


# Calculating Gas Flow
## Through Orifices

A TECHNICAL GUIDE

O'Keefe Controls Co.

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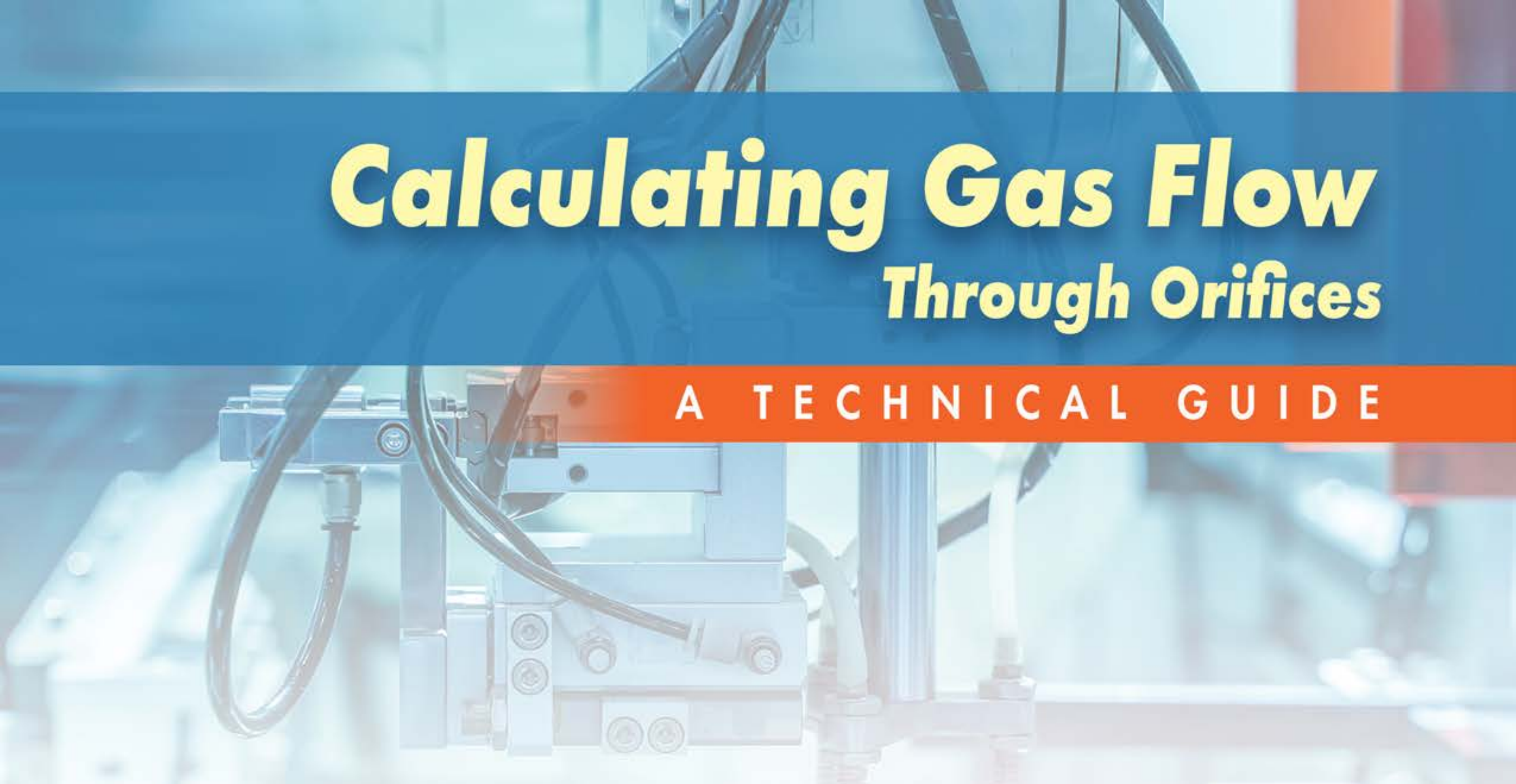

# Calculating Gas Flow Through Orifices

## A TECHNICAL GUIDE

With the broad array of applications for industrial gases, controlling gas flow is a subject of vital importance. To achieve the extremely accurate, repeatable results necessary to successful operation, ***precision*** is required in gas flow. It is crucial to understand the science behind gas flow — the various factors that are involved in achieving precise control — and to be able to use that information to determine the correct orifice size that will create the desired results.

There are several technical factors which must be considered when calculating flow through orifices, including pressure, temperature, type of gas, and others. To help simplify the selection process, precision orifice manufacturers often provide flow charts within a common range to help engineers specify the correct orifice size for their application. However, not all applications fall within the data set included on the charts.

In addition to providing such charts, our Technical Guide details a number of formulas which can be used to extend orifice flow data beyond the charts, when specific factors of the application require it. These include high or low pressure, temperature, and more. Examples are shown for each, making this a valuable resource for engineers and system designers. If further help is needed regarding a specific application, the engineers at O'Keefe Controls Co. are readily available.

# PRESSURE

## High Pressure Extrapolation

**To calculate flow rates at pressures higher than those on the attached charts, use the following formula:**

$$Q_{HP} = Q_{80} \times \frac{P_{HP} + 14.7}{94.7}$$

$Q_{HP}$ = Flow at elevated pressure (above 80 psig)

$Q_{80}$ = Chart flow reading at 80 psig

$P_{HP}$ = Elevated pressure in psig

**Example:**

To calculate the flow for the No. 16 metal orifice at 150 psig supply pressure:

$$Q_{HP} = 17.9 \times \frac{150 + 14.7}{94.7} = 31.13 \text{ SCFH}$$

(from chart)

## Low Pressure Extrapolation

**To calculate flow rates at pressures lower than those on the charts, use the following formula:**

$$Q_{LP} = Q_5 \sqrt{\frac{P_{LP}^2 + 29.4\, P_{LP}}{13.12}}$$

$Q_{LP}$ = Flow at the low pressure (below 5 psig.)

$Q_5$ = Chart flow reading at 5 psig.

$P_{LP}$ = Low pressure in psig.

**Example:**

To calculate the flow at a supply pressure of 0.5 psig. for the No. 16 metal orifice:

$$Q_{LP} = 3.26 \frac{\sqrt{0.5^2 + 29.4(.5)}}{13.12} = 0.96 \text{ SCFH}$$

(from chart)

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## TEMPERATURE EFFECTS

*The flow of gases through an orifice varies inversely as the absolute temperature. As the gas temperature rises and the gas density decreases, the mass flow rate also decreases.*

**To extend the chart data on the attached pages for air flow, use the following formula:**

$$Q_T = Q_S\sqrt{\frac{T_S}{T_T}}$$

Where:

$T_S$ = standard absolute temperature °R (°R = 460 + °F).

$T_T$ = non standard absolute temperature °R.

$Q_S$ = flow from chart at 70°F = 530°R.

$Q_T$ = flow at a different temperature.

**Example:**

At 70°F and an inlet pressure of 25 psig the No. 60 (.060" dia.) orifice has a flow rate of 52.8 SLPM (see chart, page 8).

Under similar conditions, the air flow rate at 300°F is:

$$Q_T = 52.8\sqrt{\frac{530}{760}} = 44.09 \text{ SLPM}$$

(from chart) ↑ 52.8

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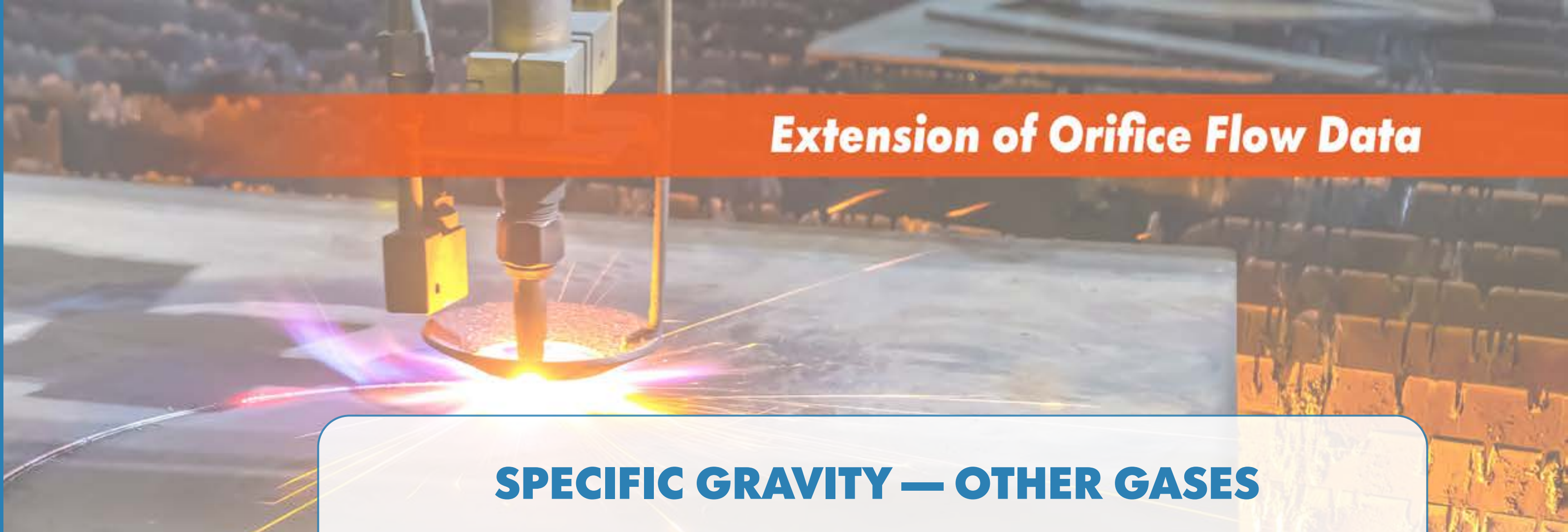

