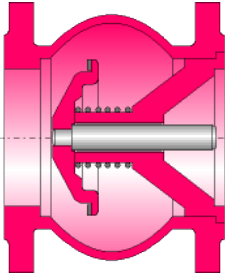




Swing Check Valve (User defined)



Model description:

This model of component calculates the minor head loss (pressure drop) generated by the flow in an axial check valve installed in a straight pipe.

The swing check valve characteristics are defined by the user. The pressure drop of the valve is characterized by a flow coefficient "Kvs", "Cvs" or "Avs" at full opening. The model also takes into account the partial opening of the valve, the opening is partial when the pressure at the inlet of the valve is between the pressure at the begin of opening and the minimum pressure for full opening.

Model formulation:

Cross-sectional area (m²):

$$A = \pi \cdot \frac{D^2}{4}$$

Mean velocity (m/s):

$$U = \frac{Q}{A}$$

Mass flow rate (kg/s):

$$G = Q \cdot \rho$$

Reynolds number:

$$Re = \frac{U \cdot D}{\nu}$$

● check valve at full opening:

Local resistance coefficient:

$$K_{turb} = \frac{2 \cdot A^2}{\left(\frac{Kvs}{36023}\right)^2}$$

$$K_{turb} = \frac{2 \cdot A^2}{\left(\frac{Cvs}{41650}\right)^2}$$

$$K_{turb} = \frac{2 \cdot A^2}{Avs^2}$$

Total pressure loss coefficient (based on mean velocity):

$$K = K_{turb}$$

Total pressure loss (Pa):

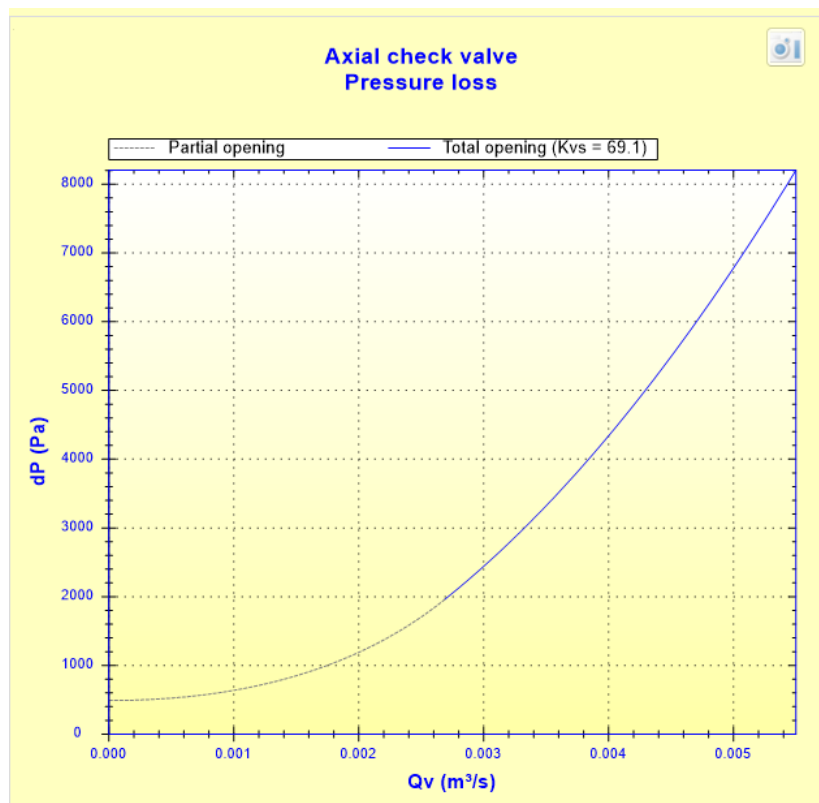
$$\Delta P = K \cdot \frac{\rho \cdot U^2}{2}$$

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- check valve at partial opening:

The pressure drop at partial opening is estimated by curvilinear interpolation between the pressure at the begin of opening "Pbo" and the minimum pressure for full opening "Pto".

$$\Delta P = f(Qv, Pbo, Pto)$$

The figure below shows an example of the pressure drop of a check valve with partial opening.



