

### VA Flowmeter Sizing Data

To select the proper size Variable Area flowmeter for a specific application – liquid or gas service, it is necessary to convert the flow to be measured to an equivalent air or water flowrate. The nearest standard range VA flowmeter can then be found in the Roxspur Measurement and Control flow catalogue.

#### SIZING FOR LIQUIDS

For Volumetric Flow At Standard Reference Condition of 20°C

Definition of Sizing Factor (K)

- Water equivalent flowrate:  $Q_1 = \text{Sizing Factor (K)} \times \text{max Liquid Flow } Q_2$ , ie  $Q_1 = K \times Q_2$

- Max Flow liquid  $Q_2 = \frac{Q_1 \text{ (Water equiv. Flow)}}{\text{Sizing Factor (K)}}$

- Sizing Factor (K) =  $\sqrt{\frac{6.96 \times X_2}{7.96 - X_2}}$

Where  $X_2 = \text{Liquid density at working conditions (g/cm}^3\text{)}$

Example 1

To establish water equivalent flowrate and tube float combination for:

1.5 l/min paraffin, working density 0.80 g/cm<sup>3</sup>

- Sizing factor (K) =  $\sqrt{\frac{6.96 \times 0.80}{7.96 - 0.80}} = 0.882$

- Water equivalent  $Q_1 = 0.882 \times 1.5 = 1.323 \text{ l/min}$

- Nearest standard range = 200 to 1500 cm<sup>3</sup>/min using GTF 2ASS Tube & Float

- Equivalent paraffin flowrate =

$\frac{200 \text{ (min)}}{0.882}$  to  $\frac{1500 \text{ (max)}}{0.882}$

ie, 227 to 1700 cm<sup>3</sup>/min paraffin

- Select meter type from VA flowmeter section of catalogue.

- The flowmeter can then be supplied calibrated for: 0.2 to 1.7 l/min of paraffin.

#### LIQUID DENSITY CORRECTIONS

Liquid Density (g/cm <sup>3</sup> )	For Volumetric units (eg l/min) multiply scale reading of water flow rate (in same units) by factor	For Gravimetric units (eg g/min) multiply scale reading of water flow rate (in same units) by factor
0.60	1.328	0.797
0.65	1.271	0.826
0.70	1.221	0.855
0.75	1.175	0.881
0.80	1.134	0.907
0.85	1.096	0.932
0.90	1.062	0.955
0.95	1.030	0.978
1.00	1.000	1.000
1.05	0.972	1.021
1.10	0.947	1.041
1.15	0.922	1.061
1.20	0.900	1.080
1.25	0.878	1.098
1.30	0.858	1.115
1.35	0.839	1.132
1.40	0.821	1.149
1.45	0.803	1.165
1.50	0.787	1.180
1.55	0.771	1.195
1.60	0.756	1.209
1.65	0.741	1.223
1.70	0.727	1.237
1.75	0.714	1.250
1.80	0.701	1.262
1.85	0.689	1.274
1.90	0.677	1.286
1.95	0.665	1.298
2.00	0.654	1.309

## SIZING FOR GASES

For Volumetric Flow at Standard Reference Conditions of 20°C and 1.013 bar abs. (ATP)

Definition of Sizing Factor (K):

- Air equivalent flowrate  
(F) = Sizing factor (K) x Max gas flow (F<sub>2</sub>)

Note: F<sub>2</sub> MUST BE EXPRESSED IN FREE VOLUMES OF GAS (ie, MEASURED AT ATP)

- Sizing factor (K) =  $\sqrt{r \times \frac{T_2}{P_2} \times \frac{1.013}{293}}$

Where: r = Relative density of Gas to be measured  
P<sub>2</sub> = Absolute Operating Pressure (bar)  
T<sub>2</sub> = Gas Temperature (Kelvin)

### Example 2

To establish equivalent air flowrate and suitable tube and float combination for 15 l/min acetylene (free volume measured at ATP) working at 5 barg and 40°C.

