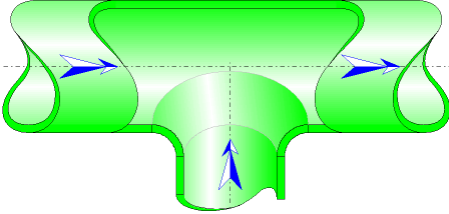




Combining radiused-edged T-junction Circular Cross-Section (MILLER)



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 lateral branch (m^2):

$$A_1 = \pi \cdot \frac{D_1^2}{4}$$

Cross-sectional area of the common branch and the straight branch (m^2):

$$A_2 = \pi \cdot \frac{D_2^2}{4}$$

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

$$Q_3 = Q_1 + Q_2$$

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

$$U_1 = \frac{Q_1}{A_1}$$

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

$$U_2 = \frac{Q_2}{A_2}$$

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

$$U_3 = \frac{Q_3}{A_2}$$

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

$$G_1 = Q_1 \cdot \rho$$

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

$$G_2 = Q_2 \cdot \rho$$

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

$$G_3 = Q_3 \cdot \rho$$

Reynolds number in the lateral branch:

$$Re_1 = \frac{U_1 \cdot D_1}{\nu}$$

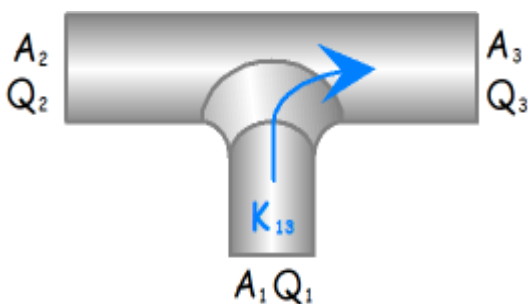
Reynolds number in the straight branch:

$$Re_2 = \frac{U_2 \cdot D_2}{\nu}$$

Reynolds number in the common branch:

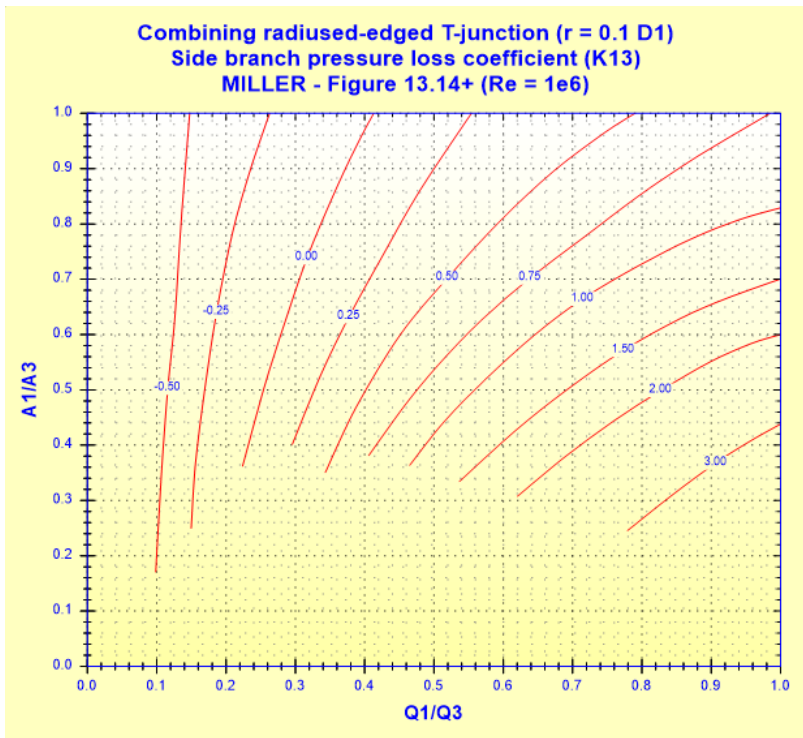
$$Re_3 = \frac{U_3 \cdot D_2}{\nu}$$

Pressure loss coefficient of the lateral branch (based on mean velocity in the common branch):

