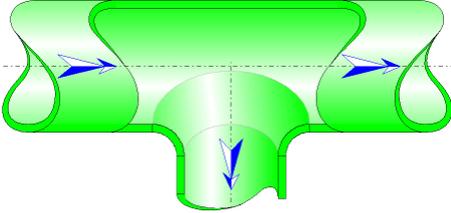




Dividing radiused-edged T-junction Circular Cross-Section (Pipe Flow - Guide)



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):

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

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:

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

Reynolds number in the straight branch:

$$NRe_2 = \frac{V_2 \cdot d_1}{\nu}$$

Reynolds number in the side branch:

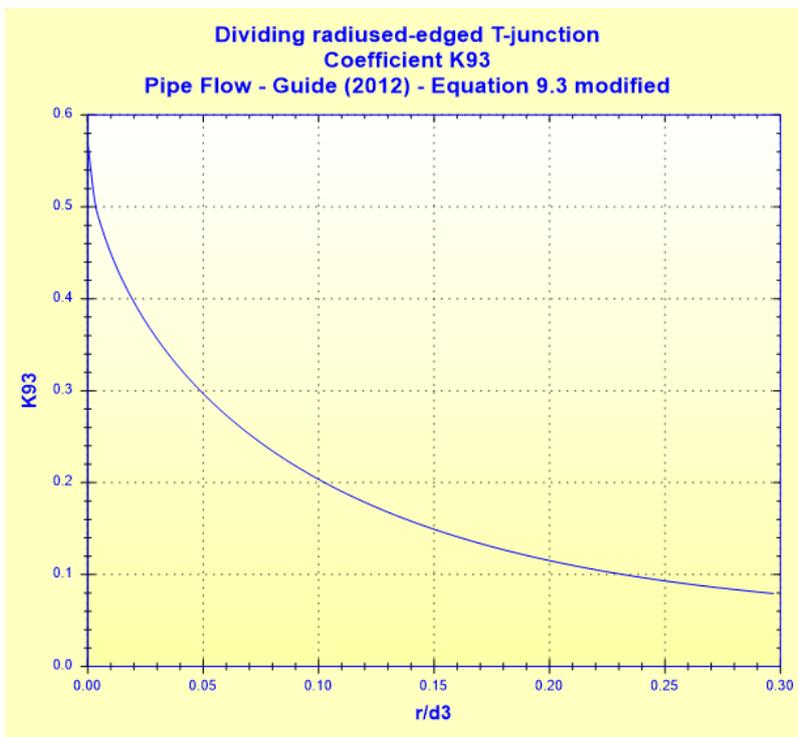
$$NRe_3 = \frac{V_3 \cdot d_3}{\nu}$$

Coefficient K_{93} :

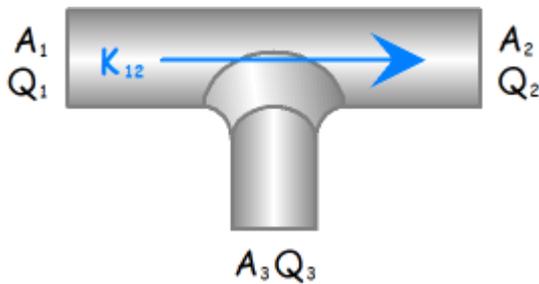
$$K_{93} = 0.57 - 1.07 \cdot \left(\frac{r}{d_3}\right)^{1/2} - 2.13 \cdot \left(\frac{r}{d_3}\right) + 8.24 \cdot \left(\frac{r}{d_3}\right)^{3/2} - 8.48 \cdot \left(\frac{r}{d_3}\right)^2 + 2.9 \cdot \left(\frac{r}{d_3}\right)^{5/2}$$

([1])

equation S16.1.2)

