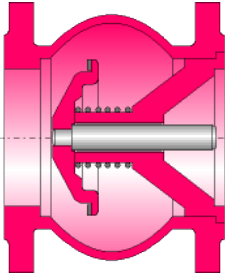




Axial Check Valve (Manufacturer defined)



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 valves manufacturers. 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):

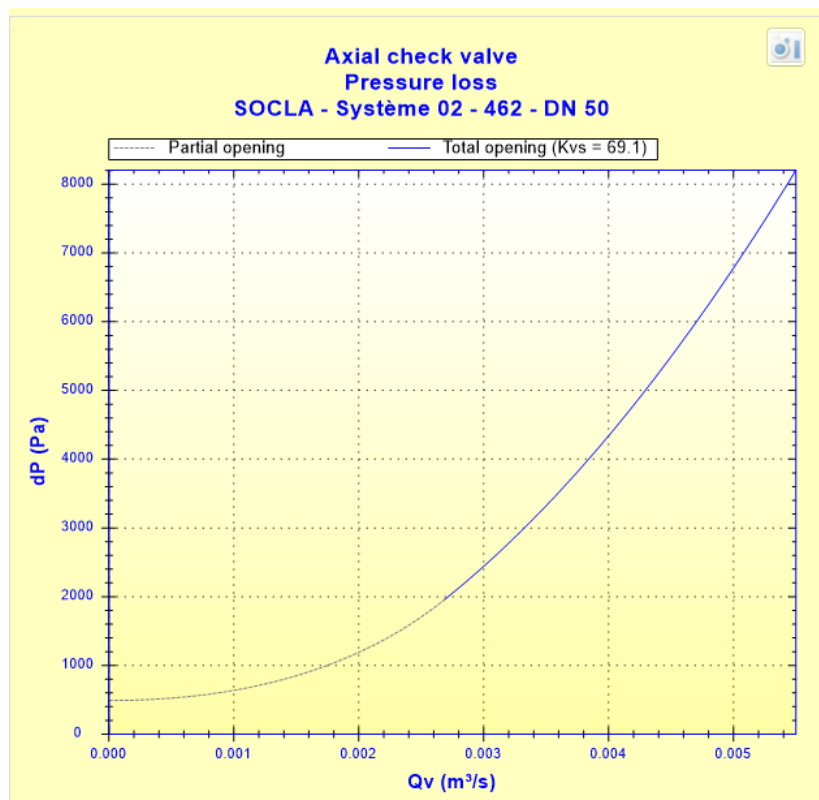
$$\Delta P = K \cdot \frac{\rho \cdot U^2}{2}$$

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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 calculation. The window title is "HydrauCalc 2021b - [Axial check valve - Manufacturer - SOCLA - Système 02 - 402X (DN40-400)]".

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: $\nu = 1.00340E-06 \text{ m}^2/\text{s}$

Geometrical characteristics:

- Manufacturer: SOCLA - Système 02 - 402X (DN40-400)
- Model: DN 50 - NPS 2
- Flow rate: G = 4.9910 kg/s, Q = 0.005 m³/s
- Mean valve velocity: U = 2.546 m/s (Turbulent)
- Partial opening definition:
 - Define opening pressures:
 - Begin of opening: 0.03236 bar
 - Total opening: 0.04903 bar
- Diagram shows a valve with diameter D = 0.05 m.
- Pressure loss: $\Delta P = 0.03998771 \text{ bar}$, $\Delta H = 0.4085 \text{ m of fluid}$

Complementary results table:

Designation	Symbol	Value	Unit
Pipe cross-section area	A	0.001963496	m ²
Reynolds number	Re	126892.9	
Fully open flow coefficient Kvs	Kvs	99	
Flow coefficient Kv	Kv	89.99051	
Coefficient of local resistance	K _{turb}	1.235538	
Pressure loss coefficient (based on the mean valve velocity)	K	1.235538	
Pressure loss	ΔP	0.03998771	bar
Hydraulic power loss	Wh	19.99385	W

References:

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