.  Kin. Visc.

logY

**Geometrical characteristics**

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G 4.9910 kg/s  
Q 0.005 m<sup>3</sup>/s

3.427 m/s (Turbulent) V1

1.288 m/s (Turbulent) V2

Pressure loss  $\Delta P$  0.0228341 bar  
 $\Delta H$  0.2333 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	NRe1	147207.5	
Major diameter Reynolds number	NRe2	90251	
<input checked="" type="checkbox"/> 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)