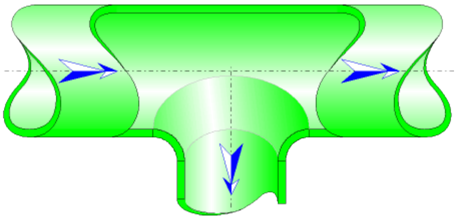
Dividing radiused-edged T-junction
Circular Cross-Section
(Pipe Flow - Guide)



Model description:

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

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 common branch (m²):

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

Cross-sectional area of the straight branch (m²):

$$A_2 = \pi \cdot \frac{d_1^2}{4}$$

Cross-sectional area of the side branch (m²):

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

Volume flow rate in the common branch (m³/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 straight branch (m/s):

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

Mean velocity in the side 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 straight branch (kg/s):

$$w_2 = Q_2 \cdot \rho_m$$

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

$$w_3 = Q_3 \cdot \rho_m$$

Reynolds number in the common branch:

$$N\mathrm{Re}_1 = \frac{V_1 \cdot d_1}{\nu}$$

Reynolds number in the straight branch:

$$N\mathrm{Re}_2 = \frac{V_2 \cdot d_1}{\nu}$$

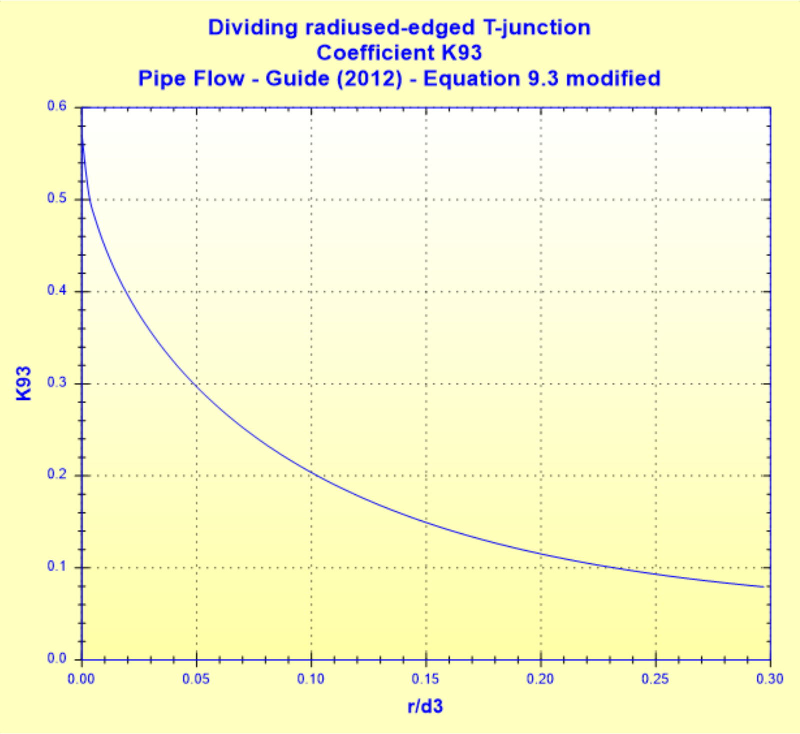
Reynolds number in the side branch:

$$N\mathrm{Re}_3 = \frac{V_3 \cdot d_3}{\nu}$$

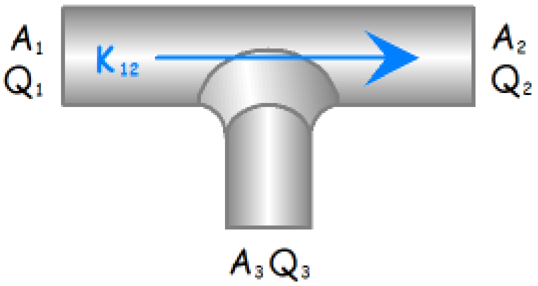
Coefficient K93:

$$K_{93} = 0.57 - 1.07 \cdot \left(\frac{r}{d_3}\right)^{1/2} - 2.13 \cdot \left(\frac{r}{d_3}\right) + 8.24 \cdot \left(\frac{r}{d_3}\right)^{3/2} - 8.48 \cdot \left(\frac{r}{d_3}\right)^{2} + 2.9 \cdot \left(\frac{r}{d_3}\right)^{5/2}$$

