



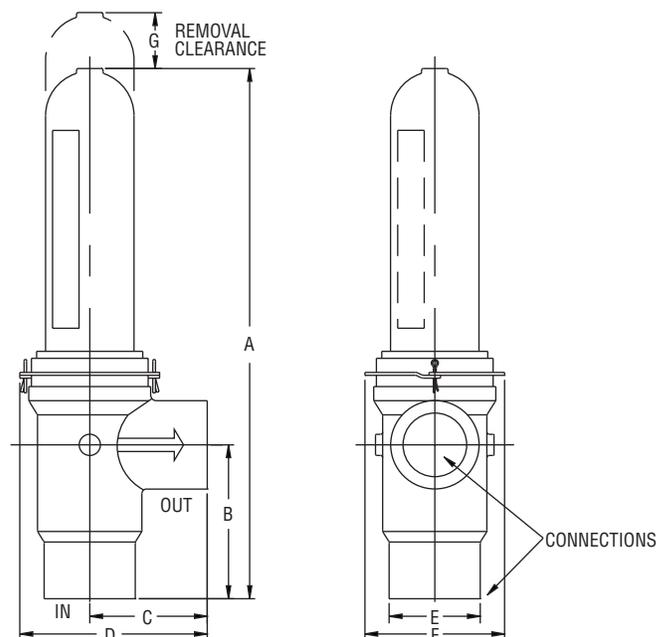
Series TVF Total View Industrial Flowmeters

Specifications - Installation and Operating Instructions



TVFS

A	B	C	D	E	F	G	Female NPT	Material
9.36	2.81	2.68	4.00	1.35	2.72	3.00	3/4"	ST. STL.
15.22	4.53	3.71	5.70	2.48	3.95	5.00	1-1/2"	ST. STL.



The Series TVF Total View Industrial Flowmeters are economically priced, tough, simple and accurate meters for water, oils, coolants, compressed gases and other industrial applications. The flowmeters have a full-scale accuracy of $\pm 2\%$ and can be disassembled quickly without the meter being removed from the pipeline for easy cleaning. The TVFS is constructed of T-316 stainless steel and features polysulphone sight tubes. The Series Total View Industrial Flowmeters are available with standard 3/4" and 1-1/2" female NPT connections. The easy to read flowmeters provide 360° rotation of scale on plastic sight tube models.

SAFETY PRECAUTIONS

Personnel safety should be considered before pressurizing and operating the system. There are numerous possibilities for error in system operation and maintenance as well as component installation. Because human eyes must necessarily come into close proximity with the flowmeter to read it, it is recommended that safety shielding be used with the meter along with safety glasses. The panel mount kit (available for most standard models) also provides shielding. Another protective measure is to use a sheet of transparent, high-impact material in a broad area in front of the meter. If hazardous, toxic, or flammable fluids are being metered, recommended safeguards should include methods to protect personnel from splash or rebound. A method of quick, safe removal of dangerous fluids should also be included.

SPECIFICATIONS

Service: Compatible gases or liquids.

Wetted Materials: Body: T-316 SS; O-rings: Buna-N; Sight Tube: Polysulfone.

Temperature Limits: See "Operating Limits" Table.

Pressure Limits: See "Operating Limits" Table.

Accuracy: $\pm 2\%$ FS.

Repeatability: $\pm 1/4\%$ of indicated flow rate.

Process Connections: 3/4" and 1-1/2" female NPT.

Scale Length: 3.2" (8 cm) for 3/4" NPT connection, 5.2" (13 cm) for 1-1/2" NPT connection.

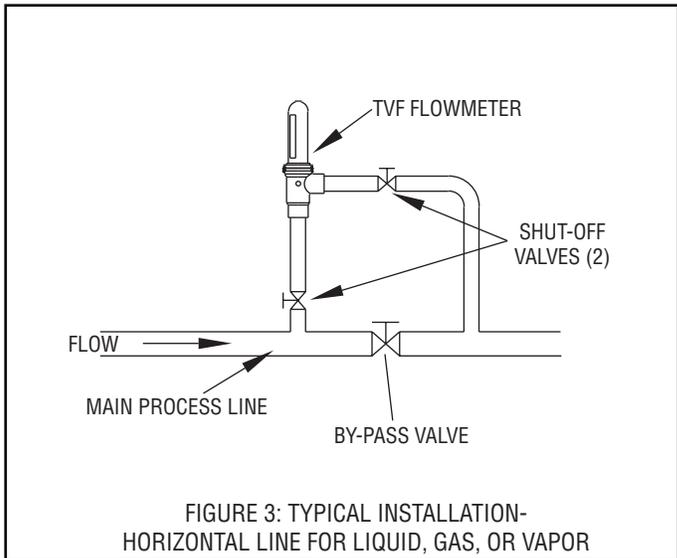
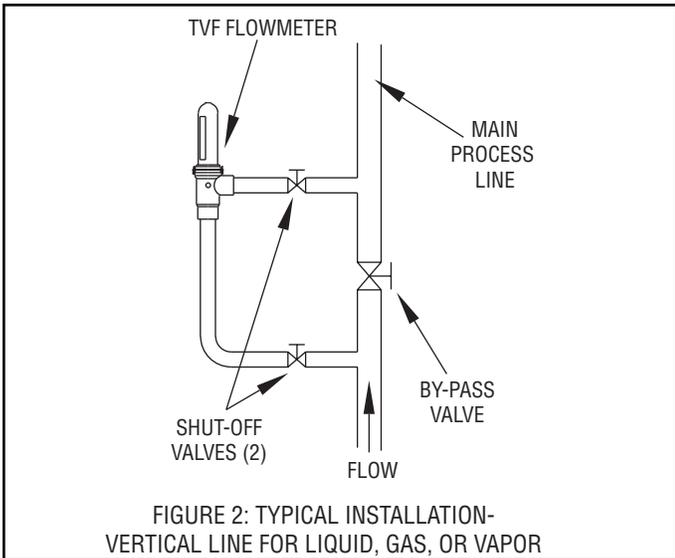
Weight: 4 lbs (1.8 kg) for 3/4", and 12 lbs (5.5 kg) for 1-1/2".

RECOMMENDED PIPING: Series TVF Flowmeters generally have no special straight run or other piping requirements. Inlet piping should be the same size as the meter connection. Some effect on meter accuracy may occur at high flow velocities if inlet piping guidelines are violated. Please refer to the table on the next page. When installing on different size pipe, use standard pipe adapters and come into the meter inlet with a nipple 8 diameters long of the same size for greatest accuracy. Control valves should be mounted on the outlet side of the meter. The use of a three valve manifold around the meter is suggested (per Figures 2 & 3) as it allows uninterrupted process flow while the meter is being cleaned.

**MAXIMUM FLOWS (WITHOUT EFFECTING ACCURACY)
FOR UNDERSIZED PIPES CONNECTED DIRECTLY TO MEM FLOWMETER INLETS**

PIPE NPS	DATA (ID) ²	MAX. * GPM LIQ.	MAX. SCFM AIR @ †			
			ATMOS	50 PSIG	100 PSIG	200 PSIG
1/4	0.132	1.72	0.864	3.80	6.74	12.6
3/8	0.243	2.98	1.59	7.00	12.4	23.2
1/2	0.387	4.74	2.53	11.1	19.8	37.2
3/4	0.679	8.31	4.44	19.5	34.7	64.9
1	1.100	13.47	7.20	31.7	56.1	105
1-1/4	1.904	23.32	12.5	58.8	97.2	182
1-1/2	2.592	31.74	17.0	74.6	132	248
2	4.272	52.29	28.0	123	218	408
2-1/2	6.096	74.56	39.9	176	311	582
3	9.413	115.2	61.6	271	480	804
4	16.209	198.4	106	467	827	1549
6	36.784	450.0	241	1059	1878	3514

* Data per *Cameron Hydraulic Data*. Based on 5 FPS max. liquid velocity having no effect on Series TVF Flowmeter accuracy if the inlet pipe is smaller than the meter connections.
 † SCFM = 0.445 x (psig + 14.7) x (ID)². Based on 20 FPS max. air velocity having no effect on Series TVF Flowmeter accuracy if the inlet pipe is smaller than the meter connections.



OPERATING LIMITS FOR SERIES TVF FLOWMETERS

BODY SIZE AND DESCRIPTION	Maximum Non-Shock Working Pressure, PSIG @ °F (bar @ °C)							
	70°F (21°C)	80°F (26°C)	100°F (37°C)	120°F (48°C)	140°F (60°C)	200°F (93°C)	250°F (121°C)	300°F (148°C)
3/4" Stainless and Polysulfone	300 (20.6)	300 (20.6)	300 (20.6)	300 (20.6)	300 (20.6)	300 (20.6)	250 (17.2)	115 (7.9)
1-1/2" Stainless and Polysulfone	180 (12.4)	180 (12.4)	180 (12.4)	180 (12.4)	180 (12.4)	180 (12.4)	145 (10.0)	70 (4.8)

* Operating limits given are based on water or air. For more severe service, corrosives, and other media and/or environmental factors, an additional correction factor down-rating these limits may be required. Limits are based on testing and practical experience. Possible extreme application conditions cannot be foreseen. Thus, data is offered only as a guide. It in no way constitutes a specific recommendation or warranty expressed or implied. The operating limits should not be exceeded under any circumstances. If there is any doubt regarding the safe operating limit for a specific application, please consult the factory prior to installation and pressurization of the flow device.

INSTALLATION

PREPARATION: Series TVF flowmeters are ready to install as-is, although the sight tube may need repositioning so the scale is visible after installation. First, remove the protective caps from the connection ports. **ALSO, REMOVE THE PLASTIC SHIPPING TUBING ABOVE THE INLET CAP IN THE METER CORE TUBE!** Check that the float moves freely within the core tube, and that no packing materials are in the meter.

Apply wrenches only on the flats or outer rims of the connection ports. Avoid over-tightening, and do not use wrenches on other portions of the body or sight tube. When solvent cementing in the vicinity of a meter with a polysulfone sight tube, the tube should be removed until the cement dries and fumes clear.

SURGE CHAMBERS & ACCUMULATORS: Flowmeters are more accurate and less likely to be damaged when the fluid flow is smooth. If the meter must be installed on a line where reciprocating pumps or compressors causing pulsation are used, surge chambers or accumulators are strongly suggested to damp the shock wave.

SIGHT TUBE ROTATION: On visual (the float disk is seen) indication models with PLASTIC sight tubes, grasp the tube firmly BY HAND near the body and twist until the scale faces the desired direction. **USE NO TOOLS!**

STARTUP

System flow should be started with the by-pass valve open and meter inlet and outlet valves closed. After the system is operating, open the meter inlet valve gradually to equalize internal pressure. Then slowly crack meter outlet valve and wait for float to stabilize. Finally, slowly open the meter outlet and/or flow regulating valve all the way and close the system by-pass valve. **AVOID SUDDEN SURGES THAT CAUSE THE METER FLOAT TO SLAM INTO THE TOP OF THE SIGHT TUBE!** Although not essential, the meter sight tube should be filled to a level above the float on liquid systems. The snorkel tube (present in most standard models) allows escape of entrapped gases except for a small pocket in the upper end which helps cushion hydraulic shock. To assure proper filling and to flush any foreign particles from the meter, operate the system at full flow briefly at startup.

READING FLOW

Read flow directly from the scale as the number nearest the top edge of the float indicator disk.

