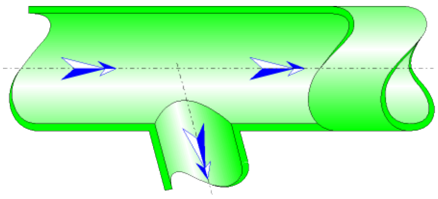
Dividing sharp-edged junction
Circular Cross-Section
(MILLER)



Model description:

This model of component calculates the minor head loss (pressure drop) generated by the flow in a dividing sharp-edged 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:

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

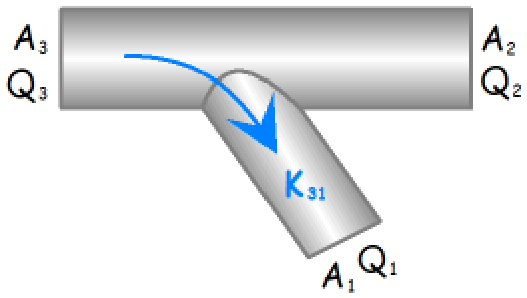
Reynolds number in the straight branch:

$$\mathrm{Re}_2 = \frac{U_2 \cdot D_3}{\nu}$$

Reynolds number in the common branch:

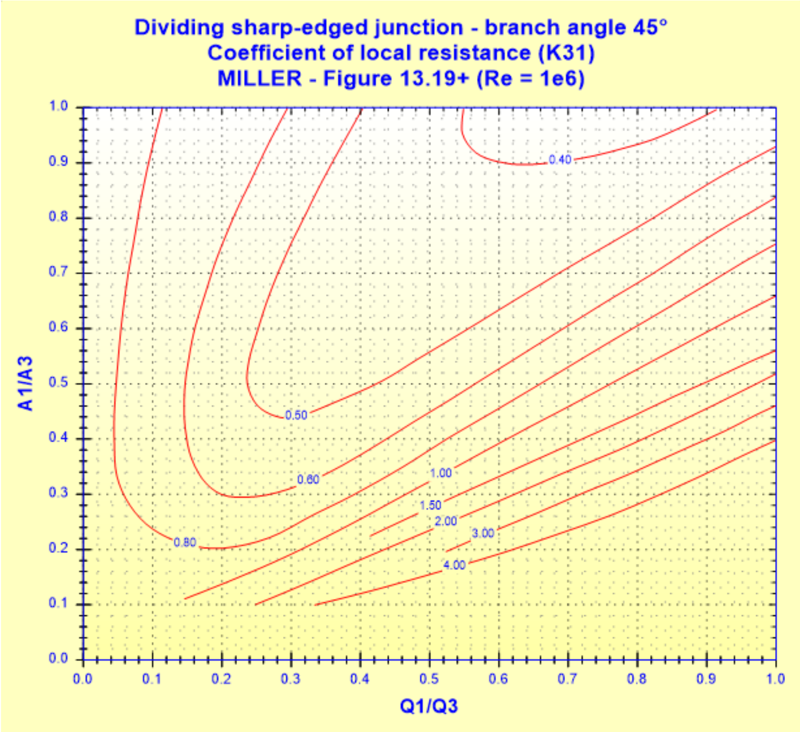
$$\mathrm{Re}_3 = \frac{U_3 \cdot D_3}{\nu}$$

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



- Angle $\theta = 45°$

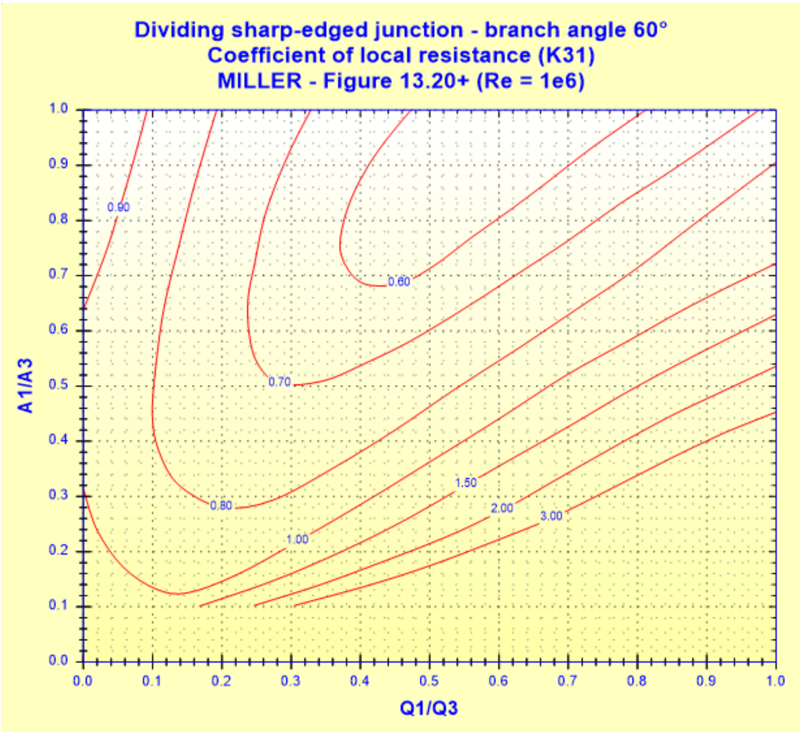
$$K_{31} = f\left(\frac{Q_1}{Q_3}, \frac{A_1}{A_3}\right)$$ ([1] figure 13.19+)



