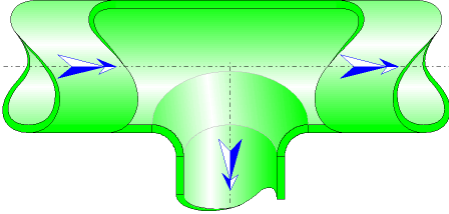




Dividing radiused-edged T-junction Circular Cross-Section (MILLER)



Model description:

This model of component calculates the minor head loss (pressure drop) generated by the flow in a 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 lateral branch (m²):

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

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

$$A_3 = \pi \cdot \frac{D_3^2}{4}$$

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

$$U_2 = \frac{Q_2}{A_3}$$

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

$$U_3 = \frac{Q_3}{A_3}$$

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:

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

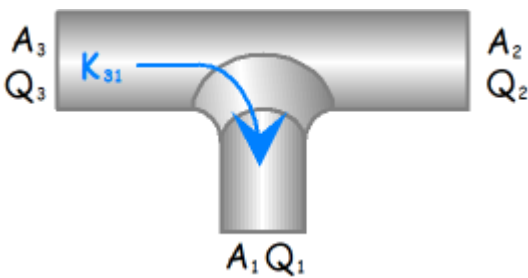
Reynolds number in the straight branch:

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

Reynolds number in the common branch:

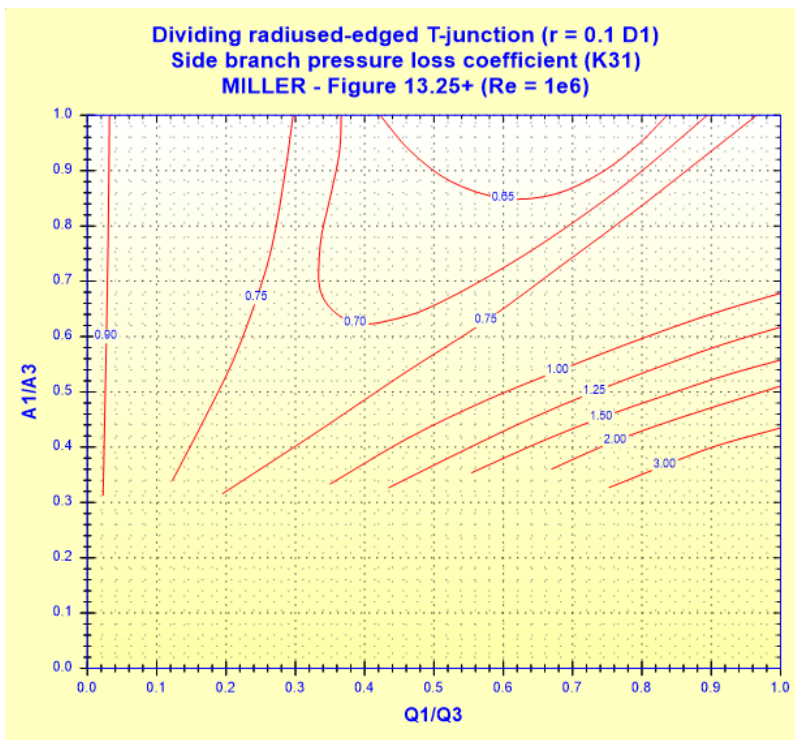
$$Re_3 = \frac{U_3 \cdot D_3}{\nu}$$

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

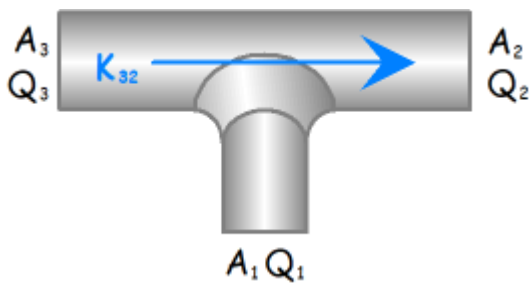


$$K_{31} = f\left(\frac{Q_1}{Q_3}, \frac{A_1}{A_3}\right)$$

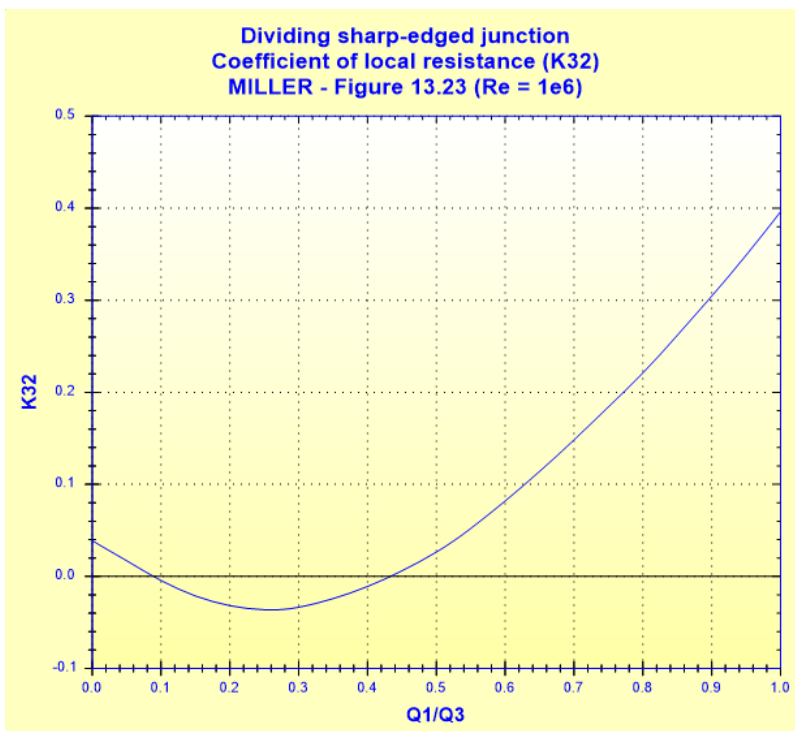
([1] figure 13.25+)



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



$$K_{32} = f\left(\frac{Q_1}{Q_3}\right) \quad ([1] \text{ figure 13.23})$$



Pressure loss in the lateral branch (Pa):

$$\Delta P_{31} = K_{31} \cdot \frac{\rho \cdot U_3^2}{2} \quad ([1] \text{ equation 13.3})$$

Pressure loss in the straight branch (Pa):

$$\Delta P_{32} = K_{32} \cdot \frac{\rho \cdot U_3^2}{2} \quad ([1] \text{ equation 13.4})$$

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

$$\Delta H_{31} = K_{31} \cdot \frac{U_3^2}{2 \cdot g}$$

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

$$\Delta H_{32} = K_{32} \cdot \frac{U_3^2}{2 \cdot g}$$

Hydraulic power loss in the lateral branch (W):

$$Wh_{31} = \Delta P_{31} \cdot Q_1$$

Hydraulic power loss in the straight branch (W):

$$Wh_{32} = \Delta P_{32} \cdot Q_2$$

Symbols, Definitions, SI Units:

D_1	Diameter of the lateral branch (m)
D_3	Diameter of the common branch and the straight branch (m)
A_1	Cross-sectional area of the lateral branch (m ²)
A_3	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_{31}	Pressure loss coefficient of the lateral branch (based on mean velocity in the common branch) ()

- K_{32} Pressure loss coefficient of the straight branch (based on mean velocity in the common branch) ()
- ΔP_{31} Pressure loss in the lateral branch (Pa)
- ΔP_{32} Pressure loss in the straight branch (Pa)
- ΔH_{31} Head loss of fluid in the lateral branch (m)
- ΔH_{32} Head loss of fluid in the straight branch (m)
- Wh_{31} Hydraulic power loss in the lateral branch (W)
- Wh_{32} 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 ($A_1/A_3 \geq 0.3$)
note: for cross-sections area ratios lower than 0.3 the pressure loss coefficients "K₃₁" is extrapolated

Example of application:

The screenshot shows the HydraulCalc 2019b software interface for a T-junction analysis. The fluid is Water @ 1 atm [HC] with a temperature of 20 °C and a pressure of 1.013 bar. The fluid density is 998.2061 kg/m³, dynamic viscosity is 0.00100159 N.s/m², and kinematic viscosity is 1.00340E-06 m²/s. The geometrical characteristics include a side branch diameter D1 of 0.0431 m, a straight passage diameter D2 of 0.0431 m, and a rounded radius r of 0.00431 m. The flow rates are G3 = 5.9892 kg/s, G2 = 4.9910 kg/s, and G1 = 0.9982 kg/s. The velocities are U3 = 1.546 m/s (Turbulent), U2 = 1.288 m/s (Turbulent), and U1 = 0.685 m/s (Turbulent). The pressure losses are ΔP31 = 0.008719273 bar, ΔP32 = -0.0003040763 bar, and ΔP33 = 0.0703 bar. The head losses are ΔH31 = 0.0891 m of fluid, ΔH32 = -0.0031 m of fluid, and ΔH33 = 0.0703 m. The complementary results table is as follows:

Designation	Symbol	Value	Unit
Side branch cross-section area	A1	0.001458963	m²
Straight passage cross-section area	A2	0.003881508	m²
Common channel cross-section area	A3	0.003881508	m²
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)	K31	0.7311198	
Straight passage pressure loss coefficient (based on U3)	K32	-0.0254971	
Side branch hydraulic power loss	Wh1	0.8719273	W
Straight passage hydraulic power loss	Wh2	-0.1520382	W

References:

