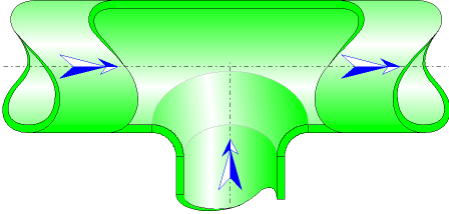




Combining radiused-edged T-junction Circular Cross-Section (Pipe Flow - Guide)



Model description:

This model of component calculates the minor head loss (pressure drop) generated by the flow in a combining 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):

$$A_1 = \pi \cdot \frac{d_2^2}{4}$$

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:

$$NRe_1 = \frac{V_1 \cdot d_2}{\nu}$$

Reynolds number in the straight branch:

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

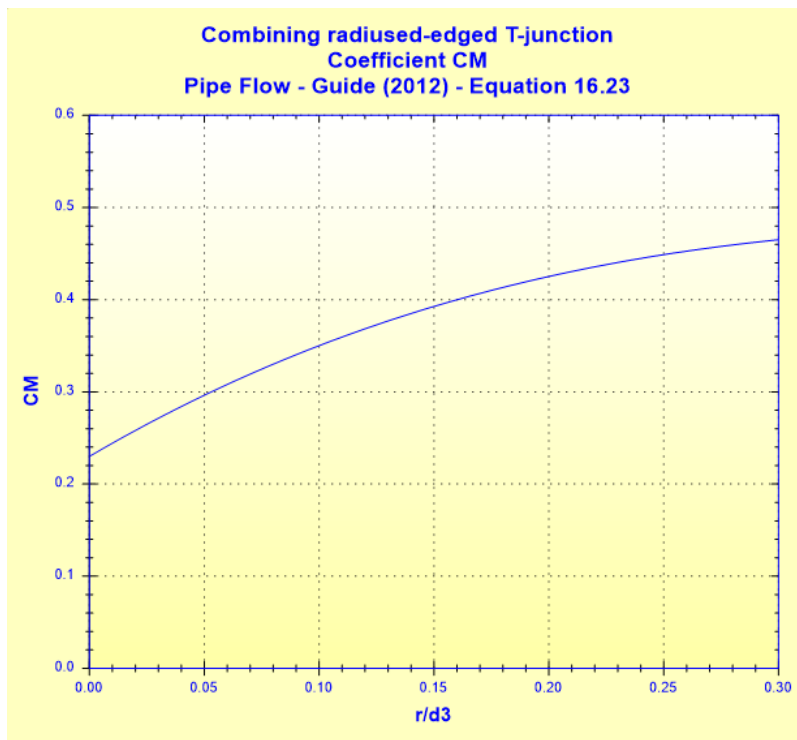
Reynolds number in the side branch:

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

Coefficient C_M :

$$C_M = 0.23 + 1.46 \cdot \left(\frac{r}{d_3}\right) - 2.75 \cdot \left(\frac{r}{d_3}\right)^2 + 1.65 \cdot \left(\frac{r}{d_3}\right)^3$$

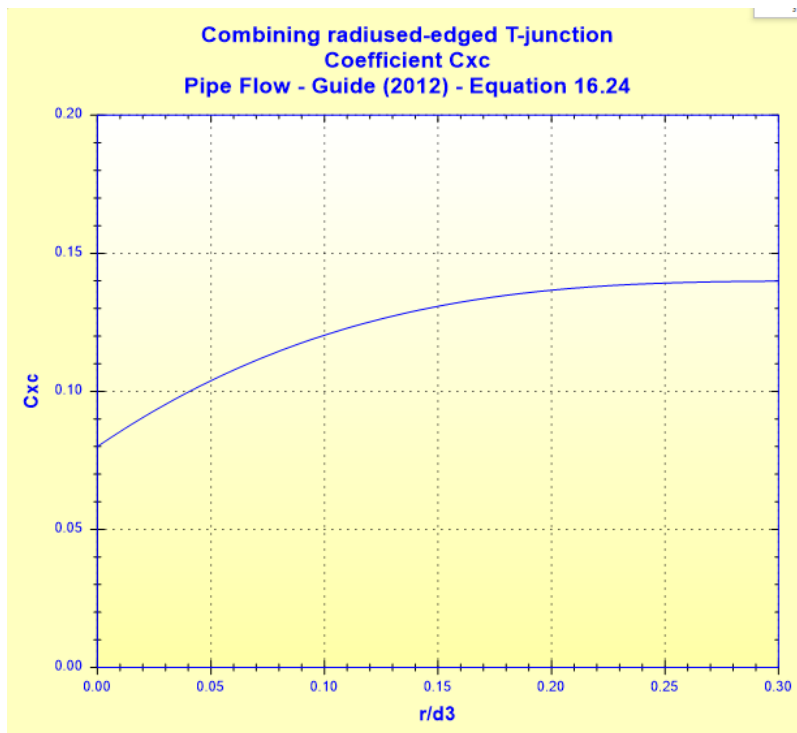
([1] equation 16.23)



