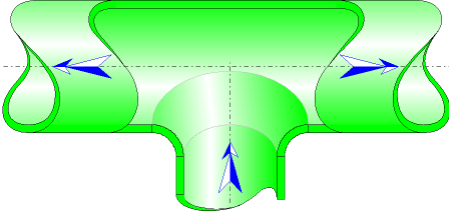




Symmetric dividing radiused-edged T-junction Circular Cross-Section (Pipe Flow - Guide)



Model description:

This model of component calculates the minor head loss (pressure drop) generated by the flow in a symmetric dividing radiused-edged T-junction with three legs of equal area.

The head loss by friction in the inlet and outlet piping is not taken into account in this component.

Model formulation:

Cross-sectional area of the three branches (m^2):

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

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

$$A_3 = \pi \cdot \frac{d_3^2}{4}$$

with $d_1 = d_2 = d_3 = d$

Volume flow rate in the common branch (m^3/s):

$$Q_1 = Q_2 + Q_3$$

Mean velocity in the common branch (m/s):

$$V_1 = \frac{Q_1}{A_1}$$

Mean velocity in the left branch (m/s):

$$V_2 = \frac{Q_2}{A_2}$$

Mean velocity in the right branch (m/s):

$$V_3 = \frac{Q_3}{A_3}$$

Mass flow rate in the common branch (kg/s):

$$w_1 = Q_1 \cdot \rho_m$$

Mass flow rate in the left branch (kg/s):

$$w_2 = Q_2 \cdot \rho_m$$

Mass flow rate in the right branch (kg/s):

$$w_3 = Q_3 \cdot \rho_m$$

Reynolds number in the common branch:

$$NRe_1 = \frac{V_1 \cdot d_1}{\nu}$$

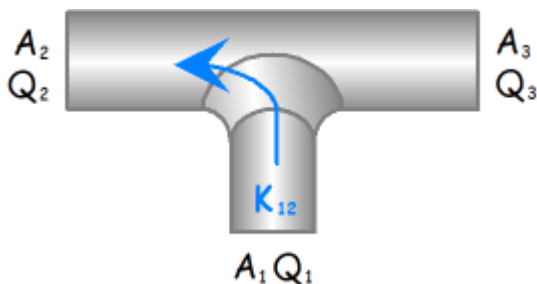
Reynolds number in the left branch:

$$NRe_2 = \frac{V_2 \cdot d_2}{\nu}$$

Reynolds number in the right branch:

$$NRe_3 = \frac{V_3 \cdot d_3}{\nu}$$

Pressure loss coefficient of the left branch:

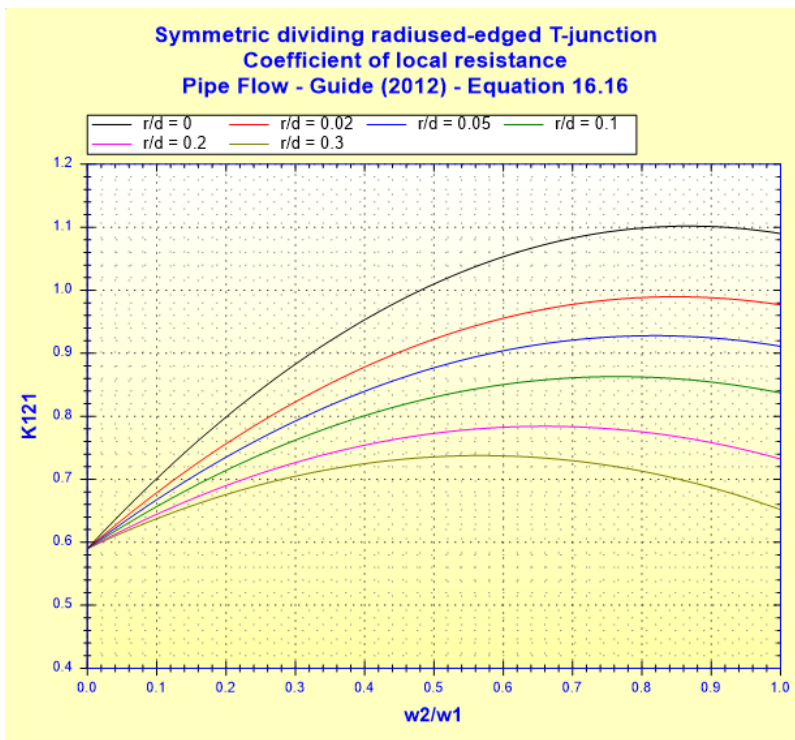


Coefficient based on mean velocity in the common branch:

$$K_{12} = 0.59 + \left(1.18 - 1.84 \cdot \sqrt{\frac{r}{d}} + 1.16 \cdot \frac{r}{d} \right) \cdot \frac{w_2}{w_1} - \left(0.68 - 1.04 \cdot \sqrt{\frac{r}{d}} + 1.16 \cdot \frac{r}{d} \right) \cdot \frac{w_2^2}{w_1^2}$$