■ Angle $\theta = 60°$

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

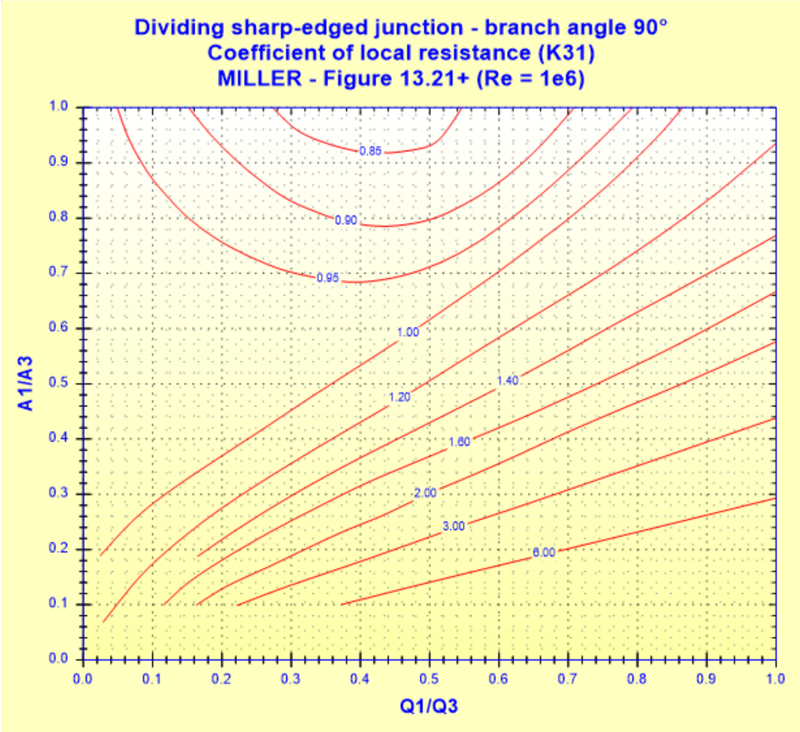
([1] figure 13.20+)



■ Angle $\theta = 90°$

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

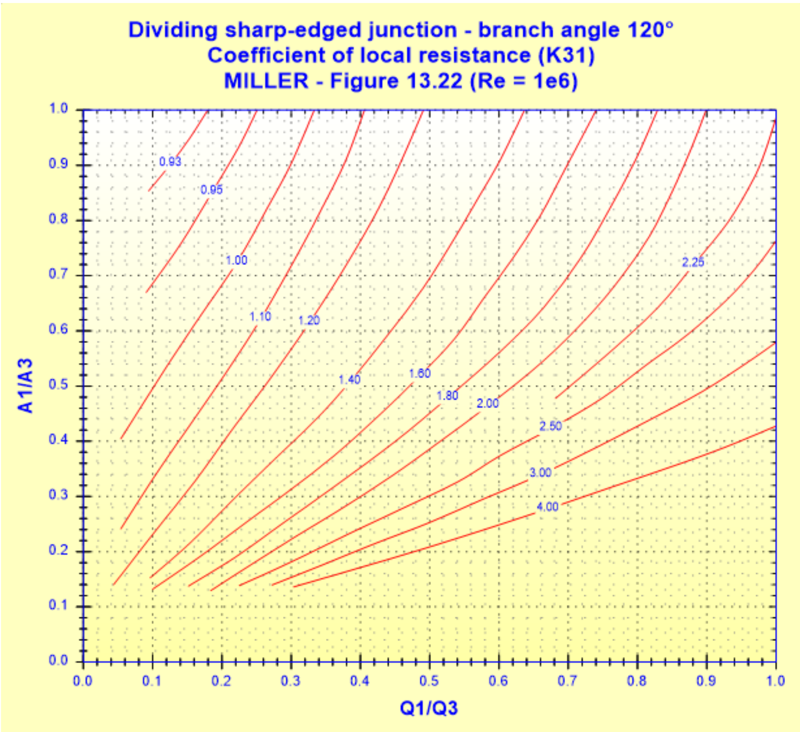
([1] figure 13.21+)



