Control Valve Cv and Kv for Steam (IEC 60534)

Flow coefficient Kv and Cv of a control valve or pressure reducing valve on steam by IEC 60534-2-1, with the expansion factor and the choked-flow check.

Method: IEC 60534-2-1:2011 (compressible fluids); ANSI/ISA-75.01.01; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Steam flow	10,000	kg/h
Upstream pressure (absolute)	10.500	bar
Downstream pressure (absolute)	4.0000	bar
Steam condition at the inlet	Dry saturated	
Steam temperature (superheated only)	250.00	°C
Specific heat ratio of steam 1.3 for superheated steam; 1.135 for dry saturated steam.	1.1350	
Pressure differential ratio factor of the valve From the valve maker; about 0.7 for single-seat globe valves, 0.2–0.5 for ball and butterfly valves.	0.72000	

Calculated results

Parameter	Value	Unit
Flow coefficient Kv	82.582	
Flow coefficient Cv	95.590	
Pressure drop ratio Δp/p₁	0.61905	
Choked limit of the ratio	0.58371	
Expansion factor	0.66667	
Steam density at the inlet	5.3907	kg/m³
Choked (1 = yes)	1.0000	

Notes for this case

- The flow is choked: the pressure drop ratio exceeds F_γ·x_T, the coefficient is sized on the limit, and noise will be high; consider a low-noise trim or two stages.

Formula and method

$$x = \frac{p_1 - p_2}{p_1} \qquad F_\gamma = \frac{\gamma}{1.4} \qquad x_s = \min(x,\ F_\gamma x_T) \qquad Y = 1 - \frac{x_s}{3\,F_\gamma\,x_T}$$

$$K_v = \frac{W}{31.6\,Y\sqrt{x_s\,p_1\,\rho_1}} \qquad C_v = \frac{W}{27.3\,Y\sqrt{x_s\,p_1\,\rho_1}} \qquad (W \text{ in kg/h},\ p_1 \text{ in bar},\ \rho_1 \text{ in kg/m}^3)$$

Variables

W	steam flow	kg/s
p_1	upstream pressure, absolute	Pa
p_2	downstream pressure, absolute	Pa
state	dry saturated or superheated steam	–
T_s	steam temperature (superheated)	K
γ	specific heat ratio of steam	–

x_T	pressure differential ratio factor of the valve	–
K_v	flow coefficient Kv	–
C_v	flow coefficient Cv	–
x	pressure drop ratio	–
$F_\gamma x_T$	choked limit of the ratio	–
Y	expansion factor	–
ρ_1	steam density at the inlet	kg/m³
choked	1 when the flow is choked	–
x_s	ratio used for sizing	–

Method and standards

IEC 60534-2-1:2011 for compressible fluids without attached fittings, with the numerical constants N_6 of its Table 1 (31.6 for Kv and 27.3 for Cv with kg/h, bar and kg/m³). Steam density from FireCAD's IAPWS-IF97.

Assumptions and limits

- No reducers on the valve (F_P = 1).
- x_T from the maker at the operating opening.
- γ is your entry and is not checked against the steam state: about 1.3 for superheated and 1.135 for dry saturated steam.
- Noise and outlet velocity are not checked; choked steam valves usually need low-noise trim.

References

• IEC 60534-2-1:2011 (compressible fluids)
• ANSI/ISA-75.01.01
• IAPWS R7-97(2012) IF97

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/instrumentation/control-valves/control-valve-cv-steam

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Reopens the calculator with the inputs of this report.