## SPECIFIC GRAVITY — OTHER GASES

*Specific gravity is used to correct for the differences in density between the gas being measured and the standard reference gas used in the flow rate calculation. Our flow charts are based on air at **70° F** and **14.7 psia.** To obtain the flow of gases other than air, multiply the air flow values on the charts by the chart multiplier below.*

**To convert air flow from the attached chart to another gas flow, use the following formula:**

$$\text{Flow (gas)} = \text{Flow (air)} / \sqrt{\text{S.G. (gas)}}$$

Where:

S.G. = specific gravity of gas relative to air

**Example:**

To obtain flow rate for helium when air flow is 5 SCFH:

S.G. = .138 for Helium

$$\text{Flow (Helium)} = \text{Flow (air)} / \sqrt{.138} = 5 / .371 = 13.48 \text{ SCFH}$$

| Gas | Specific Gravity | Chart Multiplier |
|---|---|---|
| Air | 1.0 | 1.0 |
| Argon | 1.379 | .852 |
| Carbon Dioxide | 1.53 | .809 |
| Helium | .138 | 2.68 |
| Hydrogen | .0696 | 3.79 |
| Methane | .554 | 1.34 |
| Natural Gas | .61 | 1.28 |
| Nitrogen | .972 | 1.01 |
| Oxygen | 1.1053 | .95 |
| Propane | 1.56 | .80 |

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## OTHER ORIFICE SIZES (not on charts)

**To calculate the required diameter of an orifice not included in the charts on pages 7-9 use the following formula:**

The equations are based on data taken for a no. 60 (.060" dia.) orifice.

$$d_L = .060 \sqrt{\frac{Q_L}{Q_{60}}} \text{ in. dia.}$$

Where:
$d_L$ = diameter of the unknown orifice.
$Q_L$ = flow through the unknown orifice.
$Q_{60}$ = flow from chart on pages 7-9.

**Example:** (Data from page 8) At supply pressure of 50 psig and outlet at standard conditions:

$Q_{60}$ = 87.4 SLPM (from chart)
Let:
$Q_L$ = 600 SLPM @ 50 psig

$$d_L = .060 \sqrt{\frac{600}{87.4}} = .157 \text{ in. dia.}$$

## CONVERSIONS

### Flow Conversions

**SCFH** - standard cu. ft. per hour
**SLPM** - standard liters per min.
**SCCM** - standard cu. cm. per min.

SCFH x **.472** = SLPM
SCFH x **472** = SCCM
SLPM x **1000** = SCCM

**Example:**
5 SCFH x .472 = 2.36 SLPM

### Pressure Conversions

**PSIG** - pounds per sq. in. gage
**Kg/CM²** - kilograms per sq. cm
**KPA** - kilo pascals
**Bar** - unit of pressure equal to 1 atmospheric pressure at sea level
**In-$H_2O$** - pressure produced by 1" $H_2O$

PSIG x **.0703** = $Kg/CM^2$
PSIG x **6.895** = KPA
PSIG x **.0689** = Bars
PSIG x **27.68** = In. $H_2O$

**Example:**
25 psig x 6.895 = 172.37 KPA

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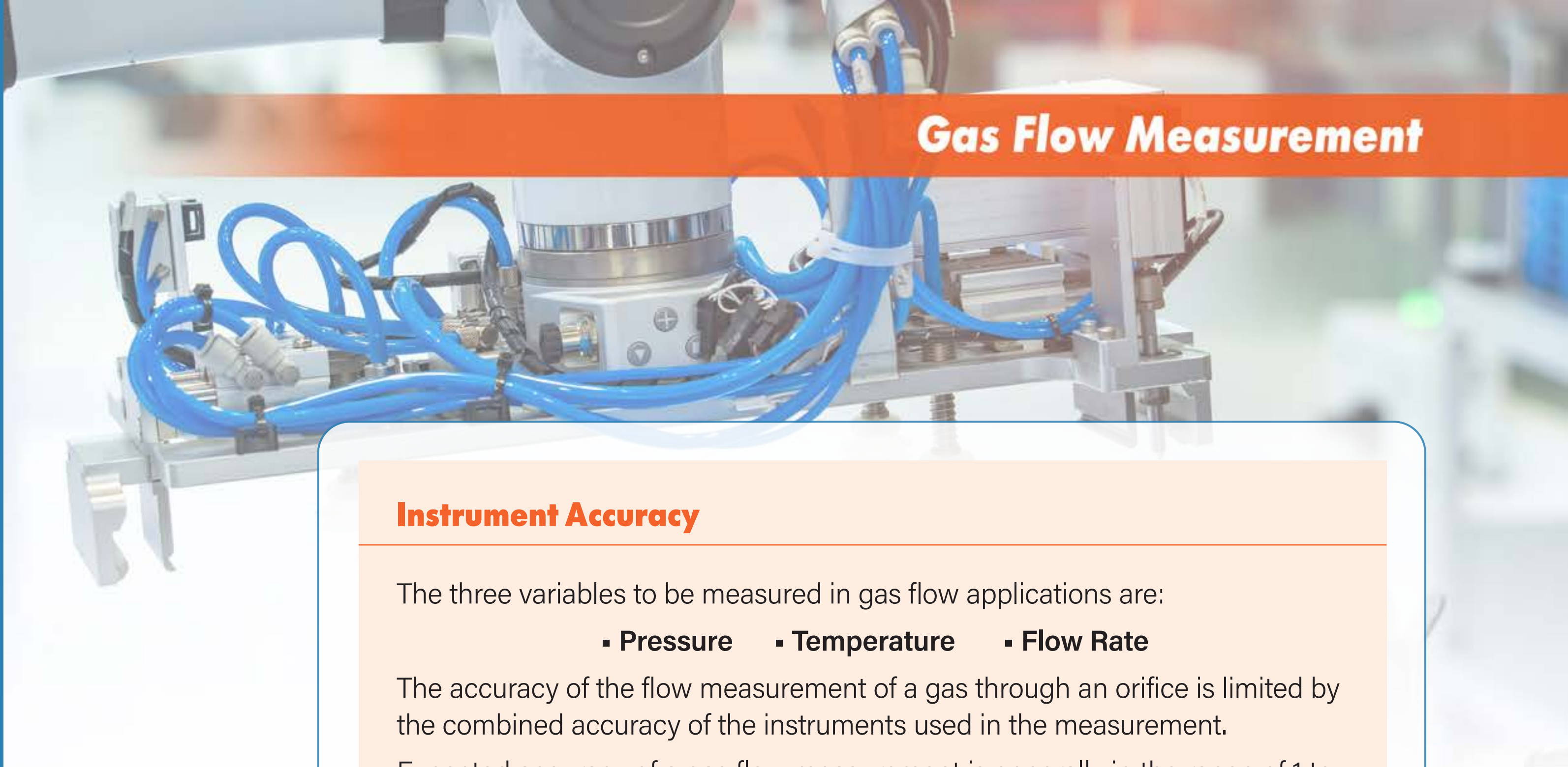




## Instrument Accuracy

The three variables to be measured in gas flow applications are:

- **Pressure**
- **Temperature**
- **Flow Rate**

The accuracy of the flow measurement of a gas through an orifice is limited by the combined accuracy of the instruments used in the measurement.

Expected accuracy of a gas flow measurement is generally in the range of 1 to 20%. 1% accuracy can only be achieved with high quality instruments.

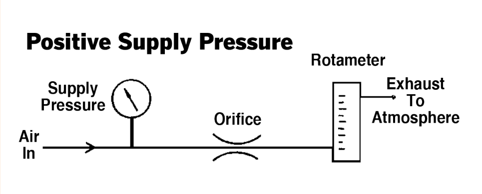
## Rotameters

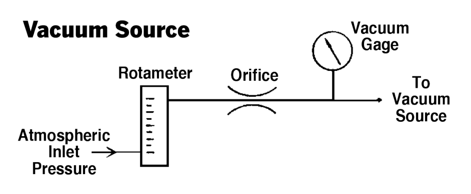
Rotameters for measurement of air or other gas flows must be used for the conditions for which they are calibrated. Typically they are calibrated for the following:

- **Air Flow**
- **Outlet Conditions – 14.7 psig @ 70°F**

Rotameters can be calibrated for other gas flows or other outlet pressure conditions. Manufacturers also provide graphs or tables for correction of measured data when conditions vary from the calibration conditions.

When using rotameters calibrated for standard outlet conditions use the test procedures shown below.




## Mass Flow Meters

Mass flow meters are generally insensitive to gas pressure or barometric pressure conditions. Consequently their location in the test circuit is not critical. Consult your instrument manufacturer for recommended test procedures.

# Metal Orifice Air Flow – SCFH

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| | Orifice Diameter Inches | 0.004 | 0.005 | 0.006 | 0.007 | 0.008 | 0.009 | 0.010 | 0.011 | 0.012 | 0.013 | 0.014 | 0.015 | 0.016 | 0.017 | 0.018 | 0.019 | 0.020 | 0.021 | 0.022 | 0.023 | 0.024 | 0.025 | 0.026 | 0.027 | 0.028 | 0.029 | 0.031 | 0.032 | 0.033 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Size Number** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** | **25** | **26** | **27** | **28** | **29** | **31** | **32** | **33** |
| | $C_v$ | 0.00035 | 0.00061 | 0.00086 | 0.0012 | 0.0015 | 0.0019 | 0.0025 | 0.0028 | 0.0034 | 0.0038 | 0.0043 | 0.0050 | 0.0055 | 0.0067 | 0.0073 | 0.0080 | 0.0088 | 0.0096 | 0.011 | 0.012 | 0.013 | 0.014 | 0.016 | 0.017 | 0.018 | 0.019 | 0.022 | 0.024 | 0.025 |
| Supply Pressure – psig | 1 | 0.075 | 0.136 | 0.182 | 0.269 | 0.360 | 0.479 | 0.593 | 0.653 | 0.843 | 0.962 | 1.11 | 1.30 | 1.40 | 1.64 | 1.82 | 2.03 | 2.22 | 2.39 | 2.73 | 2.99 | 3.26 | 3.54 | 4.05 | 4.13 | 4.68 | 5.06 | 5.62 | 6.10 | 6.42 |
| | 5 | 0.18 | 0.33 | 0.45 | 0.64 | 0.85 | 1.10 | 1.37 | 1.51 | 1.94 | 2.25 | 2.56 | 2.99 | 3.26 | 3.73 | 4.20 | 4.70 | 5.23 | 5.62 | 6.29 | 6.87 | 7.48 | 8.12 | 9.20 | 9.41 | 10.5 | 11.3 | 12.4 | 13.6 | 14.4 |
| | 10 | 0.25 | 0.47 | 0.65 | 0.91 | 1.21 | 1.57 | 1.97 | 2.14 | 2.73 | 3.14 | 3.56 | 4.13 | 4.26 | 4.79 | 5.38 | 6.00 | 6.70 | 7.48 | 9.17 | 10.1 | 11.0 | 11.8 | 13.0 | 13.6 | 15.2 | 16.6 | 18.3 | 19.9 | 21.1 |
| | 15 | 0.34 | 0.59 | 0.82 | 1.14 | 1.53 | 1.97 | 2.48 | 2.67 | 3.43 | 3.92 | 4.45 | 5.17 | 5.30 | 6.04 | 6.84 | 7.56 | 8.50 | 9.34 | 11.3 | 12.6 | 13.6 | 14.7 | 16.1 | 16.8 | 18.6 | 20.3 | 22.5 | 24.6 | 26.1 |
| | 20 | 0.40 | 0.70 | 0.97 | 1.38 | 1.80 | 2.33 | 2.92 | 3.16 | 4.07 | 4.64 | 5.28 | 6.08 | 6.29 | 7.20 | 8.18 | 9.03 | 10.3 | 11.1 | 13.5 | 14.7 | 16.1 | 17.3 | 18.9 | 19.7 | 21.8 | 23.7 | 26.3 | 28.6 | 30.3 |
| | 25 | 0.47 | 0.82 | 1.12 | 1.59 | 2.08 | 2.69 | 3.37 | 3.62 | 4.66 | 5.30 | 6.06 | 6.95 | 7.25 | 8.31 | 9.43 | 10.4 | 11.8 | 12.7 | 15.5 | 16.8 | 18.3 | 19.9 | 21.6 | 22.7 | 24.8 | 27.1 | 30.1 | 32.6 | 34.5 |
| | 30 | 0.53 | 0.92 | 1.26 | 1.80 | 2.37 | 3.03 | 3.81 | 4.09 | 5.23 | 5.98 | 6.80 | 7.82 | 8.20 | 9.39 | 10.7 | 11.8 | 13.4 | 14.4 | 17.4 | 19.0 | 20.7 | 22.5 | 24.4 | 25.4 | 28.0 | 30.5 | 33.7 | 36.7 | 39.0 |
| | 40 | 0.64 | 1.15 | 1.56 | 2.22 | 2.92 | 3.75 | 4.68 | 5.02 | 6.44 | 7.31 | 8.33 | 9.56 | 10.1 | 11.6 | 13.2 | 14.5 | 16.5 | 17.8 | 21.4 | 23.3 | 25.4 | 27.5 | 29.9 | 31.1 | 34.1 | 37.1 | 41.1 | 44.7 | 47.7 |
| | 50 | 0.76 | 1.37 | 1.86 | 2.67 | 3.50 | 4.45 | 5.55 | 5.93 | 7.59 | 8.62 | 9.83 | 11.3 | 12.1 | 13.8 | 15.7 | 17.3 | 19.6 | 21.2 | 25.2 | 27.5 | 30.1 | 32.6 | 35.2 | 36.7 | 40.3 | 43.9 | 48.5 | 53.0 | 56.4 |
| | 60 | 0.89 | 1.59 | 2.16 | 3.09 | 4.05 | 5.13 | 6.40 | 6.84 | 8.75 | 10.0 | 11.3 | 13.0 | 14.0 | 16.0 | 18.2 | 20.0 | 22.7 | 24.6 | 29.2 | 31.8 | 34.7 | 37.5 | 40.7 | 42.4 | 46.4 | 50.4 | 55.9 | 61.0 | 65.0 |
| | 70 | 1.02 | 1.82 | 2.46 | 3.54 | 4.60 | 5.83 | 7.27 | 7.76 | 9.92 | 11.3 | 12.8 | 14.7 | 16.0 | 18.2 | 20.7 | 22.9 | 25.9 | 28.0 | 33.1 | 36.0 | 39.2 | 42.6 | 46.0 | 48.1 | 52.5 | 57.2 | 63.6 | 69.3 | 73.9 |
| | 80 | 1.14 | 2.04 | 2.75 | 3.96 | 5.15 | 6.53 | 8.12 | 8.67 | 11.1 | 12.6 | 14.3 | 16.5 | 17.9 | 20.5 | 23.3 | 25.6 | 29.0 | 31.6 | 37.1 | 40.3 | 43.9 | 47.7 | 51.3 | 53.6 | 58.7 | 64.0 | 71.2 | 77.8 | 82.6 |
| | 90 | 1.27 | 2.27 | 3.05 | 4.41 | 5.70 | 7.20 | 8.96 | 9.56 | 12.2 | 13.9 | 15.9 | 18.3 | 19.9 | 22.7 | 25.9 | 28.4 | 32.2 | 35.0 | 40.9 | 44.5 | 48.5 | 52.8 | 56.8 | 59.3 | 65.0 | 71.0 | 78.8 | 86.0 | 91.5 |
| | 100 | 1.40 | 2.48 | 3.35 | 4.83 | 6.25 | 7.88 | 9.81 | 10.5 | 13.4 | 15.3 | 17.4 | 20.0 | 21.8 | 25.0 | 28.4 | 31.1 | 35.2 | 38.1 | 44.7 | 48.7 | 53.2 | 58.1 | 62.3 | 65.3 | 71.4 | 78.0 | 86.7 | 94.5 | 101 |
| Vacuum Level In. Hg. | 5 | 0.113 | 0.203 | 0.273 | 0.405 | 0.536 | 0.703 | 0.860 | 0.953 | 1.23 | 1.40 | 1.64 | 1.90 | 2.07 | 2.41 | 2.70 | 2.99 | 3.28 | 3.60 | 4.03 | 4.45 | 4.87 | 5.25 | 5.81 | 6.00 | 6.70 | 7.23 | 8.01 | 8.73 | 9.15 |
| | 10 | 0.145 | 0.263 | 0.356 | 0.521 | 0.687 | 0.892 | 1.10 | 1.20 | 1.55 | 1.77 | 2.06 | 2.37 | 2.62 | 2.99 | 3.35 | 3.79 | 4.15 | 4.62 | 5.17 | 5.68 | 6.12 | 6.63 | 7.29 | 7.59 | 8.48 | 9.11 | 10.1 | 10.9 | 11.5 |
| Choked Flow | 15 | 0.158 | 0.284 | 0.392 | 0.568 | 0.744 | 0.964 | 1.20 | 1.30 | 1.68 | 1.91 | 2.26 | 2.59 | 2.86 | 3.28 | 3.71 | 4.11 | 4.64 | 4.92 | 5.53 | 6.04 | 6.61 | 7.08 | 7.73 | 8.01 | 8.90 | 9.56 | 10.7 | 11.5 | 12.1 |
| | 20 | 0.158 | 0.284 | 0.392 | 0.568 | 0.744 | 0.964 | 1.20 | 1.30 | 1.68 | 1.91 | 2.26 | 2.59 | 2.86 | 3.28 | 3.71 | 4.11 | 4.64 | 4.92 | 5.53 | 6.04 | 6.61 | 7.08 | 7.73 | 8.01 | 8.90 | 9.56 | 10.7 | 11.5 | 12.1 |
| | 30 | 0.158 | 0.284 | 0.392 | 0.568 | 0.744 | 0.964 | 1.20 | 1.30 | 1.68 | 1.91 | 2.26 | 2.59 | 2.86 | 3.28 | 3.71 | 4.11 | 4.64 | 4.92 | 5.53 | 6.04 | 6.61 | 7.08 | 7.73 | 8.01 | 8.90 | 9.56 | 10.7 | 11.5 | 12.1 |