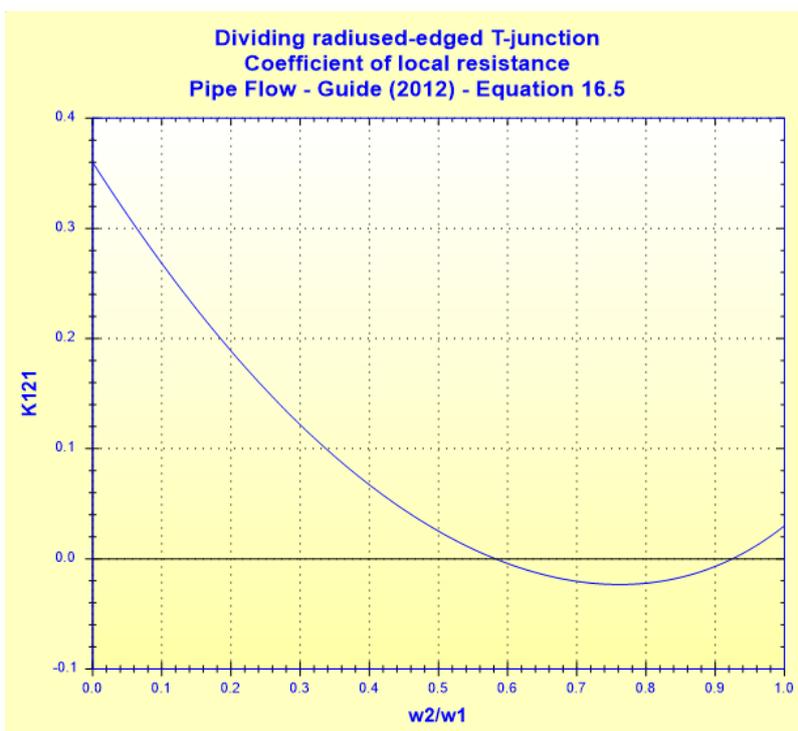


Pressure loss coefficient of the straight branch:



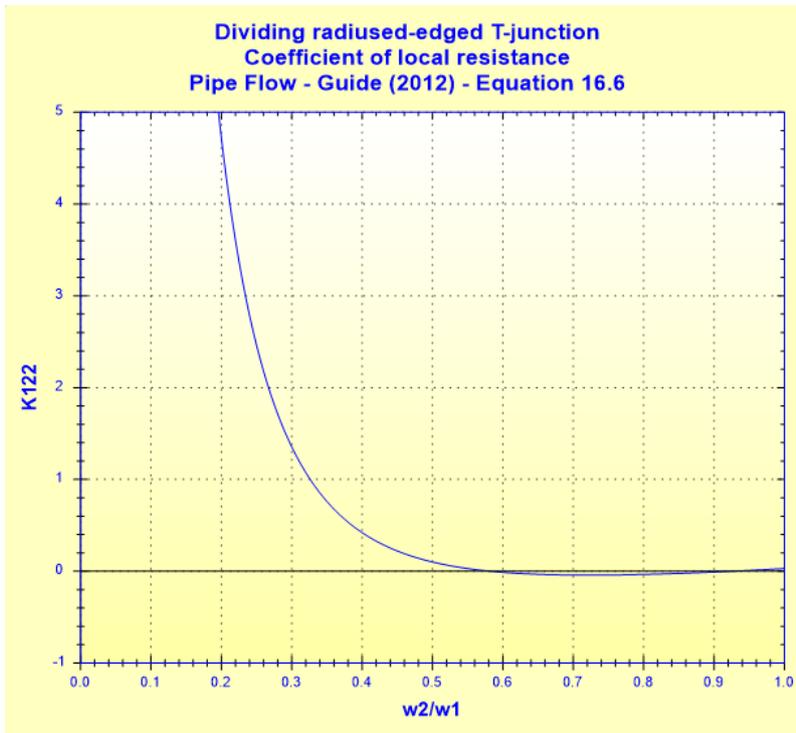
Coefficient based on mean velocity in the common branch:

$$K_{12_1} = 0.36 - 0.98 \cdot \frac{w_2}{w_1} + 0.62 \cdot \frac{w_2^2}{w_1^2} + 0.03 \cdot \frac{w_2^8}{w_1^8} \quad ([1] \text{ equation 16.5})$$