([1] equation §16.1.2)



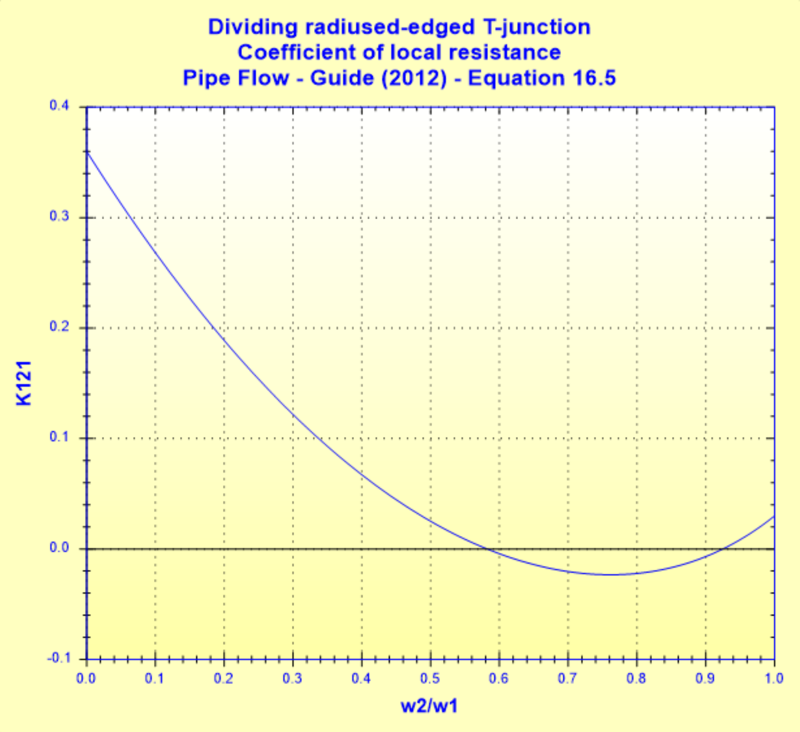
Pressure loss coefficient of the straight branch:



Coefficient based on mean velocity in the common branch:

$$K_{12_1} = 0.36 - 0.98 \cdot \frac{w_2}{w_1} + 0.62 \cdot \frac{w_2^{\,2}}{w_1^{\,2}} + 0.03 \cdot \frac{w_2^{\,8}}{w_1^{\,8}}$$

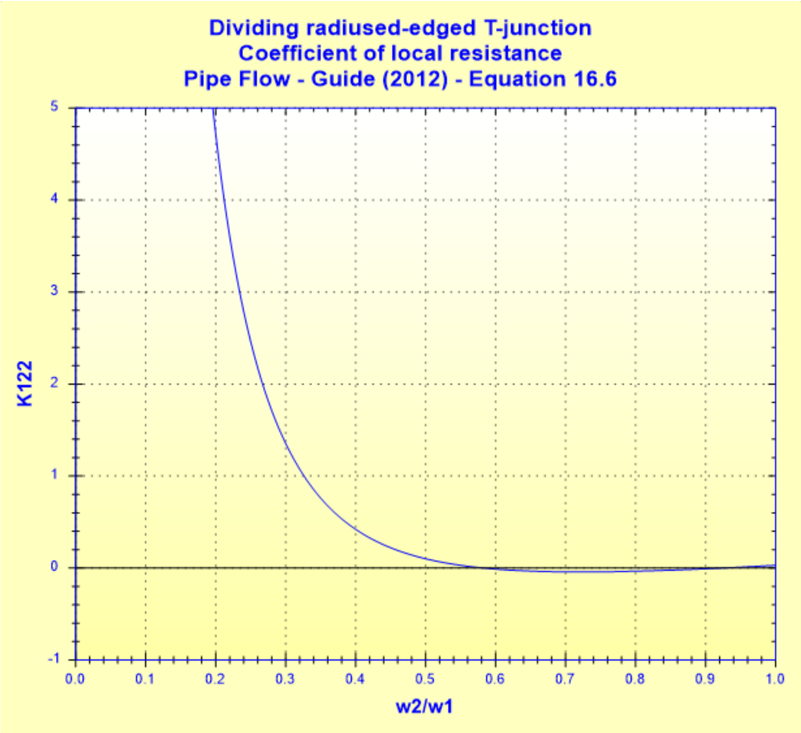
([1] equation 16.5)