| | **Orifice Diameter Inches** | 0.035 | 0.037 | 0.038 | 0.039 | 0.040 | 0.041 | 0.042 | 0.043 | 0.047 | 0.052 | 0.055 | 0.060 | 0.063 | 0.067 | 0.070 | 0.073 | 0.076 | 0.079 | 0.081 | 0.086 | 0.089 | 0.094 | 0.096 | 0.100 | 0.104 | 0.109 | 0.113 | 0.120 | 0.125 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Size Number** | **35** | **37** | **38** | **39** | **40** | **41** | **42** | **43** | **47** | **52** | **55** | **60** | **63** | **67** | **70** | **73** | **76** | **79** | **81** | **86** | **89** | **94** | **96** | **100** | **104** | **109** | **113** | **120** | **125** |
| | Cv | 0.028 | 0.031 | 0.032 | 0.033 | 0.036 | 0.038 | 0.039 | 0.041 | 0.048 | 0.059 | 0.068 | 0.081 | 0.088 | 0.10 | 0.11 | 0.12 | 0.13 | 0.14 | 0.15 | 0.17 | 0.18 | 0.20 | 0.21 | 0.23 | 0.25 | 0.27 | 0.31 | 0.34 | 0.37 |
| Supply Pressure – psig | 1 | 7.37 | 8.12 | 8.75 | 9.45 | 9.75 | 9.90 | 10.6 | 11.4 | 13.6 | 17.0 | 19.9 | 23.7 | 25.9 | 30.1 | 33.6 | 35.9 | 39.3 | 43.0 | 46.0 | 49.7 | 53.7 | 60.2 | 63.7 | 69.8 | 75.2 | 83.9 | 91.4 | 101 | 106 |
| | 5 | 16.3 | 18.0 | 19.3 | 20.6 | 21.6 | 22.5 | 23.9 | 25.6 | 30.1 | 37.3 | 43.0 | 50.6 | 55.3 | 64.2 | 71.6 | 76.5 | 83.5 | 91.3 | 97.5 | 108 | 116 | 131 | 138 | 150 | 162 | 180 | 195 | 216 | 229 |
| | 10 | 22.5 | 25.0 | 26.5 | 28.8 | 30.5 | 31.4 | 33.1 | 35.6 | 41.0 | 51.9 | 57.4 | 68.2 | 74.6 | 86.2 | 96.6 | 103 | 112 | 121 | 131 | 144 | 153 | 172 | 181 | 196 | 216 | 237 | 250 | 286 | 314 |
| | 15 | 27.8 | 30.7 | 32.6 | 35.4 | 37.5 | 38.6 | 40.5 | 43.2 | 50.0 | 62.9 | 69.7 | 82.6 | 90.3 | 104 | 117 | 125 | 136 | 147 | 158 | 174 | 185 | 207 | 218 | 235 | 261 | 286 | 303 | 345 | 377 |
| | 20 | 32.4 | 36.0 | 38.4 | 41.5 | 44.3 | 45.3 | 47.7 | 50.9 | 58.7 | 74.2 | 82.0 | 97.3 | 106 | 123 | 138 | 146 | 160 | 172 | 185 | 203 | 216 | 242 | 256 | 275 | 305 | 335 | 354 | 403 | 445 |
| | 25 | 37.5 | 41.5 | 44.1 | 47.9 | 50.9 | 52.3 | 54.9 | 58.5 | 67.6 | 85.4 | 94.5 | 112 | 122 | 141 | 158 | 168 | 183 | 198 | 212 | 233 | 248 | 278 | 292 | 316 | 347 | 381 | 405 | 464 | 511 |
| | 30 | 42.4 | 47.0 | 50.0 | 54.2 | 57.6 | 59.3 | 62.3 | 66.3 | 76.3 | 96.6 | 107 | 126 | 138 | 160 | 179 | 190 | 206 | 222 | 239 | 265 | 280 | 314 | 331 | 356 | 392 | 432 | 458 | 525 | 578 |
| | 40 | 52.5 | 58.1 | 67.2 | 67.0 | 71.2 | 73.3 | 76.9 | 82.0 | 94.3 | 119 | 132 | 156 | 170 | 196 | 220 | 233 | 254 | 273 | 295 | 324 | 343 | 384 | 405 | 439 | 483 | 532 | 566 | 648 | 714 |
| | 50 | 62.5 | 69.1 | 73.7 | 79.7 | 85.0 | 87.5 | 91.7 | 97.5 | 112 | 142 | 157 | 185 | 202 | 233 | 261 | 278 | 301 | 324 | 347 | 384 | 407 | 456 | 481 | 523 | 576 | 634 | 672 | 771 | 850 |
| | 60 | 72.7 | 80.5 | 86.0 | 92.8 | 99 | 102 | 107 | 113 | 130 | 165 | 182 | 214 | 233 | 269 | 301 | 320 | 347 | 375 | 400 | 445 | 473 | 530 | 559 | 606 | 667 | 735 | 780 | 894 | 985 |
| | 70 | 83.1 | 91.7 | 98.1 | 106 | 113 | 117 | 122 | 129 | 148 | 187 | 207 | 244 | 267 | 307 | 343 | 362 | 394 | 428 | 458 | 509 | 538 | 604 | 638 | 693 | 763 | 839 | 892 | 1021 | 1125 |
| | 80 | 93 | 103 | 110 | 119 | 127 | 131 | 137 | 145 | 167 | 210 | 231 | 273 | 298 | 343 | 384 | 405 | 443 | 481 | 513 | 570 | 604 | 678 | 716 | 778 | 856 | 943 | 1000 | 1146 | 1263 |
| | 90 | 106 | 115 | 122 | 132 | 141 | 146 | 151 | 161 | 185 | 231 | 256 | 303 | 331 | 379 | 424 | 447 | 489 | 532 | 568 | 631 | 670 | 750 | 792 | 860 | 947 | 1042 | 1106 | 1267 | 1398 |
| | 100 | 114 | 126 | 135 | 146 | 156 | 164 | 167 | 177 | 203 | 254 | 282 | 331 | 362 | 415 | 468 | 496 | 540 | 587 | 627 | 697 | 739 | 831 | 875 | 951 | 1047 | 1153 | 1225 | 1403 | 1545 |
| Vacuum Level In. Hg. | 5 | 10.4 | 11.4 | 12.3 | 13.3 | 14.3 | 14.5 | 15.4 | 16.3 | 19.2 | 23.9 | 26.4 | 31.4 | 36.2 | 42.4 | 47.7 | 50.6 | 55.1 | 60.0 | 64.0 | 70.3 | 76.1 | 84.9 | 88.6 | 96.1 | 104 | 114 | 123 | 138 | 150 |
| | 10 | 13.1 | 14.4 | 15.4 | 16.6 | 17.6 | 18.0 | 19.2 | 20.3 | 23.6 | 29.4 | 32.7 | 38.6 | 44.9 | 51.7 | 57.6 | 63.4 | 68.9 | 74.8 | 79.9 | 87.9 | 94.9 | 106 | 110 | 120 | 130 | 142 | 153 | 173 | 187 |
| Choked Flow | 15 | 13.8 | 15.2 | 16.2 | 17.4 | 18.3 | 18.8 | 20.0 | 21.1 | 24.5 | 30.5 | 33.7 | 39.4 | 46.8 | 54.0 | 60.2 | 66.1 | 71.8 | 78.0 | 83.5 | 91.7 | 99.0 | 110 | 115 | 125 | 135 | 148 | 160 | 180 | 195 |
| | 20 | 13.8 | 15.2 | 16.2 | 17.4 | 18.3 | 18.8 | 20.0 | 21.1 | 24.5 | 30.5 | 33.7 | 39.4 | 46.8 | 54.0 | 60.2 | 66.1 | 71.8 | 78.0 | 83.5 | 91.7 | 99.0 | 110 | 115 | 125 | 135 | 148 | 160 | 180 | 195 |
| | 30 | 13.8 | 15.2 | 16.2 | 17.4 | 18.3 | 18.8 | 20.0 | 21.1 | 24.5 | 30.5 | 33.7 | 39.4 | 46.8 | 54.0 | 60.2 | 66.1 | 71.8 | 78.0 | 83.5 | 91.7 | 99.0 | 110 | 115 | 125 | 135 | 148 | 160 | 180 | 195 |

Standard Conditions 70°F, 14.7 psia

SCFH – Standard Cu. Ft. Per Hour
SLPM – Standard Liters Per Minute

Above data obtained with Type B restrictor. Flow rates for other metal restrictors are essentially the same as for Type B. Above data supercedes previous publications.


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# Metal Orifice Air Flow – SLPM

O'Keefe Controls Co.