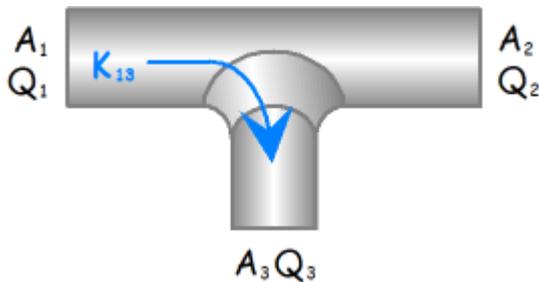


Coefficient based on mean velocity in the straight branch:

$$K_{12_2} = 0.62 - 0.98 \cdot \frac{w_1}{w_2} + 0.36 \cdot \frac{w_1^2}{w_2^2} + 0.03 \cdot \frac{w_2^6}{w_1^6} \quad ([1] \text{ equation } 16.6)$$

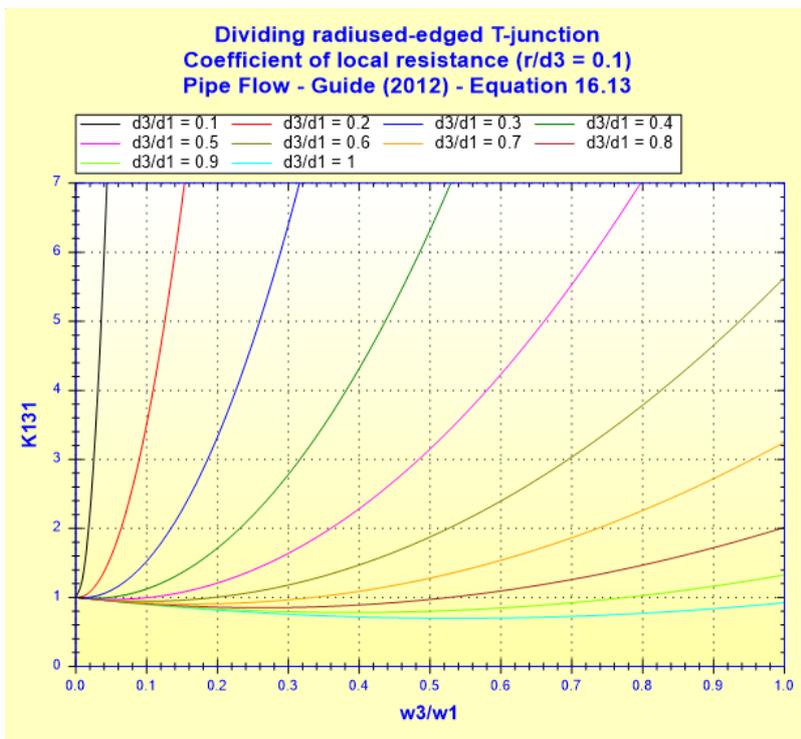


Pressure loss coefficient of the side branch:



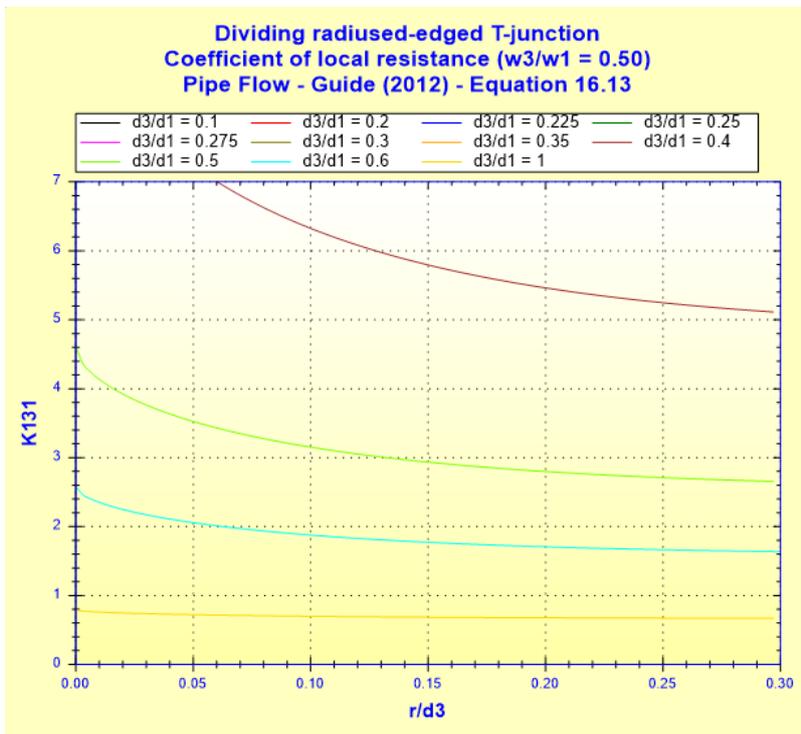
Coefficient based on mean velocity in the common branch:

$$K_{13_1} = 1 - 1.13 \cdot \frac{w_3}{w_1} + \left[0.81 + \left(1.12 \cdot \frac{d_3}{d_1} - 1.08 \cdot \frac{d_3^3}{d_1^3} + K_{93} \right) \cdot \frac{d_1^4}{d_3^4} \right] \cdot \frac{w_3^2}{w_1^2} \quad ([1] \text{ equation } 16.13)$$



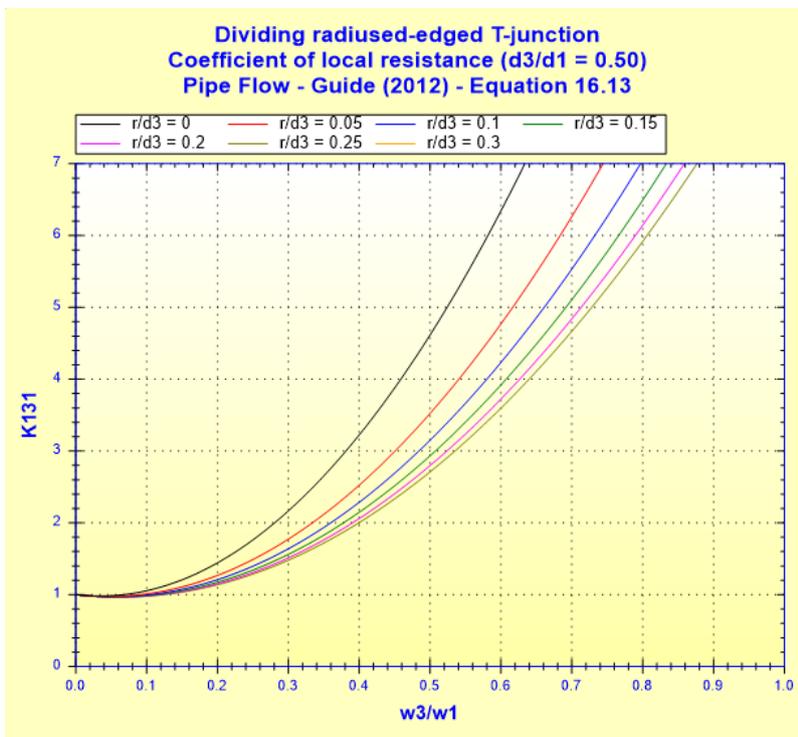
([1] equation 16.13 with $r/d_3 =$

0.1)



([1] equation 16.13 with w_3/w_1

= 0.5)



