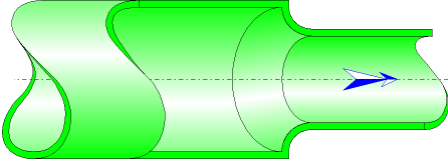




## Sudden Contraction Rounded Circular Cross-Section (IDELCHIK)



### 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:

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Ratio of small to large diameter:

$$\beta = \frac{D_0}{D_1}$$

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

$$F_0 = \pi \cdot \frac{D_0^2}{4}$$

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

$$F_1 = \pi \cdot \frac{D_1^2}{4}$$

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Mean velocity in minor diameter (m/s):

$$w_0 = \frac{Q}{F_0}$$

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Mean velocity in major diameter (m/s):

$$w_1 = \frac{Q}{F_1}$$

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Mass flow rate (kg/s):

$$G = Q \cdot \rho$$

Reynolds number in minor diameter:

$$Re_0 = \frac{w_0 \cdot D_0}{\nu}$$

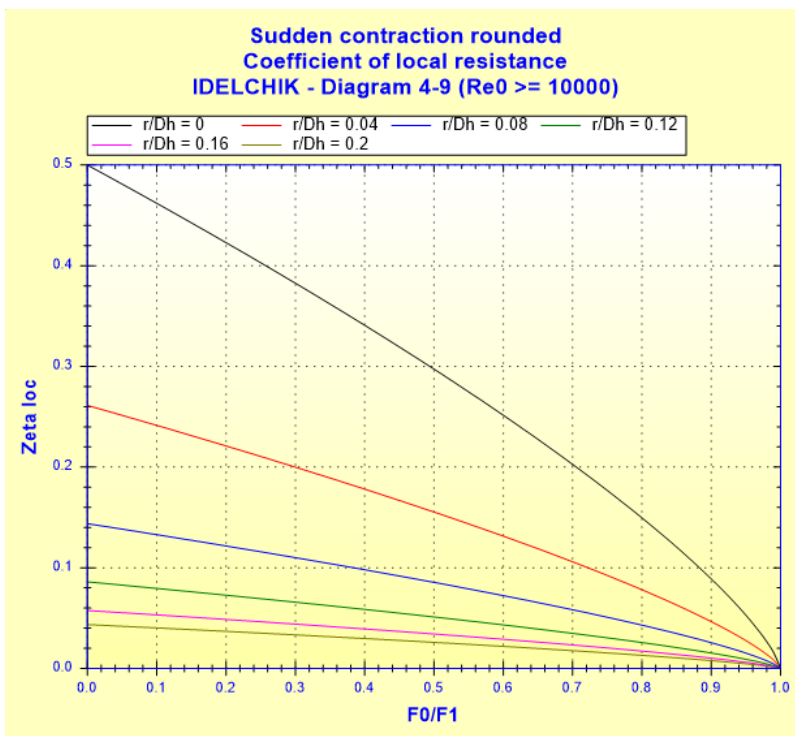
Reynolds number in major diameter:

$$Re_1 = \frac{w_1 \cdot D_1}{\nu}$$

Local resistance coefficient:

$$\zeta_{loc} = \zeta' \cdot \left(1 - \frac{F_0}{F_1}\right)^{3/4}$$

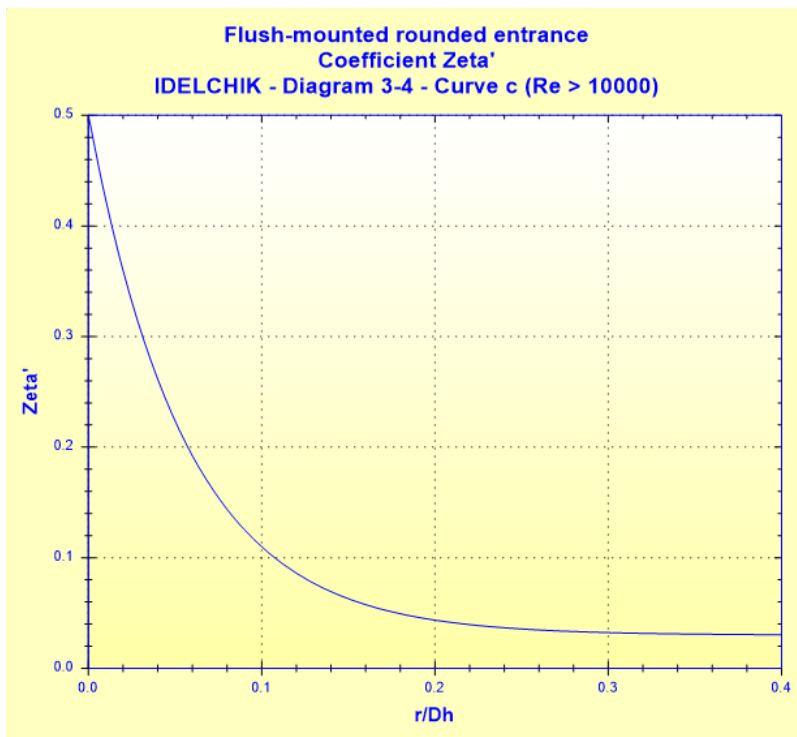
([1] diagram 4-9)



