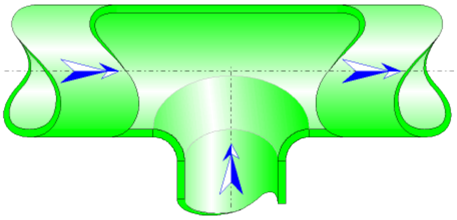
Combining radiused-edged T-junction
Circular Cross-Section
(MILLER)



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:

$$\mathrm{Re}_1 = \frac{U_1 \cdot D_1}{\nu}$$

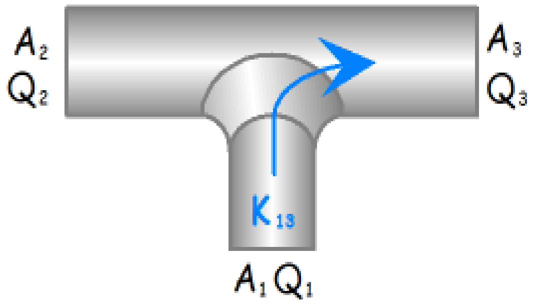
Reynolds number in the straight branch:

$$\mathrm{Re}_2 = \frac{U_2 \cdot D_2}{\nu}$$

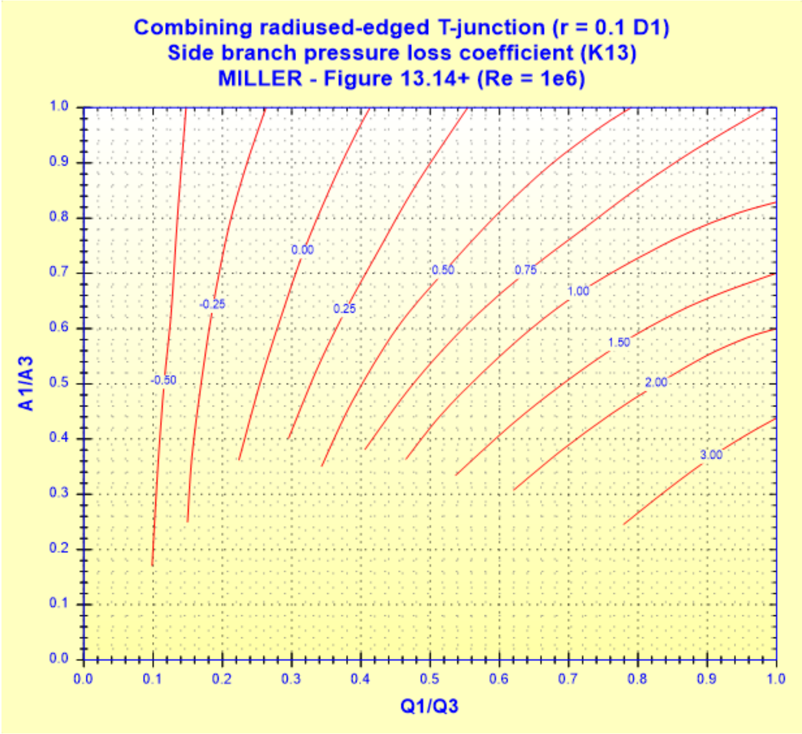
Reynolds number in the common branch:

$$\mathrm{Re}_3 = \frac{U_3 \cdot D_2}{\nu}$$

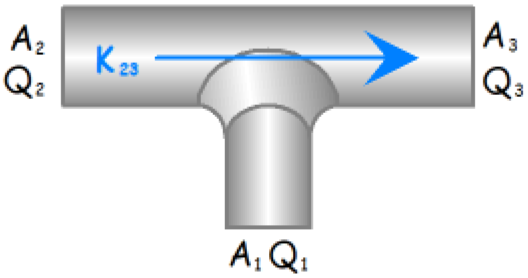
Pressure loss coefficient of the lateral branch (based on mean velocity in the common branch):



$$K_{13} = f\left(\frac{Q_1}{Q_3}, \frac{A_1}{A_3}\right)$$ ([1] figure 13.14+)

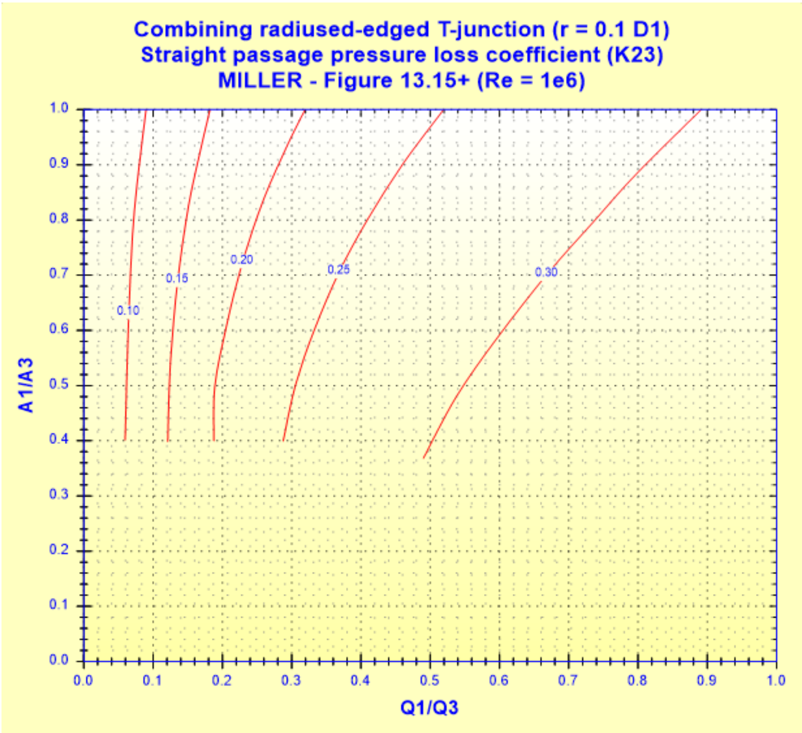


Pressure loss coefficient of the straight branch (based on mean velocity in the common branch):



$$K_{23} = f\left(\frac{Q_1}{Q_3}, \frac{A_1}{A_3}\right)$$

([1] figure 13.15+)



