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## VARIABLE AREA FLOWMETERS

### Flow Reference Section

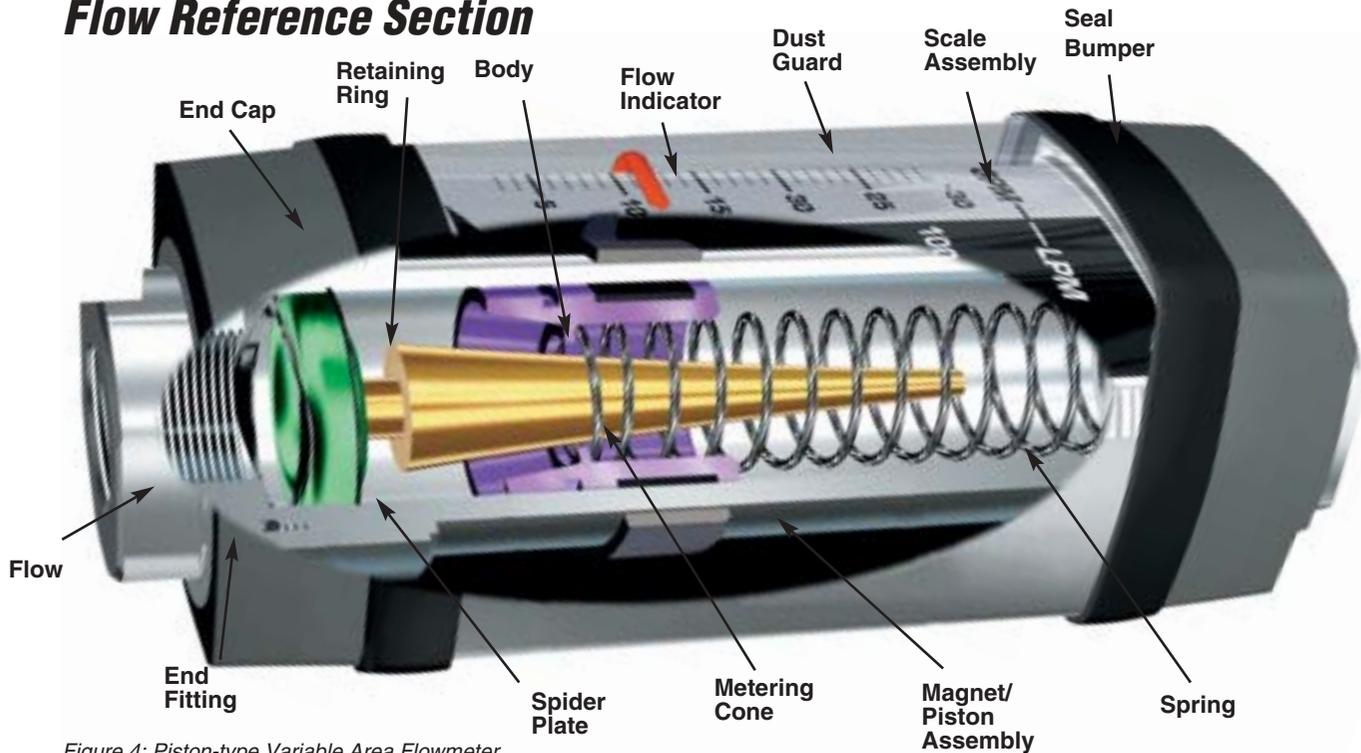


Figure 4: Piston-type Variable Area Flowmeter

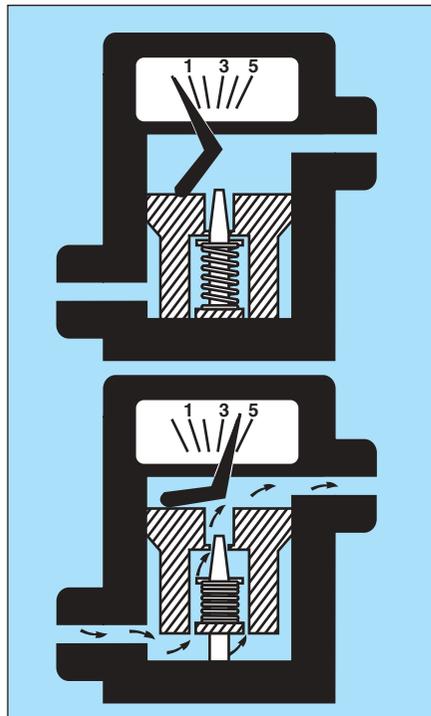


Figure 5: Flowmeters Operating Principle of FL-O Series

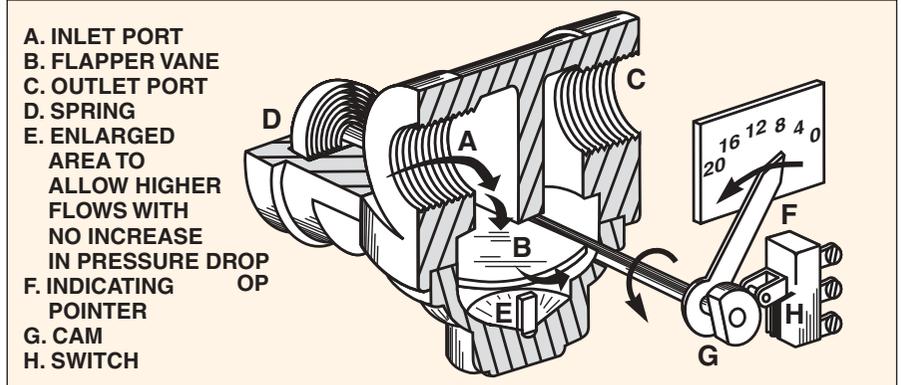


Figure 6: Flowmeters Operating Principle of FL-X Series

#### General Purpose Rotameters

FL-1000, FL-1100, FL-1200,  
FL-1300, FL-1500, FL-1600,  
FL-1700, FL-1900 Series

**For liquids:**

GPM water equivalent =  
GPM metered liquid flow x

$$\sqrt{\frac{(SGF-1) \times SGL}{(SGF - SGL)}}$$

where:

SGL= specific gravity of metered liquid at operating conditions and SGF= specific gravity of rotameter float.

This equation converts the reading of a rotameter calibrated for water to a reading appropriate for another fluid of different density. Most rotameters are very sensitive to liquid viscosity, and this equation does not take viscosity into account. Therefore, it must be considered to provide only a rough approximations.

Specific gravity of Glass = 2.53

Specific gravity of 316 SS = 8.04

**For Gases:**

SCFM air flow from rotameter reading =  
SCFM true gas flow rate x

$$\sqrt{\frac{(SG) (T_0) (14.7)}{(1.0) (530) (P_0)}}$$

where:

SG = specific gravity of metered gas (air = 1.0) at STP  
T<sub>0</sub>=temperature at operating conditions, Rankine (F + 460)  
P<sub>0</sub> = pressure at operating conditions in psia = (psig + 14.7).

This formula converts the metered flow, making allowance for the operating temperature and pressure, to an equivalent flow of air in SCFM at 21°C (70°F) and 14.7 psia. Capacity tables are in SCFM at standard temperature and pressure of 14.7 psia and 21°C (70°F).

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When used with purge rotameters (meters with +10% full scale accuracy) these equations are satisfactory, although not precise. When used with  $\pm 2\%$  full scale accuracy meters, the correlation holds as long as the viscosity of the fluid does not exceed 6 centistokes. Above this viscosity, field calibration is required.

### General Purpose Rotameters

#### FL-1400 and FL-1800 Series

General purpose glass tube rotameters with ball floats cannot be correlated with precision, due to their strong sensitivity to variations in viscosity. OMEGA® FL-1400 and FL-1800 Series rotameters are supplied with correlation charts for numerous gases at various temperatures and pressures. For highest precision, field calibration is recommended.

#### Piston and Vane Type Variable Area Flowmeters

Piston-type flowmeters use an annular orifice formed by a piston and a tapered cone. The piston is held in place at the base of the cone (in the "no flow position") by a calibrated spring. Flow through

the meter results in a differential pressure across the piston orifice that moves the piston against the spring. Piston movement and orifice area are proportional to flowrate. In case of the vane-type units, the fluid flow forces the vane to rotate against a spring, increasing the orifice area for flow. The position of the piston or vane is then read on a scale to give the flowrate. Since the force of a spring opposes the flow (in comparison to rotameters, which use gravity), these units may be mounted in any position. Scales are based on specific gravities of 0.84 for oil meters, and 1.0 for water meters. Their simplicity of design and the ease with which they can be equipped to transmit electrical signals has made them an economical alternative to rotameters for flowrate indication and control.

#### Correlation of FL-2000, 6000, 7000, 8000

Although normally calibrated for oil or water, these units can be used for other fluids as well. The reading on the flowmeter must be multiplied

by the following correction factors to account for fluid density:

$$\sqrt{.84/\text{spec. grav.}} \text{ (for oil meters) or}$$

$$\sqrt{1.0/\text{spec. grav.}} \text{ (for water meters)}$$

These units are only slightly affected by viscosity, and no correction is normally required.

#### Correlation of FL-2700, 6700, 7700, 8700

These units are calibrated to indicate standard cubic feet per minute (SCFM) of air at 100 psig and 21°C (70°F). When used at other conditions, the following corrections apply:

SCFM (true flowrate) = SCFM (indicated) / (f<sub>1</sub> x f<sub>2</sub> x f<sub>3</sub>) where:

$$f_1 = \sqrt{114.7 / (14.7 + \text{operating psig})}$$

$$f_2 = \sqrt{(460 + \text{operating } ^\circ\text{F}) / 530}$$

$$f_3 = \sqrt{\frac{\text{molecular weight of gas}}{29}}$$