([1])

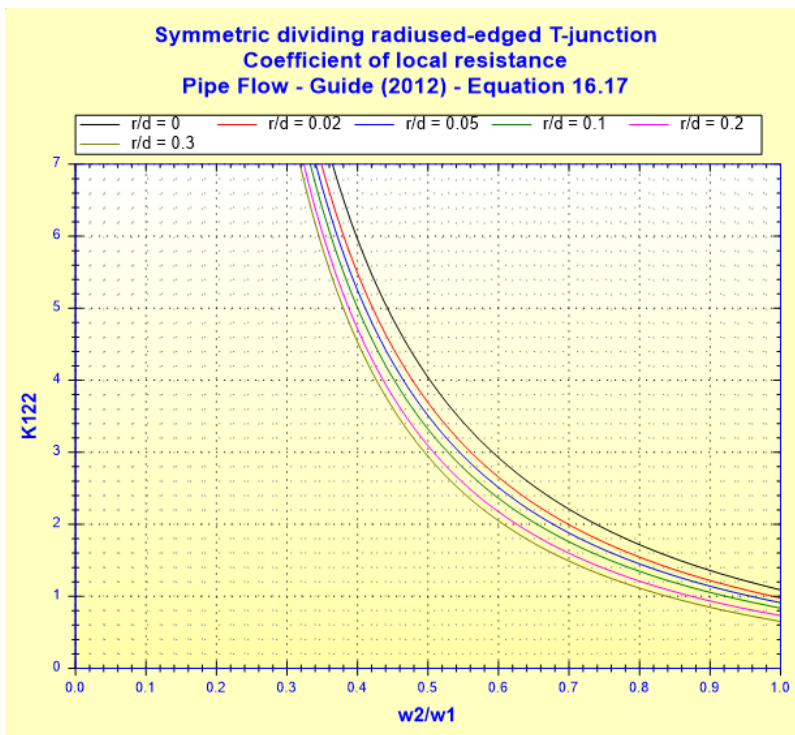
equation 16.16)



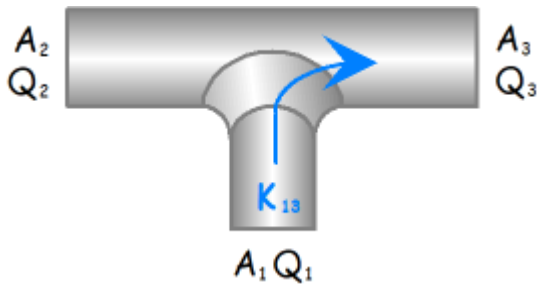
Coefficient based on mean velocity in the left branch:

$$K_{12_2} = 0.59 \cdot \frac{w_1^2}{w_2^2} + \left(1.18 - 1.84 \cdot \sqrt{\frac{r}{d}} + 1.16 \cdot \frac{r}{d} \right) \cdot \frac{w_1}{w_2} - 0.68 + 1.04 \cdot \sqrt{\frac{r}{d}} - 1.16 \cdot \frac{r}{d} \quad ([1])$$

equation 16.17)



Pressure loss coefficient of the right branch:

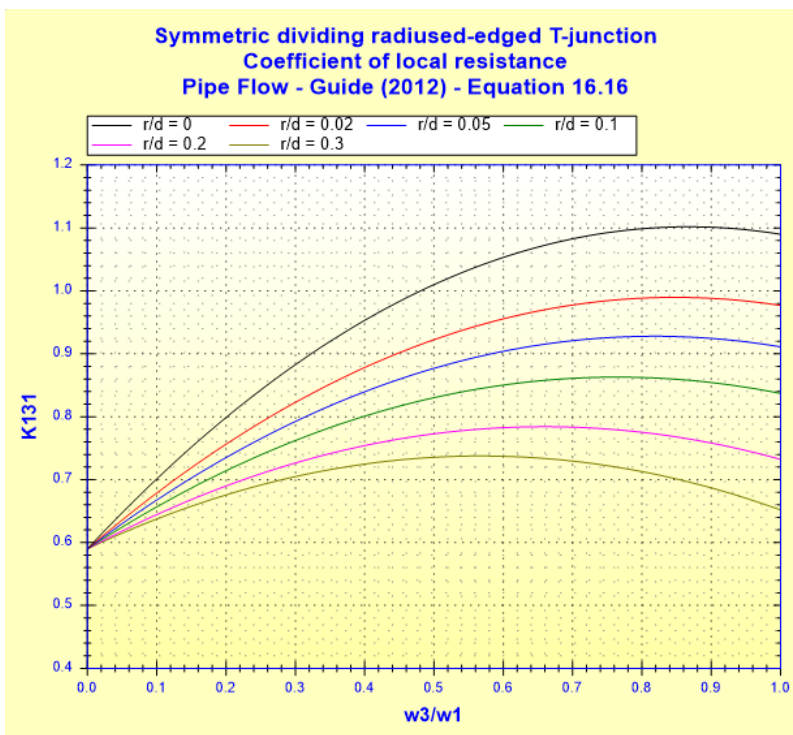


Note: for the right branch, the formulas are the same as those of the left branch, with subscript 3 instead of subscript 2.

Coefficient based on mean velocity in the common branch:

$$K_{13_1} = 0.59 + \left(1.18 - 1.84 \cdot \sqrt{\frac{r}{d}} + 1.16 \cdot \frac{r}{d} \right) \cdot \frac{w_3}{w_1} - \left(0.68 - 1.04 \cdot \sqrt{\frac{r}{d}} + 1.16 \cdot \frac{r}{d} \right) \cdot \frac{w_3^2}{w_1^2} \quad ([1])$$

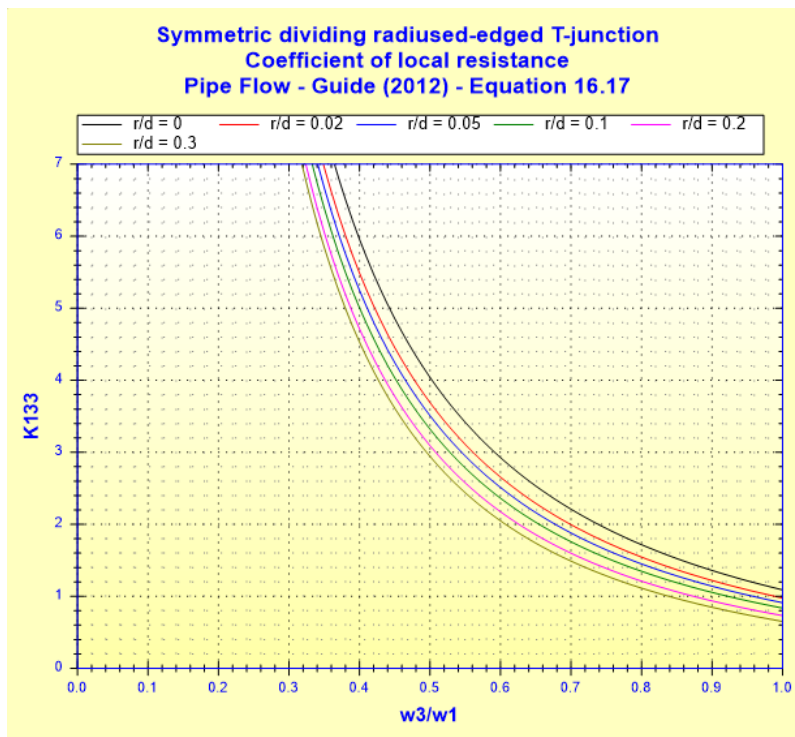
equation 16.16)



Coefficient based on mean velocity in the left branch:

$$K_{13_3} = 0.59 \cdot \frac{w_1^2}{w_3^2} + \left(1.18 - 1.84 \cdot \sqrt{\frac{r}{d}} + 1.16 \cdot \frac{r}{d} \right) \cdot \frac{w_1}{w_3} - 0.68 + 1.04 \cdot \sqrt{\frac{r}{d}} - 1.16 \cdot \frac{r}{d} \quad ([1])$$

equation 16.17)