Coefficient C_{xC} :

$$C_{xC} = 0.08 + 0.56 \cdot \left(\frac{r}{d_3}\right) - 1.75 \cdot \left(\frac{r}{d_3}\right)^2 + 1.83 \cdot \left(\frac{r}{d_3}\right)^3$$

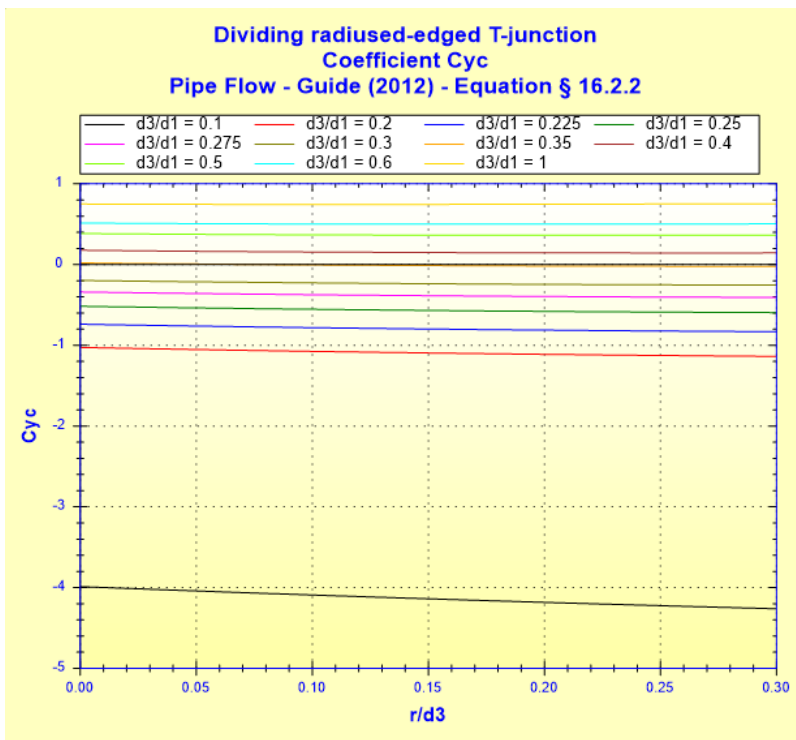
([1] equation 16.24)



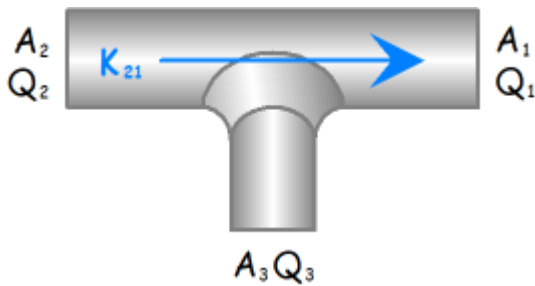
Coefficient C_{yC} :

$$C_{yC} = 1 - 0.25 \cdot \left(\frac{d_3}{d_1}\right)^{1.3} - \left(0.11 \cdot \frac{r}{d_3} - 0.65 \cdot \frac{r^2}{d_3^2} + 0.83 \cdot \frac{r^3}{d_3^3}\right) \cdot \frac{d_3^2}{d_1^2}$$

([1] equation S16.2.2)

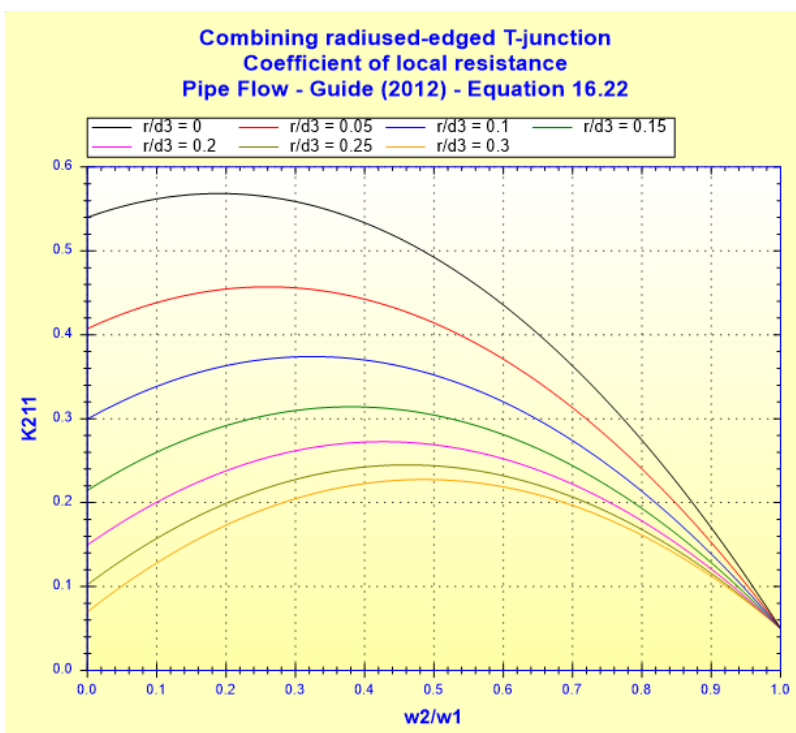


Pressure loss coefficient of the straight branch:



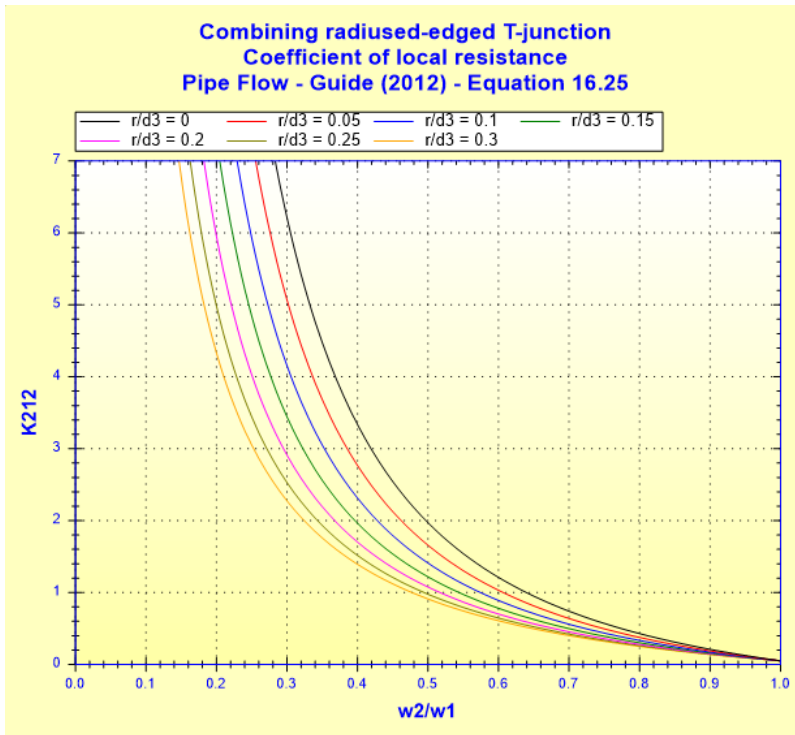
Coefficient based on mean velocity in the common branch:

$$K_{21} = 1 - 0.95 \cdot \frac{W_2^2}{W_1^2} - 2 \cdot C_{xc} \cdot \left(\frac{W_2}{W_1} - \frac{W_2^2}{W_1^2} \right) - 2 \cdot C_M \cdot \left(1 - \frac{W_2}{W_1} \right) \quad ([1] \text{ equation 16.22})$$

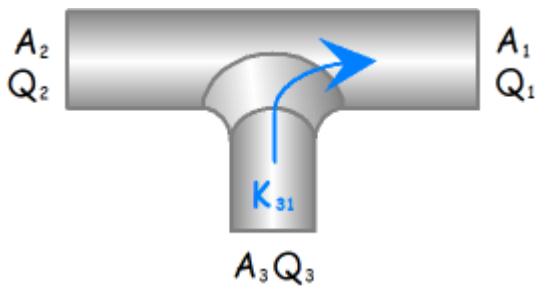


Coefficient based on mean velocity in the straight branch:

$$K_{21_2} = \frac{W_1^2}{W_2^2} - 0.95 - 2 \cdot C_{xC} \cdot \left(\frac{W_1}{W_2} - 1 \right) - 2 \cdot C_M \cdot \left(\frac{W_1^2}{W_2^2} - \frac{W_1}{W_2} \right) \quad ([1] \text{ equation } 16.25)$$



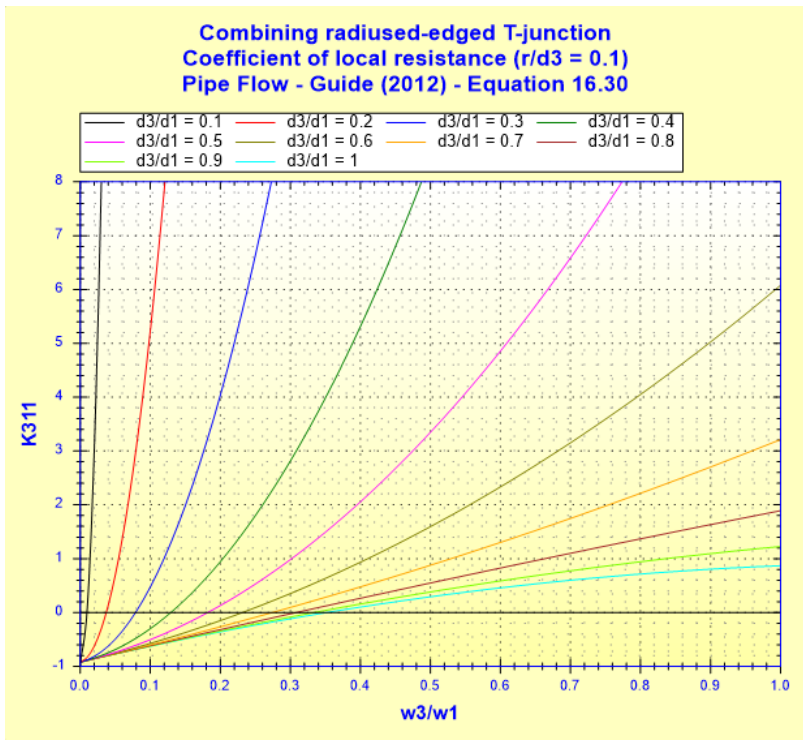
Pressure loss coefficient of the side branch:



Coefficient based on mean velocity in the common branch:

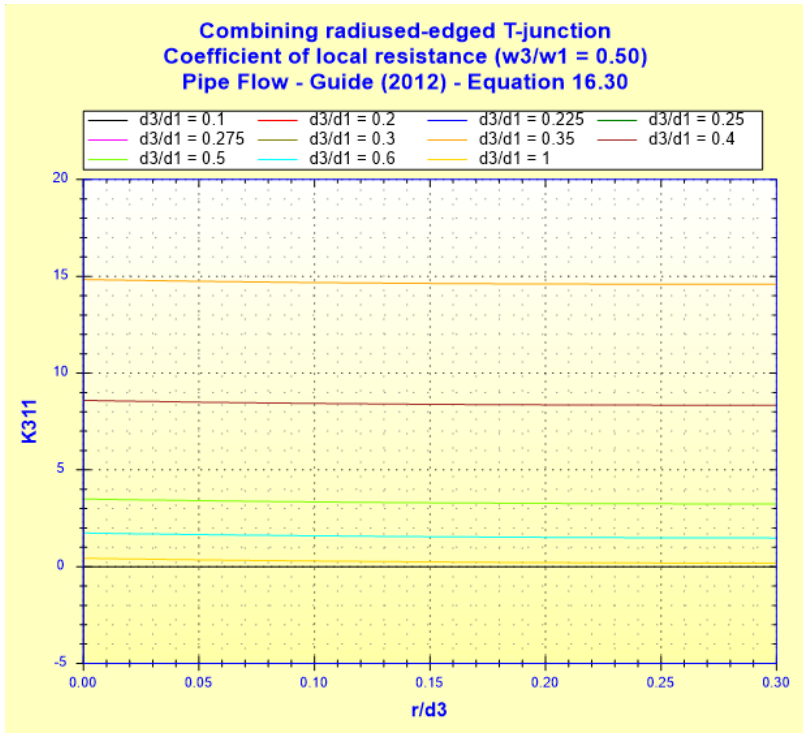
$$K_{31_1} = -0.92 + 2 \cdot (2 - C_{xC} - C_M) \cdot \frac{W_3}{W_1} + \left[(2 \cdot C_{yC} - 1) \cdot \frac{d_1^4}{d_3^4} + 2 \cdot (C_{xC} - 1) \right] \cdot \frac{W_3^2}{W_1^2} \quad ([1] \text{ equation } 16.30)$$

16.30)



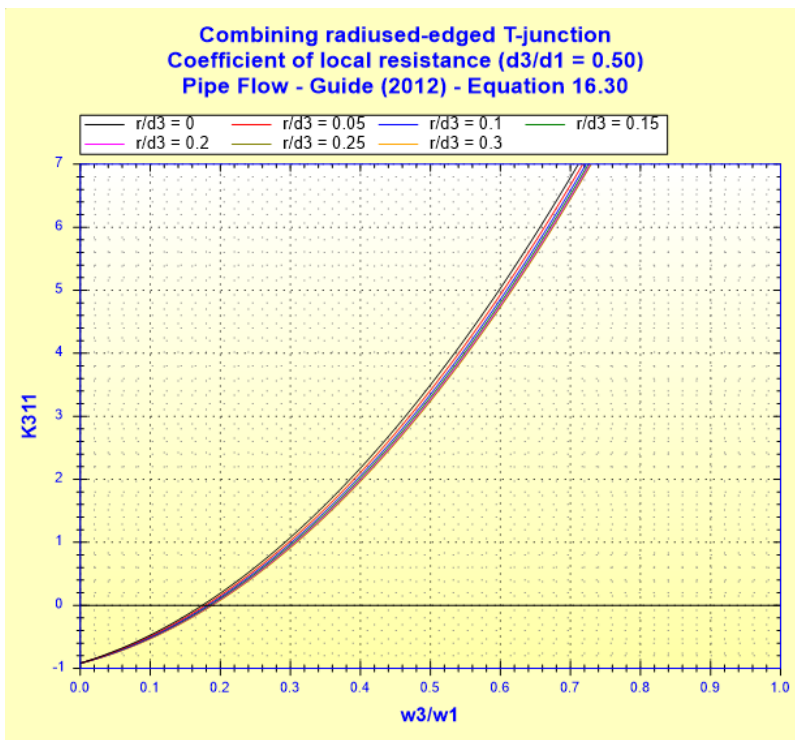
([1] Equation 16.30 with r/d_3

= 0.1)



([1] Equation 16.30 with

$w_3/w_1 = 0.5)$



([1] Equation 16.30 with

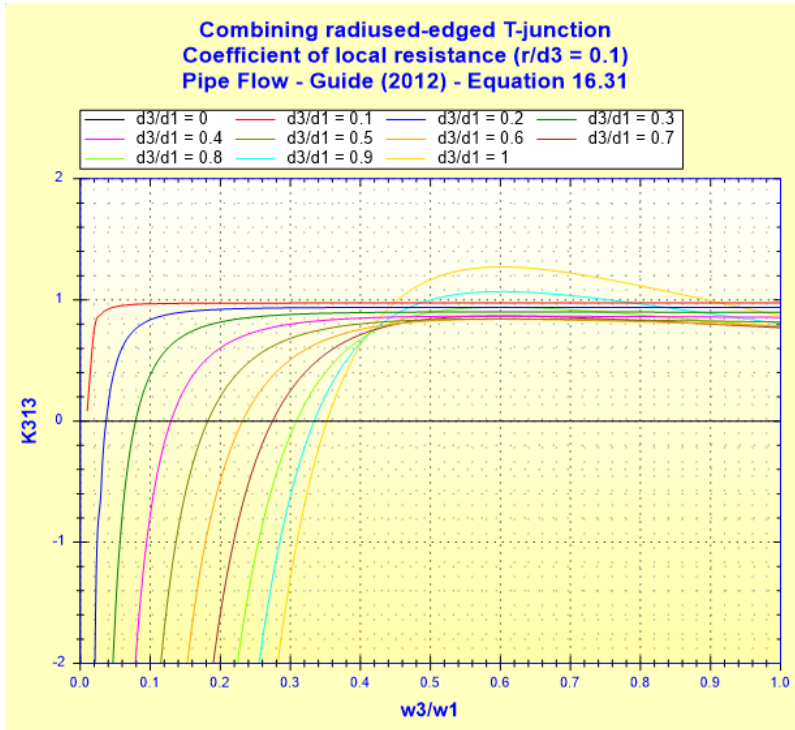
d3/d1 = 0.5)

Coefficient based on mean velocity in the straight branch:

$$K_{313} = 2 \cdot C_{yC} - 1 + \frac{d_3^4}{d_1^4} \cdot \left[2 \cdot (C_{xC} - 1) + 2 \cdot (2 - C_{xC} - C_M) \cdot \frac{W_1}{W_3} - 0.92 \cdot \frac{W_1^2}{W_3^2} \right]$$

([1] equation

16.31)



Pressure loss in the straight branch (Pa):

$$\Delta P_{21} = K_{21} \cdot \frac{\rho_m \cdot W_1^2}{2}$$

Pressure loss in the side branch (Pa):

$$\Delta P_{31} = K_{31} \cdot \frac{\rho_m \cdot w_1^2}{2}$$

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

$$\Delta H_{21} = K_{21} \cdot \frac{w_1^2}{2 \cdot g}$$

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

$$\Delta H_{31} = K_{31} \cdot \frac{w_1^2}{2 \cdot g}$$

Hydraulic power loss in the straight branch (W):

$$Wh_{21} = \Delta P_{21} \cdot Q_2$$

Hydraulic power loss in the side branch (W):

$$Wh_{31} = \Delta P_{31} \cdot Q_3$$

Symbols, Definitions, SI Units:

d_2	Diameter of the straight and side 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)
C_M	Coefficient ()
C_{xC}	Coefficient ()
C_{yC}	Coefficient ()
K_{211}	Pressure loss coefficient of the straight branch (based on mean velocity in the common branch) ()
K_{311}	Pressure loss coefficient of the side branch (based on mean velocity in the common branch) ()

- K_{212} Pressure loss coefficient of the straight branch (based on mean velocity in the straight branch) ()
- K_{313} Pressure loss coefficient of the side branch (based on mean velocity in the side branch) ()
- ΔP_{21} Pressure loss in the straight branch (Pa)
- ΔP_{31} Pressure loss in the side branch (Pa)
- ΔH_{21} Head loss of fluid in the straight branch (m)
- ΔH_{31} Head loss of fluid in the side branch (m)
- Wh_{21} Hydraulic power loss in the straight branch (W)
- Wh_{31} Hydraulic power loss in the side branch (W)
-
- ρ_m Fluid density (kg/m³)
- ν Fluid kinematic viscosity (m²/s)
- g Gravitational acceleration (m/s²)

Validity range:

- turbulent flow regime ($NRe_1 \geq 10^4$)
- diameter of common branch lower than or equal to diameter of right and straight branches ($d_3 \leq d_2$)
- rounding ratio lower than or equal to 0.4 ($r/d_3 \leq 0.4$)

Example of application:

HydrauCalc 2019b - [Combining 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/m³
Dynamic Viscosity : μ 0.00100159 N.s/m²
Kinematic Viscosity : ν 1.00340E-06 m²/s

Density Dyn. Visc. Kin. Visc.

Geometrical characteristics

Help Info

Straight passage pressure loss ΔP_{21} 0.002267547 bar
 ΔH_{21} 0.0232 m of fluid

Calculate

w2 4.9910 kg/s
Q2 0.005 m³/s
V2 1.288 m/s (Turbulent)

w1 5.9892 kg/s
Q1 0.0060 m³/s
V1 1.546 m/s (Turbulent)

r 0.00431 m
d3 0.0431 m

w3 0.9982 kg/s
Q3 0.001 m³/s
V3 0.685 m/s (Turbulent)

Side branch pressure loss
 ΔP_{31} -0.003759633 bar
 ΔH_{31} -0.0384 m of fluid

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'	w3/w1	0.1666667	
Flow rate ratio 'Straight passage / Common channel'	w2/w1	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/d3	0.1	
Diameters ratio 'Side branch / Common channel'	d3/d1	0.6130868	
Local resistance coefficient of straight branch (Equ 16.22)	K211	-0.1901361	
Local resistance coefficient of side branch (Equ 16.30)	K311	-0.315249	
Straight passage pressure loss coefficient (based on w1)	K21	0.1901361	
Side branch pressure loss coefficient (based on w1)	K31	-0.315249	
Straight passage hydraulic power loss	Wh12	1.133774	W
Side branch hydraulic power loss	Wh13	-0.3759633	W

Divers HC

References:

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

HydrauCalc
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Edition: September 2019