*If it's about precision, it's O'Keefe.*

| | Orifice Diameter Inches | 0.004 | 0.005 | 0.006 | 0.007 | 0.008 | 0.009 | 0.010 | 0.011 | 0.012 | 0.013 | 0.014 | 0.015 | 0.016 | 0.017 | 0.018 | 0.019 | 0.020 | 0.021 | 0.022 | 0.023 | 0.024 | 0.025 | 0.026 | 0.027 | 0.028 | 0.029 | 0.031 | 0.032 | 0.033 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Size Number** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** | **25** | **26** | **27** | **28** | **29** | **31** | **32** | **33** |
| | $C_v$ | 0.00035 | 0.00061 | 0.00086 | 0.0012 | 0.0015 | 0.0019 | 0.0025 | 0.0028 | 0.0034 | 0.0038 | 0.0043 | 0.0050 | 0.0055 | 0.0067 | 0.0073 | 0.0080 | 0.0088 | 0.0096 | 0.011 | 0.012 | 0.013 | 0.014 | 0.016 | 0.017 | 0.018 | 0.019 | 0.022 | 0.024 | 0.025 |
| Supply Pressure – psig | 1 | 0.035 | 0.064 | 0.086 | 0.127 | 0.170 | 0.226 | 0.280 | 0.308 | 0.398 | 0.45 | 0.52 | 0.61 | 0.66 | 0.77 | 0.86 | 0.96 | 1.05 | 1.13 | 1.29 | 1.41 | 1.54 | 1.67 | 1.91 | 1.95 | 2.21 | 2.39 | 2.65 | 2.88 | 3.03 |
| | 5 | 0.09 | 0.16 | 0.21 | 0.30 | 0.40 | 0.52 | 0.65 | 0.71 | 0.92 | 1.06 | 1.21 | 1.41 | 1.54 | 1.76 | 1.98 | 2.22 | 2.47 | 2.65 | 2.97 | 3.24 | 3.53 | 3.83 | 4.34 | 4.44 | 4.94 | 5.31 | 5.86 | 6.42 | 6.80 |
| | 10 | 0.12 | 0.22 | 0.31 | 0.43 | 0.57 | 0.74 | 0.93 | 1.01 | 1.29 | 1.48 | 1.68 | 1.95 | 2.01 | 2.26 | 2.54 | 2.83 | 3.16 | 3.53 | 4.33 | 4.75 | 5.18 | 5.55 | 6.15 | 6.43 | 7.18 | 7.83 | 8.63 | 9.40 | 9.98 |
| | 15 | 0.16 | 0.28 | 0.39 | 0.54 | 0.72 | 0.93 | 1.17 | 1.26 | 1.62 | 1.85 | 2.10 | 2.44 | 2.50 | 2.85 | 3.23 | 3.57 | 4.01 | 4.41 | 5.35 | 5.93 | 6.43 | 6.95 | 7.58 | 7.95 | 8.78 | 9.58 | 10.6 | 11.6 | 12.3 |
| | 20 | 0.19 | 0.33 | 0.46 | 0.65 | 0.85 | 1.10 | 1.38 | 1.49 | 1.92 | 2.19 | 2.49 | 2.87 | 2.97 | 3.40 | 3.86 | 4.26 | 4.84 | 5.22 | 6.35 | 6.95 | 7.58 | 8.15 | 8.90 | 9.28 | 10.3 | 11.2 | 12.4 | 13.5 | 14.3 |
| | 25 | 0.22 | 0.39 | 0.53 | 0.75 | 0.98 | 1.27 | 1.59 | 1.71 | 2.20 | 2.50 | 2.86 | 3.28 | 3.42 | 3.92 | 4.45 | 4.91 | 5.59 | 6.01 | 7.30 | 7.95 | 8.65 | 9.38 | 10.2 | 10.7 | 11.7 | 12.8 | 14.2 | 15.4 | 16.3 |
| | 30 | 0.25 | 0.44 | 0.60 | 0.85 | 1.12 | 1.43 | 1.80 | 1.93 | 2.47 | 2.82 | 3.21 | 3.69 | 3.87 | 4.43 | 5.03 | 5.56 | 6.33 | 6.81 | 8.23 | 8.98 | 9.75 | 10.6 | 11.5 | 12.0 | 13.2 | 14.4 | 15.9 | 17.3 | 18.4 |
| | 40 | 0.30 | 0.54 | 0.74 | 1.05 | 1.38 | 1.77 | 2.21 | 2.37 | 3.04 | 3.45 | 3.93 | 4.51 | 4.78 | 5.47 | 6.21 | 6.85 | 7.81 | 8.42 | 10.1 | 11.0 | 12.0 | 13.0 | 14.1 | 14.7 | 16.1 | 17.5 | 19.4 | 21.1 | 22.5 |
| | 50 | 0.36 | 0.65 | 0.88 | 1.26 | 1.65 | 2.10 | 2.62 | 2.80 | 3.58 | 4.07 | 4.64 | 5.31 | 5.70 | 6.51 | 7.40 | 8.15 | 9.26 | 10.0 | 11.9 | 13.0 | 14.2 | 15.4 | 16.6 | 17.3 | 19.0 | 20.7 | 22.9 | 25.0 | 26.6 |
| | 60 | 0.42 | 0.75 | 1.02 | 1.46 | 1.91 | 2.42 | 3.02 | 3.23 | 4.13 | 4.70 | 5.34 | 6.13 | 6.61 | 7.56 | 8.58 | 9.46 | 10.7 | 11.6 | 13.8 | 15.0 | 16.4 | 17.7 | 19.2 | 20.0 | 21.9 | 23.8 | 26.4 | 28.8 | 30.7 |
| | 70 | 0.48 | 0.86 | 1.16 | 1.67 | 2.17 | 2.75 | 3.43 | 3.66 | 4.68 | 5.32 | 6.05 | 6.96 | 7.53 | 8.61 | 9.77 | 10.8 | 12.2 | 13.2 | 15.6 | 17.0 | 18.5 | 20.1 | 21.7 | 22.7 | 24.8 | 27.0 | 30.0 | 32.7 | 34.9 |
| | 80 | 0.54 | 0.96 | 1.30 | 1.87 | 2.43 | 3.08 | 3.83 | 4.09 | 5.23 | 5.95 | 6.77 | 7.79 | 8.46 | 9.67 | 11.0 | 12.1 | 13.7 | 14.9 | 17.5 | 19.0 | 20.7 | 22.5 | 24.2 | 25.3 | 27.7 | 30.2 | 33.6 | 36.7 | 39.0 |
| | 90 | 0.60 | 1.07 | 1.44 | 2.08 | 2.69 | 3.40 | 4.23 | 4.51 | 5.78 | 6.58 | 7.49 | 8.62 | 9.38 | 10.7 | 12.2 | 13.4 | 15.2 | 16.5 | 19.3 | 21.0 | 22.9 | 24.9 | 26.8 | 28.0 | 30.7 | 33.5 | 37.2 | 40.6 | 43.2 |
| | 100 | 0.66 | 1.17 | 1.58 | 2.28 | 2.95 | 3.72 | 4.63 | 4.94 | 6.33 | 7.22 | 8.21 | 9.46 | 10.3 | 11.8 | 13.4 | 14.7 | 16.6 | 18.0 | 21.1 | 23.0 | 25.1 | 27.4 | 29.4 | 30.8 | 33.7 | 36.8 | 40.9 | 44.6 | 47.5 |
| Vacuum Level In. Hg. | 5 | 0.053 | 0.096 | 0.129 | 0.191 | 0.253 | 0.332 | 0.406 | 0.450 | 0.582 | 0.661 | 0.773 | 0.899 | 0.977 | 1.14 | 1.28 | 1.41 | 1.55 | 1.70 | 1.90 | 2.10 | 2.30 | 2.48 | 2.74 | 2.83 | 3.16 | 3.41 | 3.78 | 4.12 | 4.32 |
| | 10 | 0.069 | 0.124 | 0.168 | 0.246 | 0.324 | 0.421 | 0.519 | 0.564 | 0.730 | 0.834 | 0.972 | 1.12 | 1.24 | 1.41 | 1.58 | 1.79 | 1.96 | 2.18 | 2.44 | 2.68 | 2.89 | 3.13 | 3.44 | 3.58 | 4.00 | 4.30 | 4.77 | 5.16 | 5.43 |
| Choked Flow | 15 | 0.075 | 0.134 | 0.185 | 0.268 | 0.351 | 0.455 | 0.566 | 0.614 | 0.792 | 0.902 | 1.07 | 1.22 | 1.35 | 1.55 | 1.75 | 1.94 | 2.19 | 2.32 | 2.61 | 2.85 | 3.12 | 3.34 | 3.65 | 3.78 | 4.20 | 4.51 | 5.05 | 5.45 | 5.72 |
| | 20 | 0.075 | 0.134 | 0.185 | 0.268 | 0.351 | 0.455 | 0.566 | 0.614 | 0.792 | 0.902 | 1.07 | 1.22 | 1.35 | 1.55 | 1.75 | 1.94 | 2.19 | 2.32 | 2.61 | 2.85 | 3.12 | 3.34 | 3.65 | 3.78 | 4.20 | 4.51 | 5.05 | 5.45 | 5.72 |
| | 30 | 0.075 | 0.134 | 0.185 | 0.268 | 0.351 | 0.455 | 0.566 | 0.614 | 0.792 | 0.902 | 1.07 | 1.22 | 1.35 | 1.55 | 1.75 | 1.94 | 2.19 | 2.32 | 2.61 | 2.85 | 3.12 | 3.34 | 3.65 | 3.78 | 4.20 | 4.51 | 5.05 | 5.45 | 5.72 |

