

Flow Calculation for Gases

The coefficient of flow (Cv) is a formula which is used to determine a valve's flows under various conditions and to select the correct valve for a flow application. The Cv was designed for use with liquid flows, it expresses the flow in gallons per minute of 60° F water with a pressure drop across the valve of 1 psi. However, this same Cv value can be used to determine gas flows through a valve. The formula becomes more intricate for gases, as gases are a compressible fluids and are thus affected by temperature. Furthermore, two formulas are required to accurately estimate flow. When the upstream pressure equals or exceeds two times the downstream pressure, it is known as a "choked flow" situation. This calls for use of the Critical flow formula. If the upstream pressure is less than two times the downstream pressure, the Sub-Critical flow formula should be used.

Critical Flow When: $P_1 \geq 2 \times P_2$	Sub - Critical Flow When: $P_1 < 2 \times P_2$
$C_v = Q_G \frac{\sqrt{S.G. \times T}}{816 \times P_1}$	$C_v = \frac{Q_G}{962} \sqrt{\frac{(S.G. \times T)}{(P_1^2 - P_2^2)}}$
$Q_G = C_v \frac{816 \times P_1}{\sqrt{S.G. \times T}}$	$Q_G = 962 \times C_v \sqrt{\frac{(P_1^2 - P_2^2)}{(S.G. \times T)}}$

where:

Q_G = Gas Flow in Standard Cubic Feet per Hour P_1 = Upstream (inlet) pressure in psia
 T = Absolute temperature in °R. ($^{\circ}F + 460$) P_2 = Downstream (outlet) pressure in psia
 psia = Absolute pressure. This is psig (gage pressure) plus 14.7 (atmospheric pressure)
 S.G. = Specific Gravity of medium where air at 70° F and 14.7 psia = 1.0

Example:

Determine which orifice size should be used for the following application. Upstream pressure is 100 psig, downstream to atmosphere. The medium is 70° F methane gas (S.G.=.554) and the desired flow range is up to 600 SCFH.

$$C_v = 600 \times \frac{\sqrt{.554 \times 530}}{816 \times 114.7} = .1098$$

The Cv value at which 600 SCFH of methane will flow under the above conditions is .1098. Upon examination of our Cv table (on previous page), you can see that this value is reached at approximately turn 9.3 with our -3- (.094) orifice and at turn 5.8 with our -4- (.125) orifice. The end user can choose between approximately 5.8 or 9.3 turns of metering precision for this application.

Specific Gravities of gases	
Gas	S.G.
Acetylene	0.907
Air	1.000
Ammonia	0.588
Argon	1.379
Carbon Dioxide	1.529
Carbon Monoxide	0.965
Helium	0.138
Hydrogen	0.070
Hydrogen Chloride	1.268
Methane	0.554
Methyl Chloride	1.736
Nitrogen	0.967
Nitrous Oxide	1.517
Oxygen	1.105
Sulfur Dioxide	2.264

