Restrictive Flow Orifices

The Restrictive Flow Orifice (RFO) is for use in conjunction with high purity compressed gas applications in both the semiconductor and allied chemical industries. Matheson Tri-Gas pioneered the development of RFO technology.

Restrictive Flow Orifices are used to limit the potential danger of an uncontrolled flow from a compressed gas cylinder. Unchecked, the instantaneous flow from a 44 liter compressed gas cylinder filled to 2,000 psig can be as much as 20,000 liters per minute. By inserting an RFO into the outlet of the CGA connection the flow rate could be reduced by a factor of 100 to approximately 200 liters per minute.

The Restrictive Flow Orifice is designed to thread into the outlet of most CGA connections that have external male threads. This would include the family of DISS face seal connections (CGA 630 and 710) that are used in high purity semiconductor applications.

The RFO has no moving parts. It is about 3/8" long and is generally constructed of 316LSS. The orifice opening usually varies from 0.006" to 0.060". It is possible to have orifices that are as small as 0.004" and as large as 0.150" depending upon the application.

The orifice is generally unfiltered. A KEL-F gasket is provided as part of the assembly to help create a seal between the restrictor and the valve body. Refer to Figure 1.

The flow rate through an orifice is a function of the following variables:

- **Pressure**
- **Temperature**
- **Specific Gravity**
- **Orifice Opening**

Correlations assist in predicting the flow of a particular gas or mixture through an RFO. This is done by first determining the flow through the same RFO at the required pressure with a reference gas and then adjusting the specific gravity accordingly.

The pertinent equation is presented below.

$$\text{Flow} = \text{The Flow Rate of } N_2 \text{ at the Same Pressure} \sqrt{\frac{1}{\text{Specific Gravity}}}$$

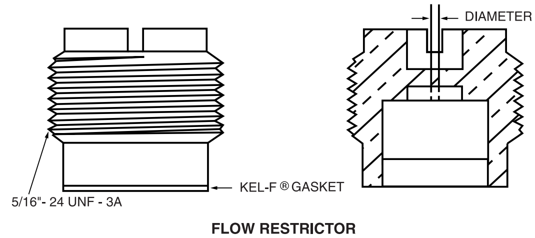

Figure 1: Restrictive Flow Orifice

Typical nitrogen flows for different orifice signs at different pressures can be found in Table I.

By using this table, a reference flow rate for nitrogen can be determined and then the reference equation can be used with this value.

For a mixture a "weighted" or "averaged" specific gravity can be used by multiplying the volume or mole fraction of each component by its specific gravity and then summing.

Table II summarizes some of the gases that can be offered with restrictive flow orifices.

In addition to providing safety features that have been mandated by various local and state codes, the restrictive flow orifice also results in a lower flow rate, which is desirable in many semiconductor applications. While the RFO was not designed to be a modulator or control valve, it will as its name implies, substantially reduce the flow rate under a specific set of pressure and temperature conditions for a given gas.

More detailed information on restrictive flow orifices is available from your local Matheson Tri-Gas Sales Engineer.

TABLE I Orifice Flow Rate at Varying Pressures

Orifice	Pressure-PSIG			
Size	0	500	1000	2000
0.006 in.	0 slpm	7 slpm	15 slpm	29 slpm
0.010 in.	0 slpm	l8 slpm	36 slpm	73 slpm
0.031 in.	0 slpm	150 slpm	310 slpm	—
0.040 in.	0 slpm	245 slpm	485 slpm	—
0.052 in.	0 slpm	535 slpm	—	

TABLE II Gases offered with Restrictive Flow Orifices Specific Gravity @ 70º (1 atm), CGA and DISS Connections

Gas	Specific Gravity	CGA STD	DISS	Gas	Specific Gravity	CGA STD	DISS	Gas	Specific Gravity	CGA STD	DISS
Ammonia	0.593	660	720	Halocarbon 116	4.820	660	716	Nitrogen Trifluoride	2.460	670	640
Argon	1.376	-	718	Halocarbon 12	4.262	660	716	Nitrous Oxide	1.528	326	-
Arsenic Pentafluoride	6.090	-	642	Halocarbon 13	3.610	660	716	Oxygen	1.105	540	714
Arsine	2.718	-	632	Halocarbon 14	3.075	-	716	Perfluoropropane	6.652	660	716
Boron Trichloride	4.045	660	634	Halocarbon 23	2.436	660	716	Phosphine	1.190	350	632
Boron Trifluoride	2.375	330	642	Helium	0.138	-	718	Phosphorus Pentafluoride	4.310	330	642
Carbon Dioxide	1.527	320	716	Hydrogen	0.070	350	724	Silane	1.120	350	632
Carbon Monoxide	0.967	350	724	Hydrogen Bromide	2.780	330	634	Silicon Tetrachloride	5.833	-	636
Chlorine	2.479	660	728	Hydrogen Chloride	1.266	330	634	Silicon Tetrafluoride	3.615	330	642
Diborane	0.950	350	632	Hydrogen Fluoride	0.689	670	638	Sulfur Hexafluoride	5.105	-	716
Dichlorosilane	3.473	678	638	Hydrogen Selenide	2.771	350	632	Trichlorosilane	4.666	-	636
Disilane	2.149	-	632	Hydrogen Sulfide	1.192	330	722	Tungsten Hexafluoride	10.674	670	638
Germane	2.634	350	632	Krypton	2.900	-	718	Xenon	4.558	-	716
Halocarbon 11	4.770	660	-	Neon	0.696	-	718				
Halocarbon 115	5.568	660	716	Nitrogen	0.967	-	718				