| | **Orifice Diameter Inches** | 0.035 | 0.037 | 0.038 | 0.039 | 0.040 | 0.041 | 0.042 | 0.043 | 0.047 | 0.052 | 0.055 | 0.060 | 0.063 | 0.067 | 0.070 | 0.073 | 0.076 | 0.079 | 0.081 | 0.086 | 0.089 | 0.094 | 0.096 | 0.100 | 0.104 | 0.109 | 0.113 | 0.120 | 0.125 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Size Number** | **35** | **37** | **38** | **39** | **40** | **41** | **42** | **43** | **47** | **52** | **55** | **60** | **63** | **67** | **70** | **73** | **76** | **79** | **81** | **86** | **89** | **94** | **96** | **100** | **104** | **109** | **113** | **120** | **125** |
| | Cv | 0.028 | 0.031 | 0.032 | 0.033 | 0.036 | 0.038 | 0.039 | 0.041 | 0.048 | 0.059 | 0.068 | 0.081 | 0.088 | 0.10 | 0.11 | 0.12 | 0.13 | 0.14 | 0.15 | 0.17 | 0.18 | 0.20 | 0.21 | 0.23 | 0.25 | 0.27 | 0.31 | 0.34 | 0.37 |
| Supply Pressure – psig | 1 | 3.48 | 3.83 | 4.13 | 4.46 | 4.60 | 4.67 | 4.99 | 5.36 | 6.43 | 8.04 | 9.40 | 11.2 | 12.2 | 14.2 | 15.9 | 16.9 | 18.5 | 20.3 | 21.7 | 23.5 | 25.4 | 28.4 | 30.1 | 32.9 | 35.5 | 39.6 | 43.1 | 47.8 | 50.1 |
| | 5 | 7.67 | 8.48 | 9.09 | 9.70 | 10.2 | 10.6 | 11.3 | 12.1 | 14.2 | 17.6 | 20.3 | 23.9 | 26.1 | 30.3 | 33.8 | 36.1 | 39.4 | 43.1 | 46.0 | 51.1 | 54.9 | 61.9 | 65.0 | 70.8 | 76.6 | 84.8 | 92.1 | 102 | 108 |
| | 10 | 10.6 | 11.8 | 12.5 | 13.6 | 14.4 | 14.8 | 15.6 | 16.8 | 19.4 | 24.5 | 27.1 | 32.2 | 35.2 | 40.7 | 45.6 | 48.5 | 52.9 | 57.3 | 61.6 | 67.9 | 72.3 | 81.0 | 85.5 | 92.3 | 102 | 112 | 118 | 135 | 148 |
| | 15 | 13.1 | 14.5 | 15.4 | 16.7 | 17.7 | 18.2 | 19.1 | 20.4 | 23.6 | 29.7 | 32.9 | 39.0 | 42.6 | 49.3 | 55.3 | 58.8 | 64.0 | 69.4 | 74.5 | 82.1 | 87.3 | 97.8 | 103 | 111 | 123 | 135 | 143 | 163 | 178 |
| | 20 | 15.3 | 17.0 | 18.1 | 19.6 | 20.9 | 21.4 | 22.5 | 24.0 | 27.7 | 35.0 | 38.7 | 45.9 | 50.1 | 58.0 | 65.0 | 69.0 | 75.3 | 81.4 | 87.3 | 95.6 | 102 | 114 | 121 | 130 | 144 | 158 | 167 | 190 | 210 |
| | 25 | 17.7 | 19.6 | 20.8 | 22.6 | 24.0 | 24.7 | 25.9 | 27.6 | 31.9 | 40.3 | 44.6 | 52.8 | 57.7 | 66.7 | 74.7 | 79.3 | 86.4 | 93.5 | 100 | 110 | 117 | 131 | 138 | 149 | 164 | 180 | 191 | 219 | 241 |
| | 30 | 20.0 | 22.2 | 23.6 | 25.6 | 27.2 | 28.0 | 29.4 | 31.3 | 36.0 | 45.6 | 50.4 | 59.7 | 65.2 | 75.4 | 84.3 | 89.5 | 97.4 | 105 | 113 | 125 | 132 | 148 | 156 | 168 | 185 | 204 | 216 | 248 | 273 |
| | 40 | 24.8 | 27.4 | 31.7 | 31.6 | 33.6 | 34.6 | 36.3 | 38.7 | 44.5 | 56.3 | 62.2 | 73.6 | 80.3 | 92.7 | 104 | 110 | 120 | 129 | 139 | 153 | 162 | 181 | 191 | 207 | 228 | 251 | 267 | 306 | 337 |
| | 50 | 29.5 | 32.6 | 34.8 | 37.6 | 40.1 | 41.3 | 43.3 | 46.0 | 52.9 | 66.9 | 74.0 | 87.4 | 95.4 | 110 | 123 | 131 | 142 | 153 | 164 | 181 | 192 | 215 | 227 | 247 | 272 | 299 | 317 | 364 | 401 |
| | 60 | 34.3 | 38.0 | 40.6 | 43.8 | 46.7 | 48.1 | 50.3 | 53.5 | 61.5 | 77.7 | 85.8 | 101 | 110 | 127 | 142 | 151 | 164 | 177 | 189 | 210 | 223 | 250 | 264 | 286 | 315 | 347 | 368 | 422 | 465 |
| | 70 | 39.2 | 43.3 | 46.3 | 50.0 | 53.3 | 55.0 | 57.4 | 61.0 | 70.0 | 88.4 | 97.6 | 115 | 126 | 145 | 162 | 171 | 186 | 202 | 216 | 240 | 254 | 285 | 301 | 327 | 360 | 396 | 421 | 482 | 531 |
| | 80 | 44.0 | 48.7 | 52.1 | 56.2 | 60.0 | 61.9 | 64.5 | 68.5 | 78.6 | 99.1 | 109 | 129 | 141 | 162 | 181 | 191 | 209 | 227 | 242 | 269 | 285 | 320 | 338 | 367 | 404 | 445 | 472 | 541 | 596 |
| | 90 | 50.0 | 54.2 | 57.8 | 62.4 | 66.7 | 68.9 | 71.5 | 76.0 | 87.2 | 109 | 121 | 143 | 156 | 179 | 200 | 211 | 231 | 251 | 268 | 298 | 316 | 354 | 374 | 406 | 447 | 492 | 522 | 598 | 660 |
| | 100 | 53.9 | 59.6 | 63.7 | 68.7 | 73.5 | 77.3 | 78.6 | 83.5 | 95.8 | 120 | 133 | 156 | 171 | 196 | 221 | 234 | 255 | 277 | 296 | 329 | 349 | 392 | 413 | 449 | 494 | 544 | 578 | 662 | 729 |
| Vacuum Level In. Hg. | 5 | 4.92 | 5.40 | 5.81 | 6.29 | 6.76 | 6.82 | 7.29 | 7.67 | 9.08 | 11.3 | 12.4 | 14.8 | 17.1 | 20.0 | 22.5 | 23.9 | 26.0 | 28.3 | 30.2 | 33.2 | 35.9 | 40.1 | 41.8 | 45.3 | 49.0 | 53.9 | 57.9 | 65.3 | 70.9 |
| | 10 | 6.18 | 6.78 | 7.29 | 7.85 | 8.31 | 8.50 | 9.08 | 9.58 | 11.1 | 13.9 | 15.4 | 18.2 | 21.2 | 24.4 | 27.2 | 29.9 | 32.5 | 35.3 | 37.7 | 41.5 | 44.8 | 50.0 | 52.1 | 56.6 | 61.2 | 67.2 | 72.2 | 81.4 | 88.4 |
| Choked Flow | 15 | 6.50 | 7.17 | 7.63 | 8.22 | 8.66 | 8.87 | 9.46 | 10.0 | 11.6 | 14.4 | 15.9 | 18.6 | 22.1 | 25.5 | 28.4 | 31.2 | 33.9 | 36.8 | 39.4 | 43.3 | 46.7 | 52.1 | 54.4 | 59.0 | 63.8 | 70.1 | 75.3 | 84.9 | 92.2 |
| | 20 | 6.50 | 7.17 | 7.63 | 8.22 | 8.66 | 8.87 | 9.46 | 10.0 | 11.6 | 14.4 | 15.9 | 18.6 | 22.1 | 25.5 | 28.4 | 31.2 | 33.9 | 36.8 | 39.4 | 43.3 | 46.7 | 52.1 | 54.4 | 59.0 | 63.8 | 70.1 | 75.3 | 84.9 | 92.2 |
| | 30 | 6.50 | 7.17 | 7.63 | 8.22 | 8.66 | 8.87 | 9.46 | 10.0 | 11.6 | 14.4 | 15.9 | 18.6 | 22.1 | 25.5 | 28.4 | 31.2 | 33.9 | 36.8 | 39.4 | 43.3 | 46.7 | 52.1 | 54.4 | 59.0 | 63.8 | 70.1 | 75.3 | 84.9 | 92.2 |

Standard Conditions 70°F, 14.7 psia

SCFH – Standard Cu. Ft. Per Hour
SLPM – Standard Liters Per Minute

Above data obtained with Type B restrictor. Flow rates for other metal restrictors are essentially the same as for Type B. Above data supercedes previous publications.


203.261.6711 | FAX- 203.261.8331 | P.O. Box 316 · Monroe, CT 06468 | info@okeefecontrols.com | www.okeefecontrols.com

# Sapphire Orifice Air Flow

O'Keefe Controls Co.