P<sub>2</sub> = 1.013 + 5 = 6.013 bar Abs,  
T<sub>2</sub> = 273 + 40 = 313 K,  
r = 0.898 (from reference table)

- Sizing Factor (K) =

$$\sqrt{0.898 \times \frac{313}{6.013} \times \frac{1.013}{293}} = 0.402$$

- Equivalent Air Flow : F<sub>1</sub> = 15 x 0.402 = 6.03 l/min
- Nearest standard range = 1 to 10 l/min Air tube for G Series Flowmeter, GTF 2BHS Tube & Float
- Equivalent Acetylene Flowrate =  
 $\frac{1 \text{ (min)}}{0.402}$  to  $\frac{10 \text{ (max)}}{0.402}$   
ie, 2.29 to 24.88 l/min Acetylene @ 5 barg
- Select meter type from VA Flowmeter section of catalogue
- The flowmeter can then be supplied calibrated for to: 25 l/min of acetylene at 40°C and 5 bar G.

## GAS DENSITY CORRECTIONS

Flowmeter scales can be infinite in variety due to the differing physical properties of gases and their operating conditions. Standard tubes for gases are calibrated for atmospheric pressure at the flowmeter outlet. If the working outlet pressure (P) is different, the scales reading (expressed at ATP) should be corrected by using the formulae:

$$\text{Actual flow Rate (@ATP)} = \sqrt{\frac{P \text{ (Bar Abs)}}{1.013}} \times \text{Scale reading}$$

$$\text{Actual flow rate (@ working pressure P)} = \sqrt{\frac{1.013}{P \text{ (Bar Abs)}}} \times \text{Scale reading}$$

Notes:

1. Density and pressure correction factors should not be applied to the lowest flowrate tubes (Frame Size 1) – consult RM&C sales
2. Tubes with scales for different operating pressures and calibration conditions are available to order.

To convert ATP air flow rates to ATP flow rates of the selected gas, divide by sizing factor K:

Gas	Chemical Formula	Relative Density (Air = 1)	Sizing Factor K
Acetylene	C <sub>2</sub> H <sub>2</sub>	0.898	0.948
Ammonia	NH <sub>3</sub>	0.588	0.767
Argon	A	1.380	1.175
Butane	C <sub>4</sub> H <sub>10</sub>	2.007	1.417
Carbon Dioxide	CO <sub>2</sub>	1.520	1.233
Carbon Monoxide	CO	0.967	0.983
Chlorine	CL <sub>2</sub>	2.450	1.565
Cyclopropane	C <sub>3</sub> H <sub>6</sub>	1.453	1.205
Ethane	C <sub>2</sub> H <sub>6</sub>	1.038	1.019
Ethylene	C <sub>2</sub> H <sub>4</sub>	0.968	0.984
Helium	He	0.138	0.371
Hydrogen	H <sub>2</sub>	0.0695	0.264
Hydrogen Chloride	HCL	1.259	1.122
Hydrogen Sulphide	H <sub>2</sub> S	1.177	1.085
Methane	CH <sub>4</sub>	0.554	0.744
Neon	Ne	0.697	0.835
Nitrogen	N <sub>2</sub>	0.968	0.984
Nitrus Oxide	N <sub>2</sub> O	1.520	1.233
Oxygen	O <sub>2</sub>	1.105	1.051
Propane	C <sub>3</sub> H <sub>8</sub>	1.522	1.234
Suphur Dioxide	SO <sub>2</sub>	2.210	1.487

Note:

1. RM&C standards express gas volumes at 1.013 bar absolute and 20°C (ATP).
2. Density of air at 1 atmosphere and 20°C = 1.204 g/l.

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Head Office: 2 Downgate Drive, Sheffield, S4 8BT, England  
Tel: +44(0)114 244 2521 Fax: +44(0)114 243 4838



10 Campbell Court, Bramley, Tadley, Hampshire, RG26 5EG, England  
Tel: +44(0)870 2200724 Fax: +44(0)1256 882986  
email: sales@roxspur.com www.roxspur.com

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