Flow coefficient:

$$K_v = 36023 \cdot Q \cdot \sqrt{\frac{\rho}{\Delta P}}$$

$$C_v = 41650 \cdot Q \cdot \sqrt{\frac{\rho}{\Delta P}}$$

$$A_v = Q \cdot \sqrt{\frac{\rho}{\Delta P}}$$

Total pressure loss coefficient (based on mean velocity):

$$K = \frac{2 \cdot \Delta P}{\rho \cdot U^2}$$

Total head loss of fluid (m):

$$\Delta H = K \cdot \frac{U^2}{2 \cdot g}$$

Hydraulic power loss (W):

$$W_h = \Delta P \cdot Q$$

Symbols, Definitions, SI Units:

D	Internal diameter (m)
A	Cross-sectional area (m ²)
Q	Volume flow rate (m ³ /s)
U	Mean velocity (m/s)
G	Mass flow rate (kg/s)
Re	Reynolds number ()
α	Opening angle (°)
K _v	Full opening flow coefficient (m ³ /h)
C _v	Full opening flow coefficient (USG/min)
A _v	Full opening flow coefficient (m ²)
K _{turb}	Local resistance coefficient for Re ≥ 10 ⁴ ()
K	Total pressure loss coefficient (based on mean velocity) ()
ΔP	Total pressure loss (Pa)
K _v	Partial opening flow coefficient (m ³ /h)
C _v	Partial opening flow coefficient (USG/min)
A _v	Partial opening flow coefficient (m ²)
P _{bo}	Pressure at the begin of opening (Pa)
P _{to}	Minimum pressure for full opening (Pa)
ΔH	Total head loss of fluid (m)
W _h	Hydraulic power loss (W)
ρ	Fluid density (kg/m ³)

- v Fluid kinematic viscosity (m^2/s)
- g Gravitational acceleration (m/s^2)

Validity range:

- flow regime: turbulent

note: for laminar flow regime ($Re < 10^4$) and for operation in partial opening, the pressure loss coefficient "K" is estimated

Example of application:

The screenshot displays the HydraulCalc 2021b software interface for an axial check valve. The interface is divided into several sections:

- Fluid characteristics:**
 - Fluid: Water @ 1 atm [HC]
 - Ref.: IAPWS IF97
 - Temperature: T = 20 °C
 - Pressure: P = 1.013 bar
 - Density: $\rho = 998.2061 \text{ kg/m}^3$
 - Dynamic Viscosity: $\mu = 0.00100159 \text{ N.s/m}^2$
 - Kinematic Viscosity: $\nu = 1.00340E-06 \text{ m}^2/s$
 - Graph: Density (kg/m³) vs Temperature (°C) showing a decreasing trend from 1000 to 950 kg/m³ as temperature increases from 10 to 100 °C.
- Geometrical characteristics:**
 - Flow coefficient at full opening: 100
 - Flow rate: G = 4.9910 kg/s, Q = 0.005 m³/s
 - Mean valve velocity: U = 2.546 m/s (Turbulent)
 - Diagram: A cross-sectional view of the axial check valve with a diameter D = 0.05 m.
 - Pressure loss: $\Delta P = 0.03238331 \text{ bar}$, $\Delta H = 0.3308 \text{ m of fluid}$
- Complementary results:**

Designation	Symbol	Value	Unit
Pipe cross-section area	A	0.001963496	m ²
Reynolds number	Re	126892.9	
Fully open flow coefficient Kvs	Kvs	100	
Flow coefficient Kv	Kv	100	
Coefficient of local resistance	K _{turb}	1.000578	
Pressure loss coefficient (based on the mean valve velocity)	K	1.000578	
Pressure loss	ΔP	0.03238331	bar
Hydraulic power loss	Wh	16.19166	W