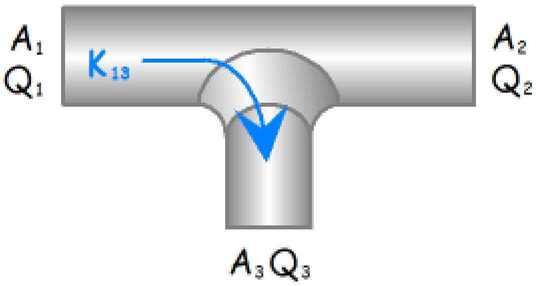
Coefficient based on mean velocity in the straight branch:

$$K_{12_2} = 0.62 - 0.98 \cdot \frac{w_1}{w_2} + 0.36 \cdot \frac{w_1^2}{w_2^2} + 0.03 \cdot \frac{w_2^6}{w_1^6}$$

([1] equation 16.6)



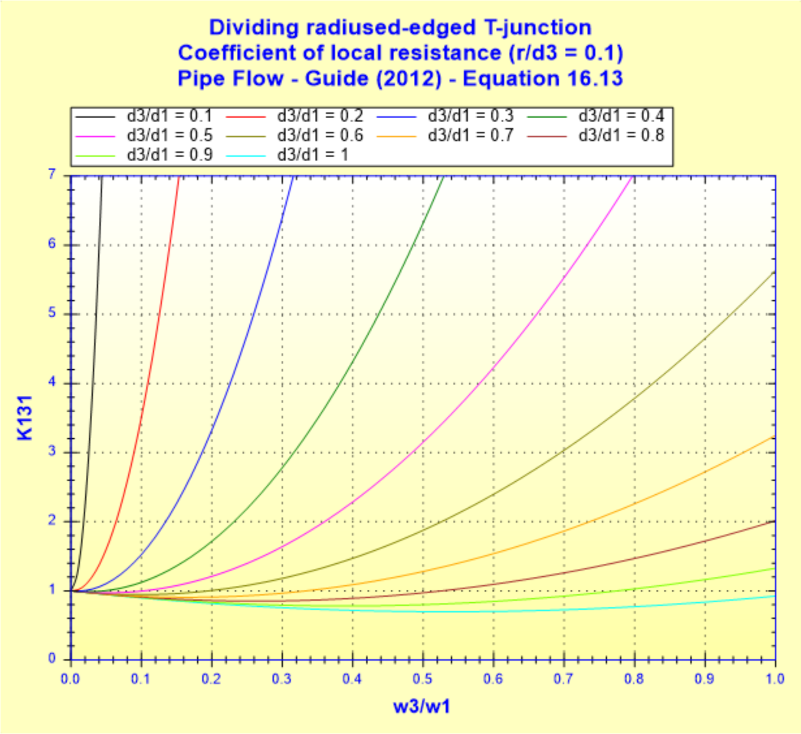
Pressure loss coefficient of the side branch:



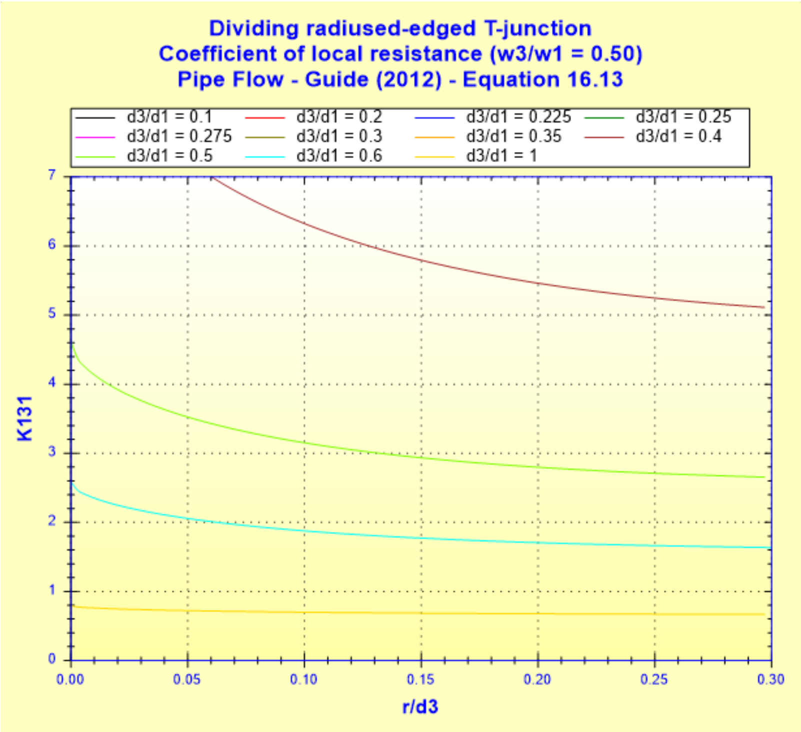
Coefficient based on mean velocity in the common branch:

$$K_{13_1} = 1 - 1.13 \cdot \frac{w_3}{w_1} + \left[0.81 + \left(1.12 \cdot \frac{d_3}{d_1} - 1.08 \cdot \frac{d_3^3}{d_1^3} + K_{93} \right) \cdot \frac{d_1^4}{d_3^4} \right] \cdot \frac{w_3^2}{w_1^2}$$

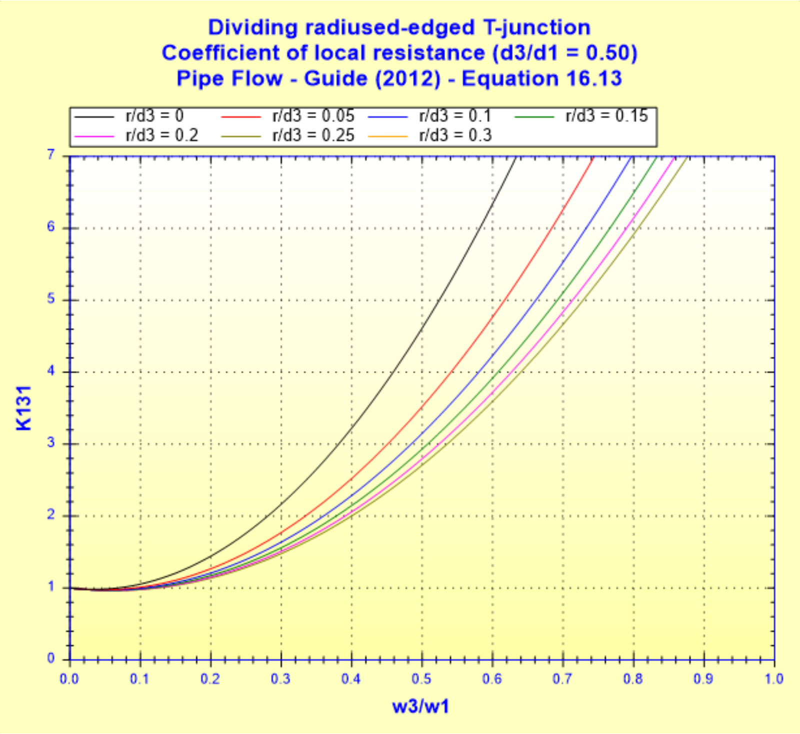
([1] equation 16.13)



([1] equation 16.13 with r/d_3 = 0.1)



([1] equation 16.13 with w_3/w_1 = 0.5)