■ Angle $\theta = 120°$

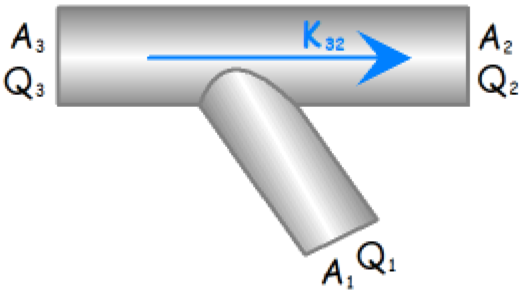
$$K_{31} = f\left(\frac{Q_1}{Q_3}, \frac{A_1}{A_3}\right)$$

([1] figure 13.22)



For any angles between 45 ° and 120 °, the coefficient K_{31} is obtained by linear interpolation between the values of K_{31} calculated at 45 °, 60 °, 90 ° and 120 °.

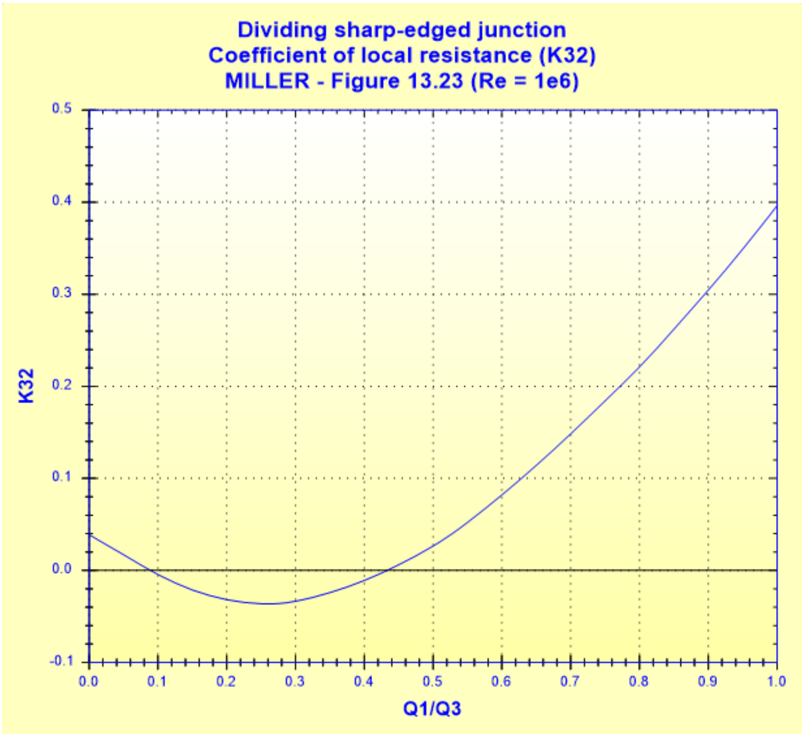
Pressure loss coefficient of the straight branch (based on mean velocity in the common branch):



■ Angle $\theta = 45° - 90°$

$$K_{32} = f\left(\frac{Q_1}{Q_3}\right)$$

([1] figure 13.23)



Pressure loss in the lateral branch (Pa):

$$\Delta P_{31} = K_{31} \cdot \frac{\rho \cdot U_3^{\ 2}}{2}$$

([1] equation 13.3)

Pressure loss in the straight branch (Pa):

$$\Delta P_{32} = K_{32} \cdot \frac{\rho \cdot U_3^{\ 2}}{2}$$

([1] 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:

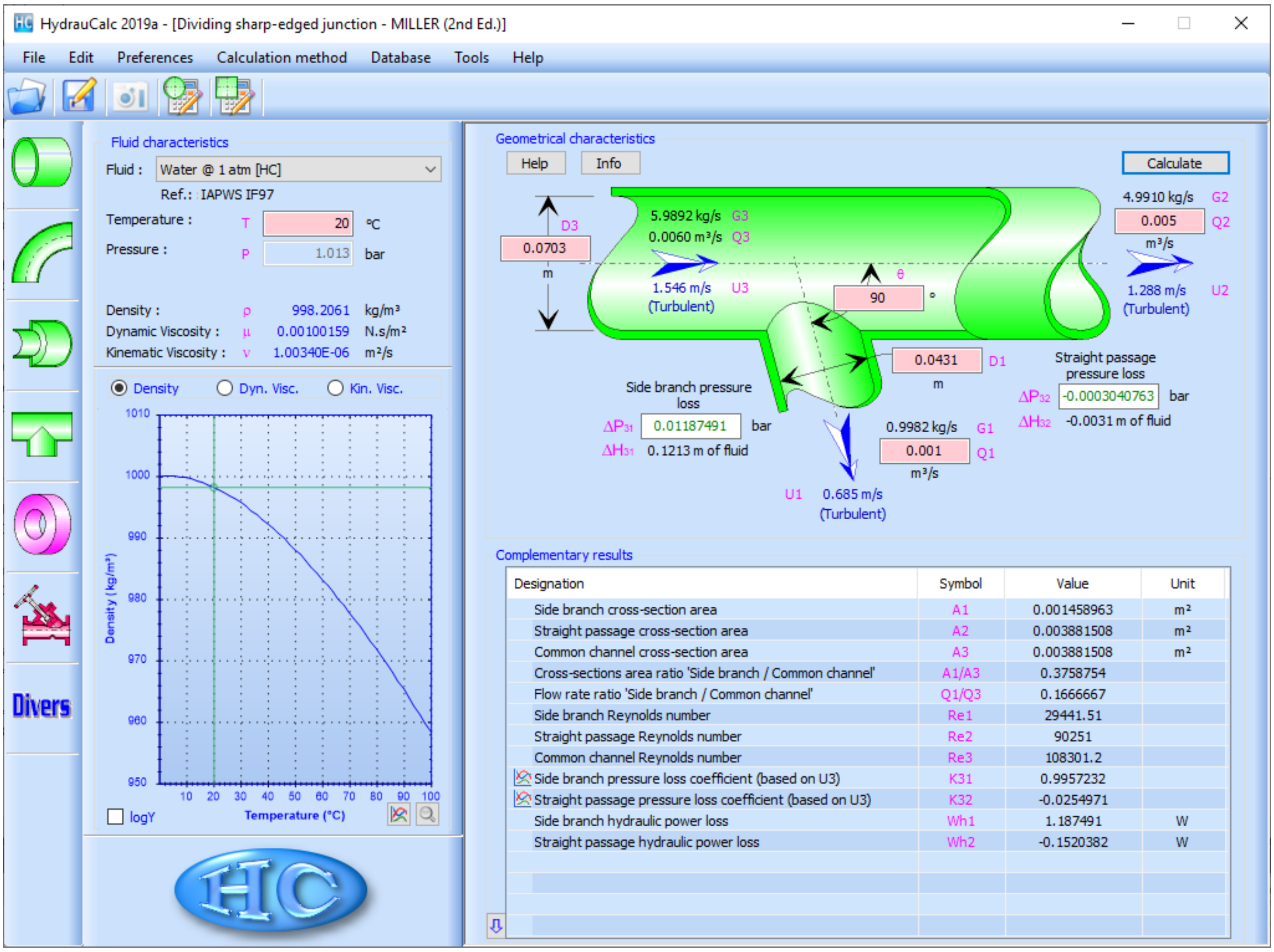
D_1	Diameter of the lateral branch (m)
D_3	Diameter of the common branch and the straight branch (m)
A_1	Cross-sectional area of the lateral branch (m²)
A_3	Cross-sectional area of the common branch and the straight branch (m²)
Q_1	Volume flow rate in the lateral branch (m³/s)
U_1	Mean velocity in the lateral branch (m/s)
Q_2	Volume flow rate in the straight branch (m³/s)
U_2	Mean velocity in the straight branch (m/s)
Q_3	Volume flow rate in the common branch (m³/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 ()
θ	Angle of the lateral branch (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/m³)
ν	Fluid kinematic viscosity (m²/s)
g	Gravitational acceleration (m/s²)

Validity range:

- turbulent flow regime ($Re_3 \geq 10^5$)
- angle of the lateral branch:
  between 45° and 120° for the pressure loss coefficient "K_{31}"
  between 45° and 90° for the pressure loss coefficient "K_{32}"

- cross-sections area ratio $A_1/A_3 \geq 0.1$
  note: for cross-sections area ratios A_1/A_3 lower than 0.1 the pressure loss coefficients "K_{31}" and "K_{32}" are extrapolated

Example of application:



References:

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