*If it's about precision, it's O'Keefe.*

## SLPM

| Orifice Diameter Inches | | 0.0012 | 0.0016 | 0.0020 | 0.0024 | 0.0028 | 0.0031 | 0.0035 | 0.0039 | 0.0043 | 0.0047 | 0.0051 | 0.0055 | 0.0059 | 0.0063 | 0.0067 | 0.0071 | 0.0079 | 0.0087 | 0.0094 | 0.0102 | 0.0110 | 0.0118 | 0.0126 | 0.0134 | 0.0142 | 0.0157 | 0.0173 | 0.0189 | 0.0205 | 0.0213 | 0.0228 | 0.0252 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Size Number | | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 36 | 40 | 44 | 48 | 52 | 54 | 58 | 64 |
| $C_v$ | | 0.000030 | 0.000053 | 0.000090 | 0.00012 | 0.00017 | 0.00022 | 0.00028 | 0.00035 | 0.00042 | 0.00050 | 0.00061 | 0.00071 | 0.00084 | 0.00094 | 0.0011 | 0.0012 | 0.0015 | 0.0018 | 0.0021 | 0.0024 | 0.0028 | 0.0032 | 0.0036 | 0.0040 | 0.0046 | 0.0057 | 0.0067 | 0.0080 | 0.0091 | 0.010 | 0.011 | 0.013 |
| Supply Pressure – psig | 1 | 0.003 | 0.005 | 0.010 | 0.014 | 0.020 | 0.025 | 0.034 | 0.040 | 0.050 | 0.058 | 0.068 | 0.080 | 0.095 | 0.106 | 0.120 | 0.139 | 0.161 | 0.194 | 0.259 | 0.275 | 0.300 | 0.340 | 0.393 | 0.446 | 0.499 | 0.677 | 0.822 | 0.965 | 1.10 | 1.12 | 1.38 | 1.69 |
| | 5 | 0.009 | 0.013 | 0.027 | 0.036 | 0.047 | 0.059 | 0.076 | 0.093 | 0.108 | 0.136 | 0.159 | 0.192 | 0.223 | 0.256 | 0.273 | 0.313 | 0.350 | 0.430 | 0.584 | 0.623 | 0.695 | 0.800 | 0.933 | 1.06 | 1.20 | 1.51 | 1.81 | 2.16 | 2.50 | 2.57 | 3.26 | 4.06 |
| | 10 | 0.010 | 0.016 | 0.036 | 0.049 | 0.065 | 0.082 | 0.107 | 0.132 | 0.164 | 0.193 | 0.228 | 0.264 | 0.308 | 0.357 | 0.382 | 0.430 | 0.480 | 0.590 | 0.830 | 0.868 | 0.968 | 1.09 | 1.27 | 1.45 | 1.63 | 2.01 | 2.43 | 2.90 | 3.32 | 3.45 | 4.43 | 5.58 |
| | 15 | 0.014 | 0.021 | 0.046 | 0.062 | 0.082 | 0.104 | 0.134 | 0.166 | 0.205 | 0.240 | 0.285 | 0.329 | 0.386 | 0.443 | 0.482 | 0.535 | 0.613 | 0.755 | 1.05 | 1.11 | 1.24 | 1.42 | 1.63 | 1.85 | 2.09 | 2.56 | 3.08 | 3.69 | 4.26 | 4.43 | 5.55 | 7.08 |
| | 20 | 0.016 | 0.025 | 0.055 | 0.074 | 0.099 | 0.125 | 0.159 | 0.197 | 0.243 | 0.284 | 0.337 | 0.390 | 0.457 | 0.525 | 0.569 | 0.635 | 0.730 | 0.910 | 1.25 | 1.32 | 1.48 | 1.70 | 1.95 | 2.20 | 2.48 | 3.04 | 3.64 | 4.36 | 5.06 | 5.31 | 6.55 | 8.33 |
| | 25 | 0.019 | 0.030 | 0.063 | 0.087 | 0.115 | 0.144 | 0.184 | 0.229 | 0.280 | 0.327 | 0.389 | 0.450 | 0.526 | 0.605 | 0.654 | 0.733 | 0.843 | 1.05 | 1.44 | 1.52 | 1.70 | 1.95 | 2.24 | 2.52 | 2.84 | 3.50 | 4.19 | 5.03 | 5.81 | 6.11 | 7.53 | 9.55 |
| | 30 | 0.022 | 0.034 | 0.072 | 0.098 | 0.132 | 0.164 | 0.208 | 0.260 | 0.317 | 0.370 | 0.440 | 0.511 | 0.595 | 0.685 | 0.710 | 0.838 | 0.958 | 1.19 | 1.63 | 1.69 | 1.91 | 2.19 | 2.52 | 2.84 | 3.19 | 3.96 | 4.75 | 5.69 | 6.57 | 6.90 | 8.48 | 10.7 |
| | 40 | 0.027 | 0.043 | 0.089 | 0.122 | 0.163 | 0.203 | 0.257 | 0.321 | 0.390 | 0.456 | 0.543 | 0.632 | 0.734 | 0.845 | 0.880 | 1.04 | 1.18 | 1.47 | 2.02 | 2.11 | 2.35 | 2.67 | 3.07 | 3.46 | 3.90 | 4.89 | 5.86 | 7.02 | 8.10 | 8.50 | 10.4 | 13.1 |
| | 50 | 0.032 | 0.052 | 0.106 | 0.147 | 0.195 | 0.241 | 0.306 | 0.383 | 0.463 | 0.542 | 0.652 | 0.753 | 0.872 | 1.00 | 1.05 | 1.24 | 1.41 | 1.75 | 2.39 | 2.50 | 2.78 | 3.16 | 3.63 | 4.08 | 4.59 | 5.83 | 6.96 | 8.35 | 9.63 | 10.1 | 12.3 | 15.5 |
| | 60 | 0.037 | 0.061 | 0.123 | 0.171 | 0.227 | 0.280 | 0.356 | 0.445 | 0.536 | 0.630 | 0.751 | 0.875 | 1.01 | 1.16 | 1.23 | 1.45 | 1.64 | 2.03 | 2.77 | 2.89 | 3.20 | 3.63 | 4.17 | 4.69 | 5.29 | 6.77 | 8.10 | 9.69 | 11.1 | 11.7 | 14.2 | 17.9 |
| | 70 | 0.042 | 0.070 | 0.141 | 0.195 | 0.259 | 0.318 | 0.403 | 0.507 | 0.609 | 0.717 | 0.855 | 0.996 | 1.15 | 1.32 | 1.40 | 1.66 | 1.87 | 2.31 | 3.14 | 3.28 | 3.62 | 4.12 | 4.72 | 5.31 | 5.99 | 7.71 | 9.23 | 11.0 | 12.7 | 13.3 | 16.0 | 20.2 |
| | 80 | 0.047 | 0.080 | 0.158 | 0.200 | 0.292 | 0.357 | 0.453 | 0.569 | 0.683 | 0.804 | 0.959 | 1.12 | 1.28 | 1.48 | 1.57 | 1.86 | 2.09 | 2.59 | 3.51 | 3.66 | 4.04 | 4.68 | 5.28 | 5.93 | 6.69 | 8.65 | 10.4 | 12.3 | 14.3 | 14.8 | 17.9 | 22.6 |
| | 90 | 0.053 | 0.089 | 0.175 | 0.244 | 0.324 | 0.396 | 0.502 | 0.632 | 0.757 | 0.891 | 1.06 | 1.24 | 1.42 | 1.64 | 1.75 | 2.06 | 2.32 | 2.87 | 3.89 | 4.05 | 4.47 | 5.07 | 5.83 | 6.56 | 7.41 | 9.60 | 11.5 | 13.7 | 15.7 | 16.4 | 19.7 | 24.9 |
| | 100 | 0.058 | 0.098 | 0.193 | 0.269 | 0.356 | 0.435 | 0.551 | 0.692 | 0.830 | 0.978 | 1.17 | 1.36 | 1.56 | 1.80 | 1.92 | 2.27 | 2.55 | 3.15 | 4.26 | 4.44 | 4.89 | 5.57 | 6.38 | 7.18 | 8.12 | 10.6 | 12.6 | 15.0 | 17.2 | 18.0 | 21.6 | 27.3 |
| Vacuum Level In. Hg. | 5 | 0.003 | 0.006 | 0.014 | 0.020 | 0.028 | 0.036 | 0.047 | 0.057 | 0.073 | 0.085 | 0.100 | 0.116 | 0.137 | 0.156 | 0.169 | 0.199 | 0.229 | 0.277 | 0.377 | 0.401 | 0.451 | 0.510 | 0.591 | 0.673 | 0.764 | 0.982 | 1.16 | 1.38 | 1.61 | 1.64 | 2.13 | 2.61 |
| | 10 | 0.004 | 0.008 | 0.018 | 0.027 | 0.036 | 0.046 | 0.061 | 0.073 | 0.093 | 0.109 | 0.128 | 0.149 | 0.175 | 0.200 | 0.217 | 0.253 | 0.292 | 0.352 | 0.482 | 0.503 | 0.556 | 0.638 | 0.734 | 0.833 | 0.955 | 1.26 | 1.51 | 1.80 | 2.06 | 2.11 | 2.55 | 3.19 |
| Choked Flow | 15 | 0.006 | 0.010 | 0.021 | 0.030 | 0.040 | 0.050 | 0.065 | 0.079 | 0.100 | 0.117 | 0.138 | 0.159 | 0.188 | 0.214 | 0.235 | 0.269 | 0.320 | 0.390 | 0.525 | 0.554 | 0.626 | 0.711 | 0.818 | 0.921 | 1.07 | 1.39 | 1.65 | 1.99 | 2.31 | 2.39 | 2.77 | 3.48 |
| | 20 | 0.006 | 0.010 | 0.021 | 0.030 | 0.040 | 0.050 | 0.065 | 0.079 | 0.100 | 0.117 | 0.138 | 0.159 | 0.188 | 0.214 | 0.235 | 0.269 | 0.320 | 0.390 | 0.525 | 0.554 | 0.626 | 0.711 | 0.818 | 0.921 | 1.07 | 1.39 | 1.65 | 1.99 | 2.31 | 2.39 | 2.77 | 3.48 |
| | 30 | 0.006 | 0.010 | 0.021 | 0.030 | 0.040 | 0.050 | 0.065 | 0.079 | 0.100 | 0.117 | 0.138 | 0.159 | 0.188 | 0.214 | 0.235 | 0.269 | 0.320 | 0.390 | 0.525 | 0.554 | 0.626 | 0.711 | 0.818 | 0.921 | 1.07 | 1.39 | 1.65 | 1.99 | 2.31 | 2.39 | 2.77 | 3.48 |