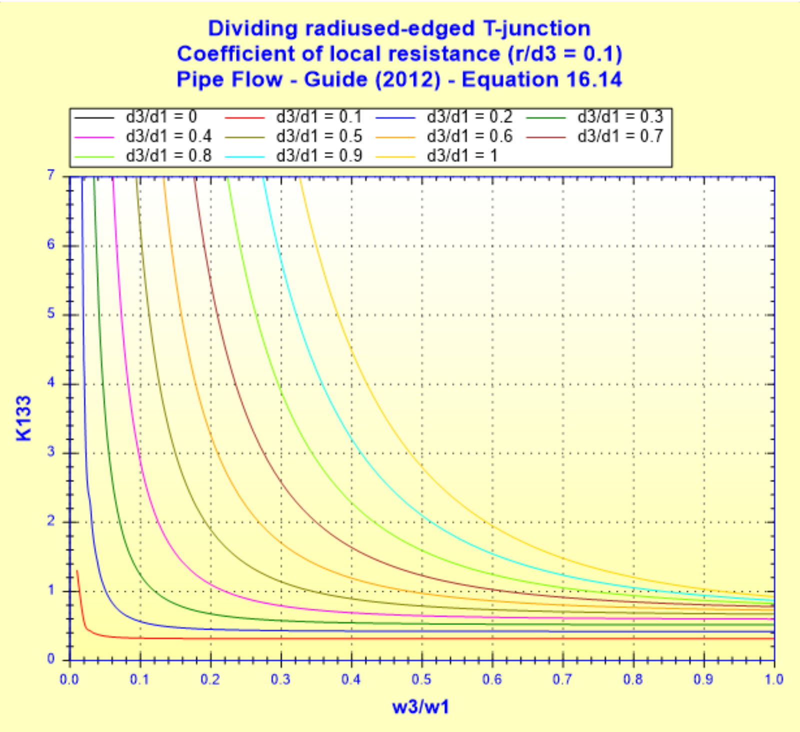


([1] equation 16.13 with d_3/d_1 = 0.5)

Coefficient based on mean velocity in the straight branch:

$$K_{13_3} = \left(0.81 - 1.13 \cdot \frac{w_1}{w_3} + \frac{w_1^2}{w_3^2}\right) \cdot \frac{d_3^4}{d_1^4} + 1.12 \cdot \frac{d_3}{d_1} - 1.08 \cdot \frac{d_3^3}{d_1^3} + K_{93}$$

([1] equation 16.14)



([1] equation 16.14 with r/d_3 = 0.1)

Pressure loss in the straight branch (Pa):

$$\Delta P_{12} = K_{12_1} \cdot \frac{\rho_m \cdot w_1^2}{2}$$

Pressure loss in the side branch (Pa):

$$\Delta P_{13} = K_{13_1} \cdot \frac{\rho_m \cdot w_1^2}{2}$$

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

$$\Delta H_{12} = K_{12_1} \cdot \frac{w_1^2}{2 \cdot g}$$

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

$$\Delta H_{13} = K_{13_1} \cdot \frac{w_1^2}{2 \cdot g}$$

Hydraulic power loss in the straight branch (W):

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

Hydraulic power loss in the side branch (W):

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

Symbols, Definitions, SI Units:

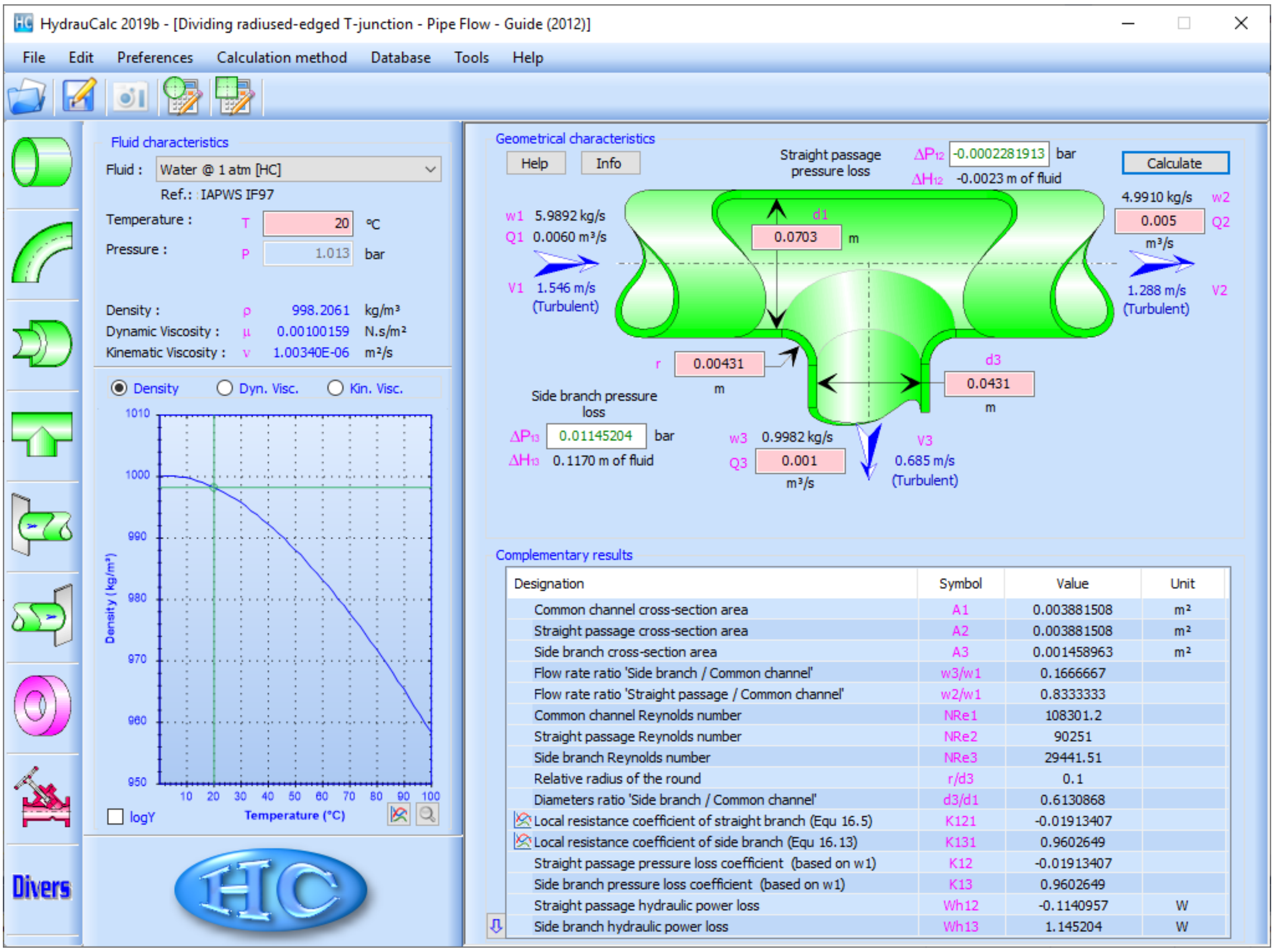
d_1	Diameter of the straight and common branches (m)
d_3	Diameter of the side branch (m)
A_1	Cross-sectional area of the common branch (m^2)
A_2	Cross-sectional area of the straight branch (m^2)
A_3	Cross-sectional area of the side branch (m^2)
Q_1	Volume flow rate in the common branch (m^3/s)
V_1	Mean velocity in the common branch (m/s)
Q_2	Volume flow rate in the straight branch (m^3/s)
V_2	Mean velocity in the straight branch (m/s)
Q_3	Volume flow rate in the side branch (m^3/s)
V_3	Mean velocity in the side branch (m/s)
w_1	Mass flow rate in the common branch (kg/s)
w_2	Mass flow rate in the straight branch (kg/s)
w_3	Mass flow rate in the side branch (kg/s)
NRe_1	Reynolds number in the common branch ()
NRe_2	Reynolds number in the straight branch ()
NRe_3	Reynolds number in the side branch ()
r	Rounded radius (m)
K_{93}	Coefficient ()
K_{121}	Pressure loss coefficient of the straight branch (based on mean velocity in the common branch) ()
K_{131}	Pressure loss coefficient of the side branch (based on mean velocity in the common branch) ()
K_{122}	Pressure loss coefficient of the straight branch (based on mean velocity in the straight branch) ()

K_{133}	Pressure loss coefficient of the side branch (based on mean velocity in the side branch) ()
ΔP_{12}	Pressure loss in the straight branch (Pa)
ΔP_{13}	Pressure loss in the side branch (Pa)
ΔH_{12}	Head loss of fluid in the straight branch (m)
ΔH_{13}	Head loss of fluid in the side branch (m)
Wh_{12}	Hydraulic power loss in the straight branch (W)
Wh_{13}	Hydraulic power loss in the side 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 ($NRe_1 \geq 10^4$)
- diameter of side branch lower than or equal to diameter of straight and common branches ($d_3 \leq d_1$)
- rounding ratio lower than or equal to 1 ($r/d_3 \leq 1$)

Example of application:



References:

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