Pressure loss in the left branch (Pa):

$$\Delta P_{12} = K_{12_1} \cdot \frac{\rho_m \cdot W_1^2}{2}$$

Pressure loss in the right branch (Pa):

$$\Delta P_{13} = K_{13_1} \cdot \frac{\rho_m \cdot W_1^2}{2}$$

Head loss of fluid in the left branch (m):

$$\Delta H_{12} = K_{12_1} \cdot \frac{W_1^2}{2 \cdot g}$$

Head loss of fluid in the right branch (m):

$$\Delta H_{13} = K_{13_1} \cdot \frac{W_1^2}{2 \cdot g}$$

Hydraulic power loss in the left branch (W):

$$Wh_{12} = \Delta P_{12} \cdot Q_2$$

Hydraulic power loss in the right branch (W):

$$Wh_{13} = \Delta P_{13} \cdot Q_3$$

Symbols, Definitions, SI Units:

- d Inside diameter of the three branches (m)
- d₁ Diameter of the common branch (m)
- d₂ Diameter of the left branch (m)

| | |
|-----------------|---|
| d_3 | Diameter of the right branch |
| A_1 | Cross-sectional area of the common branch (m^2) |
| A_2 | Cross-sectional area of the left branch (m^2) |
| A_3 | Cross-sectional area of the right branch (m^2) |
| Q_1 | Volume flow rate in the common branch (m^3/s) |
| V_1 | Mean velocity in the common branch (m/s) |
| Q_2 | Volume flow rate in the left branch (m^3/s) |
| V_2 | Mean velocity in the left branch (m/s) |
| Q_3 | Volume flow rate in the right branch (m^3/s) |
| V_3 | Mean velocity in the right branch (m/s) |
| w_1 | Mass flow rate in the common branch (kg/s) |
| w_2 | Mass flow rate in the left branch (kg/s) |
| w_3 | Mass flow rate in the right branch (kg/s) |
| NRe_1 | Reynolds number in the common branch () |
| NRe_2 | Reynolds number in the left branch () |
| NRe_3 | Reynolds number in the right branch () |
| r | Rounded radius (m) |
| K_{121} | Pressure loss coefficient of the left branch (based on mean velocity in the common branch) () |
| K_{131} | Pressure loss coefficient of the right branch (based on mean velocity in the common branch) () |
| K_{122} | Pressure loss coefficient of the left branch (based on mean velocity in the left branch) () |
| K_{133} | Pressure loss coefficient of the right branch (based on mean velocity in the right branch) () |
| ΔP_{12} | Pressure loss in the left branch (Pa) |
| ΔP_{13} | Pressure loss in the right branch (Pa) |
| ΔH_{12} | Head loss of fluid in the left branch (m) |
| ΔH_{13} | Head loss of fluid in the right branch (m) |
| Wh_{12} | Hydraulic power loss in the left branch (W) |
| Wh_{13} | Hydraulic power loss in the right branch (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 ($NRe_1 \geq 10^4$)
- three legs of equal area ($d_1 = d_2 = d_3$)
- relative radius of the round (r/d) lower than or equal to 0.3d
- ratio of mass flow rates (w_2 / w_1) and (w_3 / w_1) between 0.2 and 0.8
note: for mass flow ratios less than 0.2 or greater than 0.8, pressure loss coefficients are extrapolated

Example of application:

HydrauCalc 2019b - [Symmetric dividing radiused-edged T-junction - 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: ρ 998.2061 kg/m³
Dynamic Viscosity: μ 0.00100159 N.s/m²
Kinematic Viscosity: ν 1.00340E-06 m²/s

Density Dyn. Visc. Kn. Visc.

Divers HC

Geometrical characteristics

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Complementary results

| Designation | Symbol | Value | Unit |
|--|--------|-------------|----------------|
| Common channel cross-section area | A1 | 0.003881508 | m ² |
| Left branch cross-section area | A2 | 0.003881508 | m ² |
| Right branch cross-section area | A3 | 0.003881508 | m ² |
| Flow rate ratio 'Left branch / Common channel' | w2/w1 | 0.5 | |
| Flow rate ratio 'Right branch / Common channel' | w3/w1 | 0.5 | |
| Common channel Reynolds number | Re1 | 180502 | |
| Left branch Reynolds number | Re2 | 90251 | |
| Right branch Reynolds number | Re3 | 90251 | |
| Relative radius of the round | r/d | 0.07112376 | |
| Local resistance coefficient of left branch (Equ 16.16) | K121 | 0.8546103 | |
| Local resistance coefficient of right branch (Equ 16.16) | K131 | 0.8546103 | |
| Left branch pressure loss coefficient (based on w1) | K12 | 0.8546103 | |
| Right branch pressure loss coefficient (based on w1) | K13 | 0.8546103 | |
| Right branch hydraulic power loss | Wh21 | 14.15557 | W |
| Left branch hydraulic power loss | Wh31 | 14.15557 | W |

References:

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