## SCFH

| Orifice Diameter Inches | | 0.0012 | 0.0016 | 0.0020 | 0.0024 | 0.0028 | 0.0031 | 0.0035 | 0.0039 | 0.0043 | 0.0047 | 0.0051 | 0.0055 | 0.0059 | 0.0063 | 0.0067 | 0.0071 | 0.0079 | 0.0087 | 0.0094 | 0.0102 | 0.0110 | 0.0118 | 0.0126 | 0.0134 | 0.0142 | 0.0157 | 0.0173 | 0.0189 | 0.0205 | 0.0213 | 0.0228 | 0.0252 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Size Number | | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 36 | 40 | 44 | 48 | 52 | 54 | 58 | 64 |
| $C_v$ | | 0.000030 | 0.000053 | 0.000090 | 0.00012 | 0.00017 | 0.00022 | 0.00028 | 0.00035 | 0.00042 | 0.00050 | 0.00061 | 0.00071 | 0.00084 | 0.00094 | 0.0011 | 0.0012 | 0.0015 | 0.0018 | 0.0021 | 0.0024 | 0.0028 | 0.0032 | 0.0036 | 0.0040 | 0.0046 | 0.0057 | 0.0067 | 0.0080 | 0.0091 | 0.010 | 0.011 | 0.013 |
| Supply Pressure – psig | 1 | 0.007 | 0.011 | 0.021 | 0.030 | 0.042 | 0.053 | 0.072 | 0.085 | 0.106 | 0.123 | 0.144 | 0.169 | 0.201 | 0.225 | 0.254 | 0.294 | 0.341 | 0.411 | 0.549 | 0.583 | 0.636 | 0.720 | 0.833 | 0.945 | 1.06 | 1.43 | 1.74 | 2.04 | 2.33 | 2.37 | 2.92 | 3.58 |
| | 5 | 0.019 | 0.027 | 0.056 | 0.075 | 0.100 | 0.124 | 0.161 | 0.197 | 0.228 | 0.288 | 0.337 | 0.407 | 0.471 | 0.542 | 0.577 | 0.663 | 0.740 | 0.911 | 1.24 | 1.32 | 1.47 | 1.70 | 1.98 | 2.25 | 2.53 | 3.20 | 3.83 | 4.58 | 5.30 | 5.44 | 6.90 | 8.60 |
| | 10 | 0.021 | 0.034 | 0.076 | 0.104 | 0.138 | 0.174 | 0.227 | 0.280 | 0.347 | 0.409 | 0.483 | 0.559 | 0.653 | 0.756 | 0.809 | 0.911 | 1.02 | 1.25 | 1.76 | 1.84 | 2.05 | 2.31 | 2.69 | 3.07 | 3.45 | 4.26 | 5.15 | 6.14 | 7.03 | 7.31 | 9.39 | 11.8 |
| | 15 | 0.030 | 0.044 | 0.097 | 0.131 | 0.174 | 0.220 | 0.284 | 0.352 | 0.434 | 0.508 | 0.604 | 0.697 | 0.818 | 0.939 | 1.02 | 1.13 | 1.30 | 1.60 | 2.22 | 2.35 | 2.63 | 3.01 | 3.45 | 3.92 | 4.43 | 5.42 | 6.53 | 7.82 | 9.03 | 9.39 | 11.8 | 15.0 |
| | 20 | 0.034 | 0.053 | 0.117 | 0.157 | 0.210 | 0.265 | 0.337 | 0.417 | 0.515 | 0.602 | 0.714 | 0.826 | 0.968 | 1.11 | 1.21 | 1.35 | 1.55 | 1.93 | 2.65 | 2.80 | 3.14 | 3.60 | 4.13 | 4.66 | 5.25 | 6.44 | 7.71 | 9.24 | 10.7 | 11.3 | 13.9 | 17.6 |
| | 25 | 0.040 | 0.064 | 0.133 | 0.184 | 0.244 | 0.305 | 0.390 | 0.485 | 0.593 | 0.693 | 0.824 | 0.953 | 1.11 | 1.28 | 1.39 | 1.55 | 1.79 | 2.22 | 3.05 | 3.22 | 3.60 | 4.13 | 4.75 | 5.34 | 6.02 | 7.42 | 8.88 | 10.7 | 12.3 | 12.9 | 16.0 | 20.2 |
| | 30 | 0.046 | 0.072 | 0.152 | 0.208 | 0.280 | 0.347 | 0.441 | 0.551 | 0.672 | 0.784 | 0.932 | 1.08 | 1.26 | 1.45 | 1.50 | 1.78 | 2.03 | 2.52 | 3.45 | 3.58 | 4.05 | 4.64 | 5.34 | 6.02 | 6.76 | 8.39 | 10.1 | 12.1 | 13.9 | 14.6 | 18.0 | 22.7 |
| | 40 | 0.057 | 0.091 | 0.189 | 0.258 | 0.345 | 0.430 | 0.544 | 0.680 | 0.826 | 0.966 | 1.15 | 1.34 | 1.56 | 1.79 | 1.86 | 2.20 | 2.50 | 3.11 | 4.28 | 4.47 | 4.98 | 5.66 | 6.50 | 7.33 | 8.26 | 10.4 | 12.4 | 14.9 | 17.2 | 18.0 | 22.0 | 27.8 |
| | 50 | 0.068 | 0.110 | 0.225 | 0.311 | 0.413 | 0.511 | 0.648 | 0.811 | 0.981 | 1.15 | 1.38 | 1.60 | 1.85 | 2.13 | 2.22 | 2.63 | 2.99 | 3.71 | 5.06 | 5.30 | 5.89 | 6.69 | 7.69 | 8.64 | 9.72 | 12.4 | 14.7 | 17.7 | 20.4 | 21.4 | 26.1 | 32.8 |
| | 60 | 0.079 | 0.129 | 0.261 | 0.362 | 0.481 | 0.593 | 0.754 | 0.943 | 1.14 | 1.33 | 1.59 | 1.85 | 2.14 | 2.46 | 2.61 | 3.07 | 3.47 | 4.30 | 5.87 | 6.12 | 6.78 | 7.69 | 8.83 | 9.94 | 11.2 | 14.3 | 17.2 | 20.5 | 23.5 | 24.8 | 30.1 | 37.9 |
| | 70 | 0.089 | 0.149 | 0.299 | 0.413 | 0.549 | 0.674 | 0.854 | 1.07 | 1.29 | 1.52 | 1.81 | 2.11 | 2.43 | 2.80 | 2.97 | 3.52 | 3.96 | 4.89 | 6.65 | 6.95 | 7.67 | 8.73 | 10.0 | 11.3 | 12.7 | 16.3 | 19.6 | 23.3 | 26.9 | 28.2 | 33.9 | 42.8 |
| | 80 | 0.100 | 0.168 | 0.335 | 0.424 | 0.619 | 0.756 | 0.960 | 1.21 | 1.45 | 1.70 | 2.03 | 2.37 | 2.72 | 3.13 | 3.33 | 3.94 | 4.43 | 5.49 | 7.44 | 7.75 | 8.56 | 9.75 | 11.2 | 12.6 | 14.2 | 18.3 | 22.0 | 26.1 | 30.3 | 31.4 | 37.9 | 47.9 |
| | 90 | 0.111 | 0.188 | 0.371 | 0.517 | 0.686 | 0.839 | 1.06 | 1.34 | 1.60 | 1.89 | 2.25 | 2.62 | 3.01 | 3.47 | 3.71 | 4.36 | 4.92 | 6.08 | 8.24 | 8.58 | 9.47 | 10.7 | 12.4 | 13.9 | 15.7 | 20.3 | 24.4 | 29.0 | 33.3 | 34.7 | 41.7 | 52.8 |
| | 100 | 0.122 | 0.208 | 0.409 | 0.570 | 0.754 | 0.922 | 1.17 | 1.47 | 1.76 | 2.07 | 2.47 | 2.88 | 3.30 | 3.81 | 4.07 | 4.81 | 5.40 | 6.67 | 9.03 | 9.41 | 10.4 | 11.8 | 13.5 | 15.2 | 17.2 | 22.5 | 26.7 | 31.8 | 36.4 | 38.1 | 45.8 | 57.8 |
| Vacuum Level In. Hg. | 5 | 0.007 | 0.013 | 0.029 | 0.043 | 0.059 | 0.076 | 0.100 | 0.121 | 0.154 | 0.180 | 0.212 | 0.246 | 0.290 | 0.331 | 0.358 | 0.422 | 0.485 | 0.587 | 0.799 | 0.850 | 0.956 | 1.08 | 1.25 | 1.43 | 1.62 | 2.08 | 2.46 | 2.92 | 3.41 | 3.47 | 4.51 | 5.53 |
| | 10 | 0.009 | 0.018 | 0.039 | 0.057 | 0.076 | 0.098 | 0.128 | 0.155 | 0.197 | 0.231 | 0.271 | 0.316 | 0.371 | 0.424 | 0.460 | 0.536 | 0.619 | 0.746 | 1.02 | 1.07 | 1.18 | 1.35 | 1.56 | 1.76 | 2.02 | 2.67 | 3.19 | 3.81 | 4.36 | 4.47 | 5.40 | 6.76 |
| Choked Flow | 15 | 0.012 | 0.020 | 0.045 | 0.063 | 0.085 | 0.107 | 0.138 | 0.168 | 0.212 | 0.248 | 0.292 | 0.337 | 0.398 | 0.453 | 0.498 | 0.570 | 0.678 | 0.826 | 1.11 | 1.17 | 1.33 | 1.51 | 1.73 | 1.95 | 2.26 | 2.95 | 3.50 | 4.22 | 4.89 | 5.06 | 5.87 | 7.37 |
| | 20 | 0.012 | 0.020 | 0.045 | 0.063 | 0.085 | 0.107 | 0.138 | 0.168 | 0.212 | 0.248 | 0.292 | 0.337 | 0.398 | 0.453 | 0.498 | 0.570 | 0.678 | 0.826 | 1.11 | 1.17 | 1.33 | 1.51 | 1.73 | 1.95 | 2.26 | 2.95 | 3.50 | 4.22 | 4.89 | 5.06 | 5.87 | 7.37 |
| | 30 | 0.012 | 0.020 | 0.045 | 0.063 | 0.085 | 0.107 | 0.138 | 0.168 | 0.212 | 0.248 | 0.292 | 0.337 | 0.398 | 0.453 | 0.498 | 0.570 | 0.678 | 0.826 | 1.11 | 1.17 | 1.33 | 1.51 | 1.73 | 1.95 | 2.26 | 2.95 | 3.50 | 4.22 | 4.89 | 5.06 | 5.87 | 7.37 |

Standard Conditions 70°F, 14.7 psia

SCFH – Standard Cu. Ft. Per Hour
SLPM – Standard Liters Per Minute

Above data obtained with Type S restrictors. Flow rates for other sapphire types are essentially the same as for Type S. Above data supercedes previous publications.



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