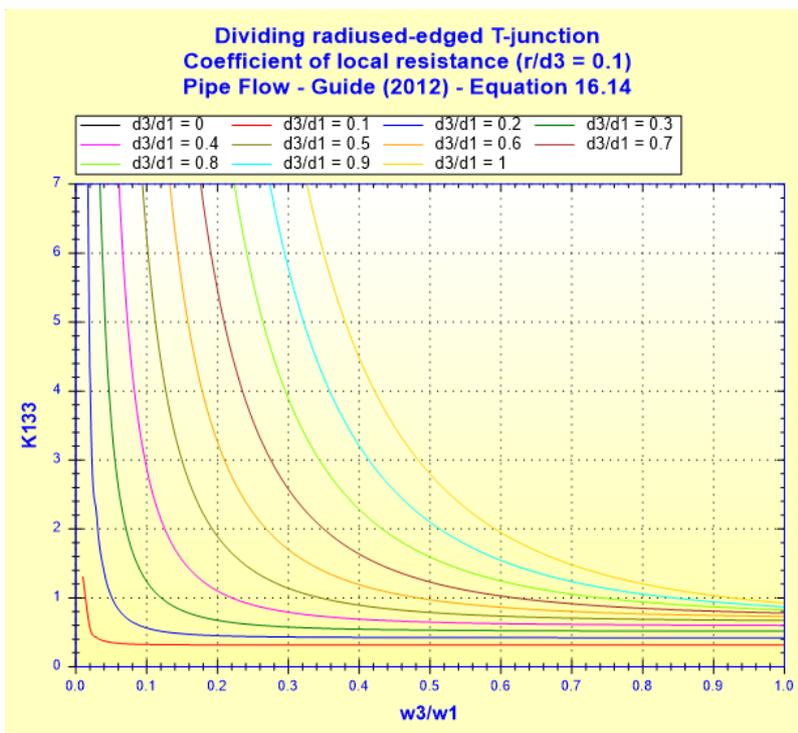
([1] equation 16.13 with d_3/d_1

= 0.5)

Coefficient based on mean velocity in the straight branch:

$$K_{13_3} = \left(0.81 - 1.13 \cdot \frac{w_1}{w_3} + \frac{w_1^2}{w_3^2} \right) \cdot \frac{d_3^4}{d_1^4} + 1.12 \cdot \frac{d_3}{d_1} - 1.08 \cdot \frac{d_3^3}{d_1^3} + K_{9_3}$$

([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:

HydrauCalc 2019b - [Dividing radiused-edged T-junction - Pipe Flow - Guide (2012)]

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: ρ 998.2061 kg/m^3
Dynamic Viscosity: μ 0.00100159 N.s/m^2
Kinematic Viscosity: ν 1.00340E-06 m^2/s

Density Dyn. Visc. Kn. Visc.

Density (kg/m^3) vs Temperature ($^\circ\text{C}$) graph showing a decreasing trend from 1000 at 0°C to approximately 950 at 100°C.

Geometrical characteristics

Help Info

Straight passage pressure loss ΔP_{12} -0.0002281913 bar
 ΔH_{12} -0.0023 m of fluid

Side branch pressure loss ΔP_{13} 0.01145204 bar
 ΔH_{13} 0.1170 m of fluid

Flow parameters:
 Inlet: w_1 5.9892 kg/s , Q_1 0.0060 m^3/s , V_1 1.546 m/s (Turbulent)
 Outlet 1: w_2 4.9910 kg/s , Q_2 0.005 m^3/s , V_2 1.288 m/s (Turbulent)
 Outlet 2: w_3 0.9982 kg/s , Q_3 0.001 m^3/s , V_3 0.685 m/s (Turbulent)

Geometrical parameters:
 Straight passage diameter: 0.0703 m
 Side branch diameter: d_3 0.0431 m
 Rounding radius: r 0.00431 m

Complementary results

Designation	Symbol	Value	Unit
Common channel cross-section area	A1	0.003881508	m^2
Straight passage cross-section area	A2	0.003881508	m^2
Side branch cross-section area	A3	0.001458963	m^2
Flow rate ratio 'Side branch / Common channel'	w_3/w_1	0.1666667	
Flow rate ratio 'Straight passage / Common channel'	w_2/w_1	0.8333333	
Common channel Reynolds number	NRe1	108301.2	
Straight passage Reynolds number	NRe2	90251	
Side branch Reynolds number	NRe3	29441.51	
Relative radius of the round	r/d_3	0.1	
Diameters ratio 'Side branch / Common channel'	d_3/d_1	0.6130868	
Local resistance coefficient of straight branch (Equ 16.5)	K121	-0.01913407	
Local resistance coefficient of side branch (Equ 16.13)	K131	0.9602649	
Straight passage pressure loss coefficient (based on w_1)	K12	-0.01913407	
Side branch pressure loss coefficient (based on w_1)	K13	0.9602649	
Straight passage hydraulic power loss	Wh12	-0.1140957	W
Side branch hydraulic power loss	Wh13	1.145204	W

References:

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

HydrauCalc
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