Pressure loss in the lateral branch (Pa):

$$\Delta P_{13} = K_{13} \cdot \frac{\rho \cdot U_3^{\ 2}}{2}$$

([1] equation 13.1)

Pressure loss in the straight branch (Pa):

$$\Delta P_{23} = K_{23} \cdot \frac{\rho \cdot U_3^{\ 2}}{2}$$

([1] 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:

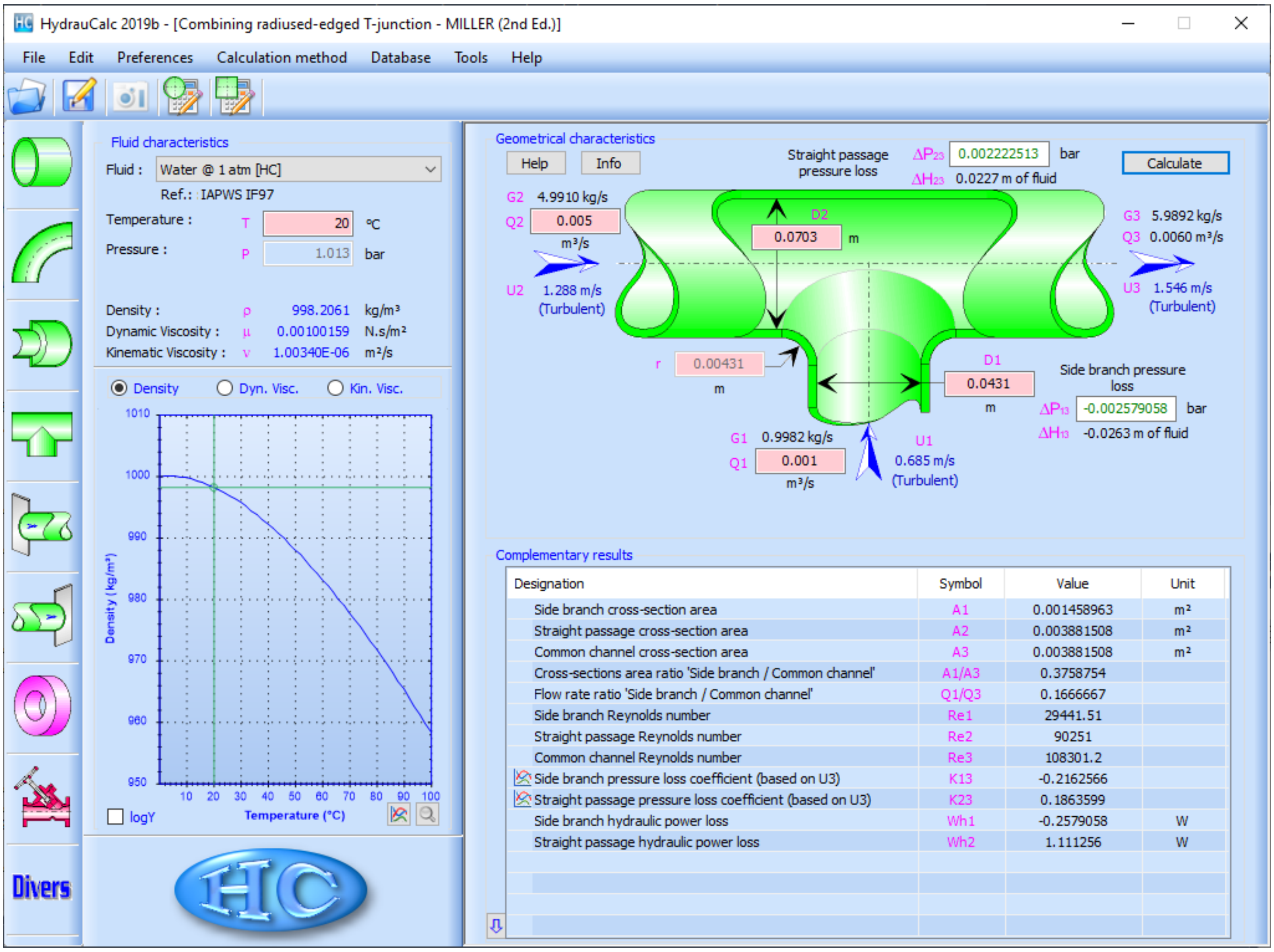
D_1	Diameter of the lateral branch (m)
D_2	Diameter of the common branch and the straight branch (m)
A_1	Cross-sectional area of the lateral branch (m^2)
A_2	Cross-sectional area of the common branch and the straight branch (m^2)
Q_1	Volume flow rate in the lateral branch (m^3/s)
U_1	Mean velocity in 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 "K_{13}" and "K_{23}" are extrapolated

Example of application:



References:

[1] Internal Flow System, Second Edition, D.S. Miller (1990)