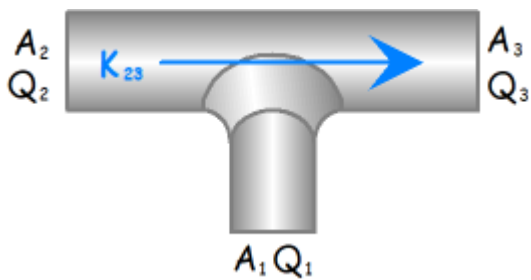


$$K_{13} = f\left(\frac{Q_1}{Q_3}, \frac{A_1}{A_3}\right)$$

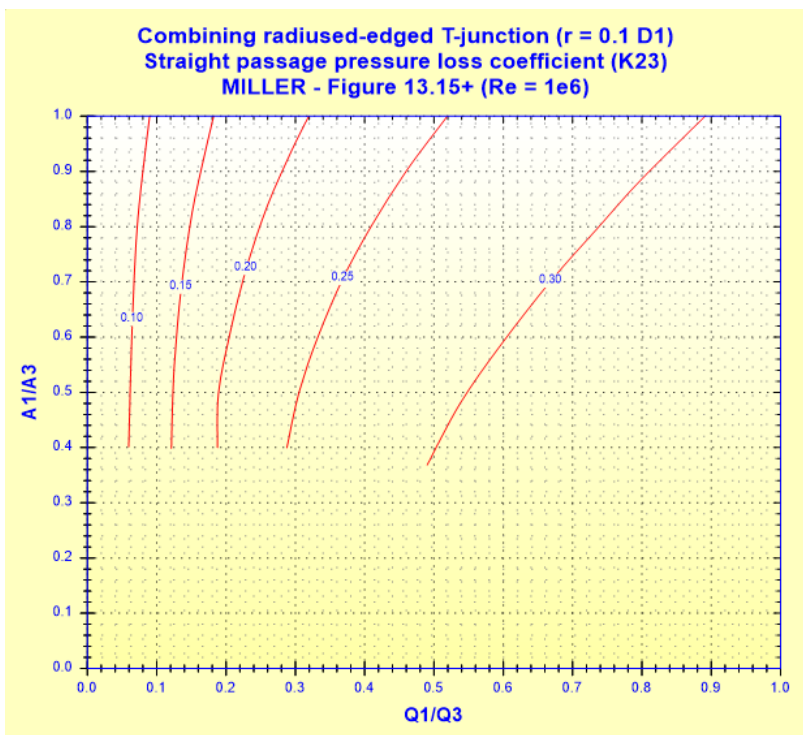
([1] figure 13.14+)



Pressure loss coefficient of the straight branch (based on mean velocity in the common branch):



$$K_{23} = f\left(\frac{Q_1}{Q_3}, \frac{A_1}{A_3}\right) \quad ([1] \text{ figure 13.15+})$$



Pressure loss in the lateral branch (Pa):

$$\Delta P_{13} = K_{13} \cdot \frac{\rho \cdot U_3^2}{2} \quad ([1] \text{ equation 13.1})$$

Pressure loss in the straight branch (Pa):

$$\Delta P_{23} = K_{23} \cdot \frac{\rho \cdot U_3^2}{2} \quad ([1] \text{ equation 13.2})$$

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

$$\Delta H_{13} = K_{13} \cdot \frac{U_3^2}{2 \cdot g}$$

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

$$\Delta H_{23} = K_{23} \cdot \frac{U_3^2}{2 \cdot g}$$

Hydraulic power loss in the lateral branch (W):

$$Wh_{13} = \Delta P_{13} \cdot Q_1$$

Hydraulic power loss in the straight branch (W):

$$Wh_{23} = \Delta P_{23} \cdot Q_2$$

Symbols, Definitions, SI Units:

D_1	Diameter of the lateral branch (m)
D_2	Diameter of the common branch and the straight branch (m)
A_1	Cross-sectional area of the lateral branch (m^2)
A_2	Cross-sectional area of the common branch and the straight branch (m^2)
Q_1	Volume flow rate in the lateral branch (m^3/s)
U_1	Mean velocity in the lateral branch (m/s)
Q_2	Volume flow rate in the straight branch (m^3/s)
U_2	Mean velocity in the straight branch (m/s)
Q_3	Volume flow rate in the common branch (m^3/s)
U_3	Mean velocity in the common branch (m/s)
G_1	Mass flow rate in the lateral branch (kg/s)
G_2	Mass flow rate in the straight branch (kg/s)
G_3	Mass flow rate in the common branch (kg/s)
Re_1	Reynolds number in the lateral branch ()
Re_2	Reynolds number in the straight branch ()
Re_3	Reynolds number in the common branch ()
r	Rounded radius (m)
K_{13}	Pressure loss coefficient of the lateral branch (based on mean velocity in the common branch) ()

- K_{23} Pressure loss coefficient of the straight branch (based on mean velocity in the common branch) ()
 ΔP_{13} Pressure loss in the lateral branch (Pa)
 ΔP_{23} Pressure loss in the straight branch (Pa)
 ΔH_{13} Head loss of fluid in the lateral branch (m)
 ΔH_{23} Head loss of fluid in the straight branch (m)
 Wh_{13} Hydraulic power loss in the lateral branch (W)
 Wh_{23} Hydraulic power loss in the straight branch (W)
- ρ Fluid density (kg/m^3)
 ν Fluid kinematic viscosity (m^2/s)
 g Gravitational acceleration (m/s^2)

Validity range:

- turbulent flow regime ($Re_3 \geq 10^5$)
- rounded radius equal to 0.1 diameter of the lateral branch ($r = 0.1 D_1$)
- cross-sections area ratio equal to or greater than 0.3 ($A_1/A_2 \geq 0.3$)
 note: for cross-sections area ratios lower than 0.3 the pressure loss coefficients "K₁₃" and "K₂₃" are extrapolated

Example of application:

The screenshot shows the HydraulCalc 2019b software interface for a T-junction analysis. The main window displays a 3D model of a T-junction with various parameters and results.

Fluid characteristics:

- Fluid: Water @ 1 atm [HC]
- Temperature: 20 °C
- Pressure: 1.013 bar
- Density: 998.2061 kg/m³
- Dynamic Viscosity: 0.00100159 N.s/m²
- Kinematic Viscosity: 1.00340E-06 m²/s

Geometrical characteristics:

- Side branch radius: $r = 0.00431$ m
- Side branch diameter: $D_1 = 0.0431$ m
- Side branch pressure loss: $\Delta P_{13} = -0.002579058$ bar, $\Delta H_{13} = -0.0263$ m of fluid
- Straight passage pressure loss: $\Delta P_{23} = 0.002222513$ bar, $\Delta H_{23} = 0.0227$ m of fluid

Complementary results:

Designation	Symbol	Value	Unit
Side branch cross-section area	A1	0.001458963	m ²
Straight passage cross-section area	A2	0.003881508	m ²
Common channel cross-section area	A3	0.003881508	m ²
Cross-sections area ratio 'Side branch / Common channel'	A1/A3	0.3758754	
Flow rate ratio 'Side branch / Common channel'	Q1/Q3	0.1666667	
Side branch Reynolds number	Re1	29441.51	
Straight passage Reynolds number	Re2	90251	
Common channel Reynolds number	Re3	108301.2	
Side branch pressure loss coefficient (based on U3)	K13	-0.2162566	
Straight passage pressure loss coefficient (based on U3)	K23	0.1863599	
Side branch hydraulic power loss	Wh1	-0.2579058	W
Straight passage hydraulic power loss	Wh2	1.111256	W

References:

