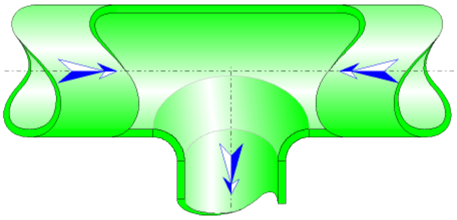
Symmetric combining radiused-edged T-junction
Circular Cross-Section
(MILLER)



Model description:

This model of component calculates the minor head loss (pressure drop) generated by the flow in a symmetric combining radiused-edged T-junction with three legs of equal area.

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 three branches (m^2):

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

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

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

with $D_1 = D_2 = D_3 = D$

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

$$Q_3 = Q_1 + Q_2$$

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

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

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

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

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

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

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

$$\boxed{G_1 = Q_1 \cdot \rho}$$

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

$$\boxed{G_2 = Q_2 \cdot \rho}$$

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

$$\boxed{G_3 = Q_3 \cdot \rho}$$

Reynolds number in the left branch:

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

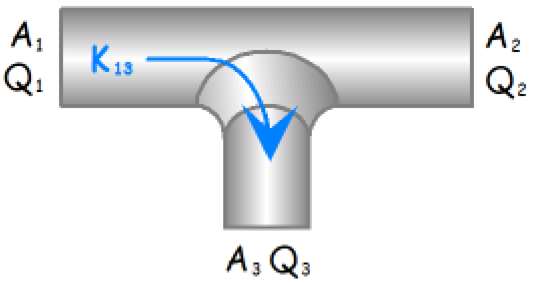
Reynolds number in the right branch:

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

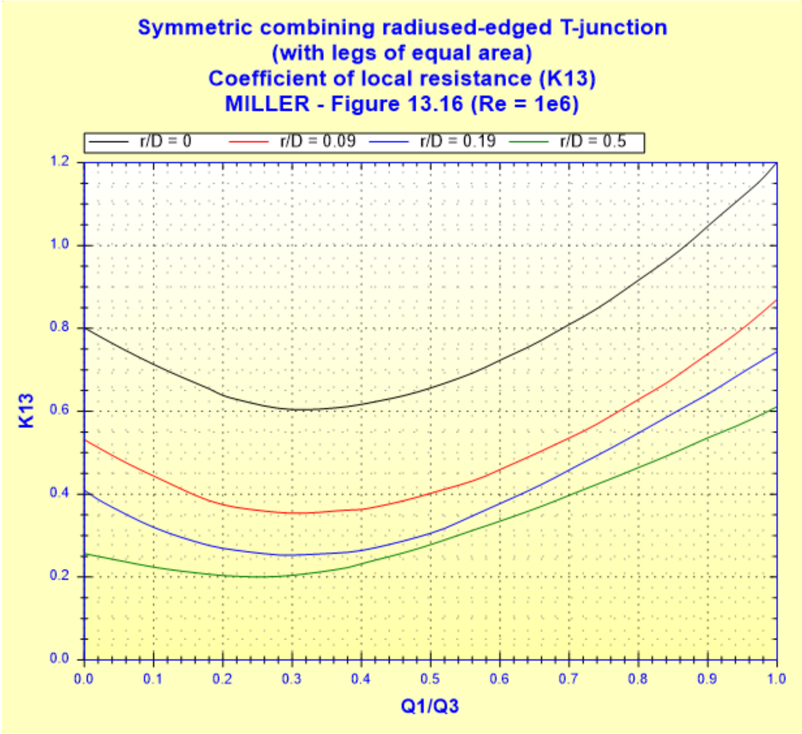
Reynolds number in the common branch:

$$\boxed{\mathrm{Re}_3 = \frac{U_3 \cdot D_3}{\nu}}$$

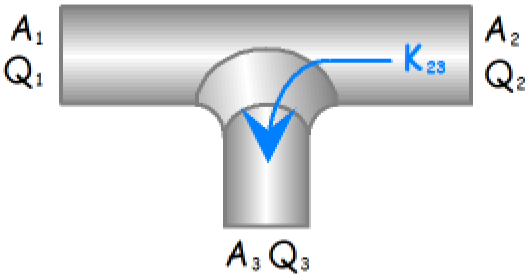
Pressure loss coefficient of the left branch (based on mean velocity in the common branch):



$$\boxed{K_{13} = f\left(\frac{Q_1}{Q_3}, \frac{r}{D}\right)}$$ ([1] figure 13.16)

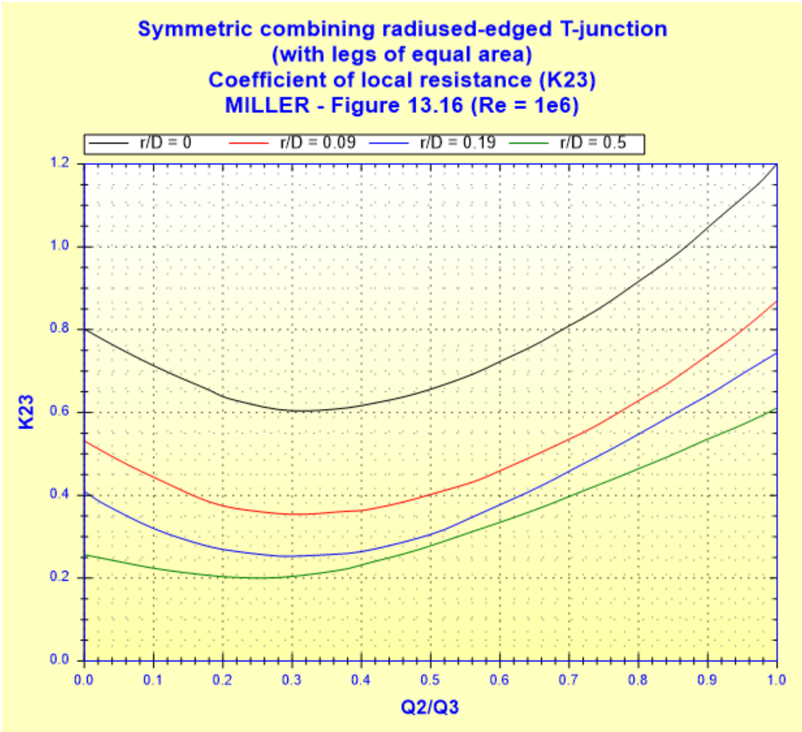


Pressure loss coefficient of the right branch (based on mean velocity in the common branch):



$$K_{23} = f\left(\frac{Q_2}{Q_3}, \frac{r}{D}\right)$$

([1] figure 13.16)



Pressure loss in the left branch (Pa):

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

([1] equation 13.1)

Pressure loss in the right branch (Pa):

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

([1] equation 13.2)

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

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

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

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

Hydraulic power loss in the left branch (W):

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

Hydraulic power loss in the right branch (W):

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

Symbols, Definitions, SI Units:

D	Inside diameter of the three branches (m)
D_1	Diameter of the left branch (m)
D_2	Diameter of the right branch (m)
D_3	Diameter of the common branch (m)
A_1	Cross-sectional area of the left branch (m^2)
A_2	Cross-sectional area of the right branch (m^2)
A_3	Cross-sectional area of the common branch (m^2)
Q_1	Volume flow rate in the left branch (m^3/s)
U_1	Mean velocity in the left branch (m/s)
Q_2	Volume flow rate in the right branch (m^3/s)
U_2	Mean velocity in the right 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 left branch (kg/s)
G_2	Mass flow rate in the right branch (kg/s)
G_3	Mass flow rate in the common branch (kg/s)
Re_1	Reynolds number in the left branch ()
Re_2	Reynolds number in the right branch ()
Re_3	Reynolds number in the common branch ()

r Rounded radius (m)

K_{13} Pressure loss coefficient of the left branch (based on mean velocity in the common branch) ()

K_{23} Pressure loss coefficient of the right branch (based on mean velocity in the common branch) ()

ΔP_{13} Pressure loss in the left branch (Pa)

ΔP_{23} Pressure loss in the right branch (Pa)

ΔH_{13} Head loss of fluid in the left branch (m)

ΔH_{23} Head loss of fluid in the right branch (m)

Wh_{13} Hydraulic power loss in the left branch (W)

Wh_{23} Hydraulic power loss in the right branch (W)

ρ Fluid density (kg/m³)

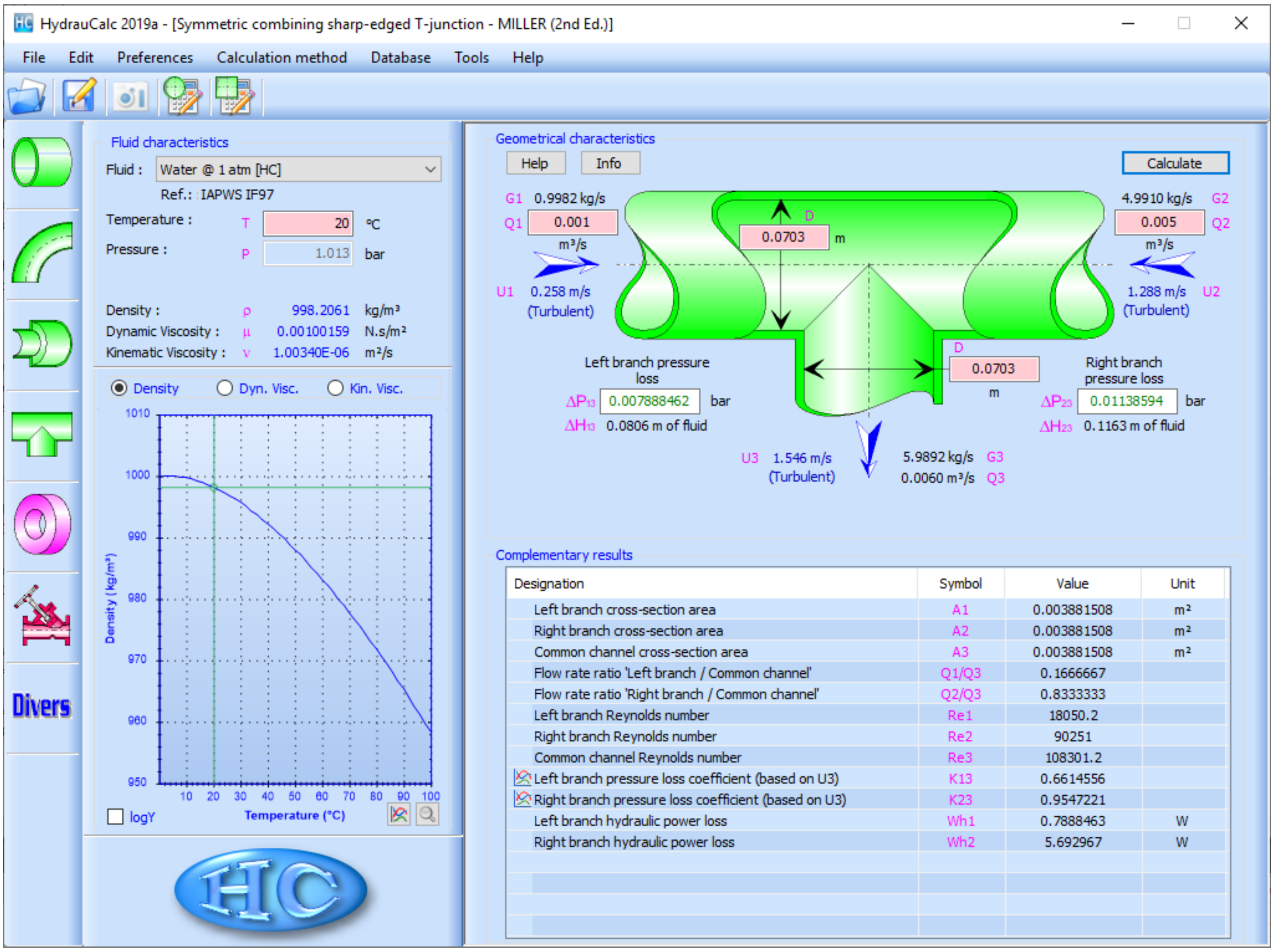
ν Fluid kinematic viscosity (m²/s)

g Gravitational acceleration (m/s²)

Validity range:

- turbulent flow regime ($Re_3 \geq 10^5$)
- three legs of equal area ($D_1 = D_2 = D_3$)
- relative radius of the round (r/D) lower than or equal to 0.5D

Example of application:



References:

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