with:

$$\zeta' = 0.03 + 0.47 \cdot 10^{-7.7 \cdot \frac{r}{D_h}}$$

([1] diagram 3-4 Curve c)



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

$$\zeta = \zeta_{loc}$$

Total pressure loss (Pa):

$$\Delta P = \zeta \cdot \frac{\rho \cdot W_0^2}{2}$$

Total head loss of fluid (m):

$$\Delta H = \zeta \cdot \frac{W_0^2}{2 \cdot g}$$

Hydraulic power loss (W):

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

**Symbols, Definitions, SI Units:**

$D_0$	Minor diameter (m)
$D_1$	Major diameter (m)
$\beta$	Ratio of small to large diameter ( )
$F_0$	Minor cross-sectional area (m <sup>2</sup> )
$F_1$	Major cross-sectional area (m <sup>2</sup> )
$Q$	Volume flow rate (m <sup>3</sup> /s)
$G$	Mass flow rate (kg/s)
$w_0$	Mean velocity in minor diameter (m/s)
$w_1$	Mean velocity in major diameter (m/s)
$Re_0$	Reynolds number in minor diameter ( )
$Re_1$	Reynolds number in major diameter ( )
$r$	Radius of the round (m)

$\zeta_{loc}$	Local resistance coefficient ( )
$\zeta$	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 ( $\text{kg/m}^3$ )
$\nu$	Fluid kinematic viscosity ( $\text{m}^2/\text{s}$ )
$g$	Gravitational acceleration ( $\text{m/s}^2$ )

### Validity range:

- turbulent flow regime in minor diameter ( $Re_0 \geq 10^4$ )
- round radius less than the radius difference ( $r < (D_1/2 - D_0/2)$ )

### Example of application:

The screenshot shows the HydraulCalc 2020a software interface for a "Sudden contraction rounded - IDELCHIK (3rd Ed.)".

**Fluid characteristics:**

- Fluid: Water @ 1 atm [HC]
- Ref.: IAPWS IF97
- Temperature: T = 20 °C
- Pressure: P = 1.013 bar
- Density:  $\rho = 998.2061 \text{ kg/m}^3$
- Dynamic Viscosity:  $\mu = 0.00100159 \text{ N.s/m}^2$
- Kinematic Viscosity:  $\nu = 1.00340E-06 \text{ m}^2/\text{s}$

**Geometrical characteristics:**

- Mass flow rate: G = 4.9910 kg/s
- Volume flow rate: Q = 0.005 m<sup>3</sup>/s
- Minor diameter: D1 = 0.0703 m
- Major diameter: D0 = 0.0431 m
- Round radius: r = 0.005 m
- Minor diameter velocity: w1 = 1.288 m/s (Turbulent)
- Major diameter velocity: w0 = 3.427 m/s (Turbulent)
- Pressure loss:  $\Delta P = 0.003708408 \text{ bar}$
- Head loss:  $\Delta H = 0.0379 \text{ m of fluid}$

**Complementary results:**

Designation	Symbol	Value	Unit
Diameters ratio	D0/D1	0.6130868	
Minor cross-section area	F0	0.001458963	m <sup>2</sup>
Major cross-section area	F1	0.003881508	m <sup>2</sup>
Cross-sections area ratio	F0/F1	0.3758754	
Ratio 'Radius of the round / small diameter'	r/Dh	0.1160093	
Minor diameter Reynolds number	Re0	147207.5	
Major diameter Reynolds number	Re1	90251	
Resistance coefficient (Diagram 3-4 Curve c)	$\zeta''$	0.09009334	
Coefficient of local resistance (Diagram 4-9)	$\zeta_{loc}$	0.06326248	
Pressure loss coefficient (based on velocity in minor diameter)	$\zeta$	0.06326248	
Hydraulic power loss	Wh	1.854204	W

### References:

[1] Handbook of Hydraulic Resistance, 3rd Edition, I.E. Idelchik