THE IDEAL WAY

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Flow Calculations for Liquids

The coefficient of flow (Cv) is a formula which is used to determine a valve's flows under various conditions and is thus useful for selecting the correct valve for a flow application. For liquids, Cv expresses the flow in gallons per minute of 60º F water with a pressure drop across the valve of 1 psi. Because gases are compressible fluids, the formula is altered to accomodate changes in density. Please refer to the following page for a Cv formula for gases. Valve specifications list a single Cv value for each valve model which represents the Cv value at full open. Ideal Aerosmith also created flow charts which display the Cv value at 15 different turns allowing for calculating flows for varying conditions at any of these points. The following is the Cv formula for liquids.

$$Cv = Q \bigg/ \sqrt{\frac{\Delta P}{S.G.}}$$

$$Q = Cv \times \sqrt{\frac{\Delta P}{S.G.}}$$

Where:
Q = Liquid flow in Gallons per Minute
ΔP = Pressure Drop. P_1 - P_2 in psi
P_1 = Upstream (inlet) pressure in psia
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 water at 60º F = 1.0

Example:
Determine which orifice size should be used for the following application. Upstream pressure is 100 psia, downstream is 60 psia. The medium is acetone (S.G.=.79) and the desired flow range is between .1 and .5 gpm.

$$Cv_{Low} = .1 \bigg/ \sqrt{\frac{40}{.79}} \qquad Cv_{High} = .5 \bigg/ \sqrt{\frac{40}{.79}}$$

$$Cv_{Low} = .0141 \qquad Cv_{High} = .0703$$

The required Cv range for this application than is .0141 to .0703. If you'll examine the Cv flow charts, you will see that the Ideal Aerosmith -2- (.0625) orifice best fits this application. The Cv value of .0141 is reached at approximately turn 2.3, while the Cv value of .0703 is reached at approximately turn 14.6. The Ideal -2- orifice will meter the desired flows between turns 2.3 and 14.6, thus offering 12.3 turns of metering precision. The optional vernier micrometer handle displays the number of turns open accurate to 1/10 turn, thus giving the user in this application 123 visual reference points.

Flow Characteristics of orifice sizes -1- (.031); -2- (.062); -3- (.094); -4- (.125)

No. Turns Open	Cv			
	-1-	-2-	-3-	-4-
1	-	0.0053	0.0176	0.0236
2	0.0007	0.0120	0.0353	0.0443
3	0.0017	0.0184	0.0509	0.0635
4	0.0027	0.0245	0.0644	0.0814
5	0.0037	0.0303	0.0762	0.0980
6	0.0047	0.0358	0.0863	0.1133
7	0.0057	0.0410	0.0948	0.1273
8	0.0067	0.0458	0.1021	0.1402
9	0.0077	0.0504	0.1081	0.1520
10	0.0087	0.0546	0.1130	0.1628
12	0.0107	0.0623	0.1204	0.1812
14	0.0127	0.0688	0.1254	0.1960
16	0.0148	0.0742	0.1292	0.2075
18	0.0169	0.0786	0.1331	0.2162
20	0.0190	0.0818	0.1383	0.2224

Specific Gravities of various liquids

Liquid	S.G.	Liquid	S.G.
Acetic Acid	1.050	Glycerine	1.260
Acetone	0.790	Glycol	1.125
Acetaldehyde	0.782	Isopropyl Alcohol	0.780
Alcohol, Ethyl	0.790	Kersosene	0.820
Alcohol, Methyl	0.800	Mercury	13.620
Aniline	1.020	Nitric Acid	1.502
Benzol	0.878	Oil, Crude	.81 to .97
Carbolic Acid	1.081	Oil, Vegetable	0.925
Ether	0.741	Sulfuric Acid	1.831
Formic Acid	1.229	Turpentine	0.870
Gasoline	0.750	Water	1.000

The Cv table is shown in a graph form on the following page.

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 60º 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: $P_1 < 2 \times P_2$
$Cv = Q_G \dfrac{\sqrt{S.G. \times T}}{816 \times P_1}$	$Cv = \dfrac{Q_G}{962} \sqrt{\dfrac{(S.G. \times T)}{(P_1^2 - P_2^2)}}$
$Q_G = Cv \dfrac{816 \times P_1}{\sqrt{S.G. \times T}}$	$Q_G = 962 \times Cv \sqrt{\dfrac{(P_1^2 - P_2^2)}{(S.G. \times T)}}$

where:

Q_G = Gas Flow in Standard Cubic Feet per Hour

T = Absolute temperature in ºR. (ºF + 460)

P_1 = Upstream (inlet) pressure in psia

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 70º F and 14.7 psia = 1.0

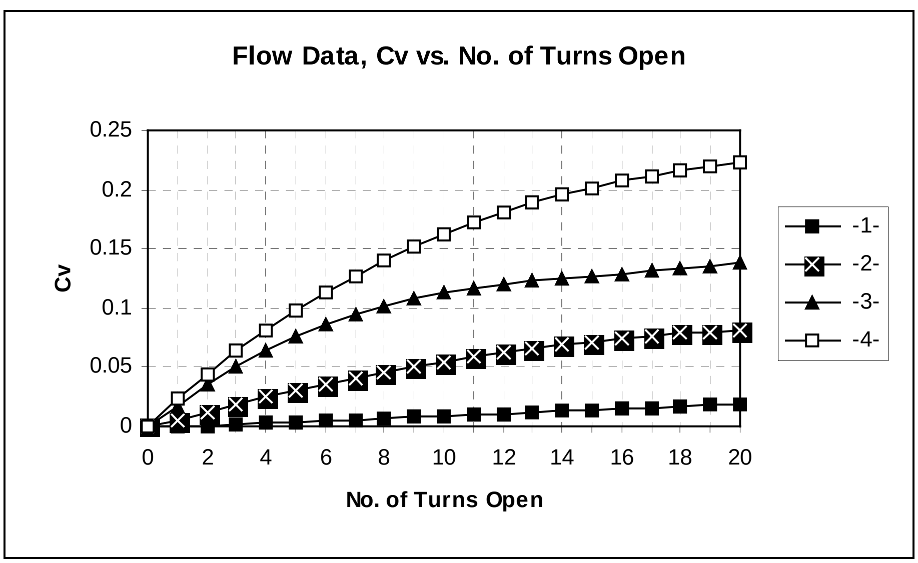
Example:

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

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

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



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