COMPENSATING FOR SYSTEM CHANGES

To find the correct flow reading for a system whose fluid conditions vary from those for which the meter is scaled, use the conversion data. The most practical method of applying the formulae is to calculate a conversion factor for the new system conditions, multiplying the scale reading by that factor. In the problems, "Qs" has been assigned a value of "1" to determine the conversion factor. (The factory can provide special scales at additional cost for other fluids and/or units.)

CAUTION: DO NOT OPERATE THE FLOWMETER ON A SYSTEM EXCEEDING THE OPERATING LIMITS OF THE UNIT. WHEN CHANGING OPERATING CONDITIONS, MAKE SURE THAT THE NEW SYSTEM CONDITIONS ARE WITHIN THE FLOWMETER OPERATING LIMITS, AND ALL WETTED MATERIALS ARE COMPATIBLE WITH THE FLUID. IF IN DOUBT, CONSULT THE FACTORY BEFORE OPERATING!!!

CORRECTING READINGS FOR NEW LIQUID CONDITIONS

$$Q_a = Q_s \sqrt{\frac{p_s (p_f - p_a)}{p_a (p_f - p_s)}} \quad \text{or} \quad Q_a = Q_s \sqrt{\frac{d_s (d_f - d_a)}{d_a (d_f - d_s)}}$$

Where:
 Q_a = Actual flow, GPM (or same units as scale).
 Q_s = Meter reading from scale, (scale units).
 p_s = Specific gravity of calibration liquid related to water in std. atmosphere at 70° F. being 1.00.
 p_a = Specific gravity of metered liquid, same base.
 d_s = Density of calibration liquid, lbs/ft³.
 d_a = Density of metered liquid, lbs/ft³.
 p_f = Specific gravity of meter float.
 d_f = Density of meter float as per table below.

FLOAT SPECIFIC GRAVITY/DENSITIES

Material	pf	df
Stainless Steel	8.05	501.1

* "Average" for these floats is f = 3.50, df = 217.8.

EXAMPLE: Using a standard stainless steel meter scaled for water (s = 1.00), what is the conversion factor for an oil with a specific gravity of 0.85?

$$Q_a = 1.00 \times \sqrt{\frac{1.00 (8.05 - 0.85)}{0.85 (8.05 - 1.00)}} = 1.096$$

CORRECTING READINGS FOR NEW GAS CONDITIONS

$$Q_g = Q_s \sqrt{\frac{P_g \times T_s \times p_s}{P_s \times T_g \times p_g}}$$

Where:
 Q_g = SCFM, corrected to new conditions.
 Q_s = SCFM read on meter scale.
 P_g = Operating pressure, psia (psig + 14.7).
 P_s = Pressure stated on scale, psia (psig + 14.7).
 T_g = Operating temperature, absolute (°F + 460).
 T_s = Temperature stated on scale, absolute (°F + 460).
 p_g = Specific gravity of metered gas.
 p_s = Specific gravity stated on scale.

EXAMPLE: If using a standard meter scale for SCFM Dry Air @ 100 psig, 70°F on argon (SP. GR. = 1.378) at 50 psig, 100°F, what would the conversion factor be?

$$Q_a = 1.00 \times \sqrt{\frac{64.7 \times 1.00 \times 530}{114.7 \times 1.378 \times 560}} = 0.522$$

Thus, actual flow of argon would be observed scale reading times 0.622.

STEAM

Series TVF flowmeters may be used for vapors such as steam. The conversion factor may be determined with the following formula:

$$M_{fh} = Q_m \frac{5.879}{\sqrt{S_v}}$$

Where:

M_{fh} = Actual flow, lbs/hr.

Q_m = Meter scale reading, standard.
(SCFM Dry Air @ 100 psig, 70°F).

S_v = Specific volume of media (from steam tables).

EXAMPLE: When using a standard Series TVF gas meter scaled for SCFM Dry Air @ 100 psig, 70°F, what is the conversion factor for lbs/hr. steam at 50 psig, 300°F?

$$M_{fh} = 1 \times \frac{5.879}{\sqrt{6.727}}$$

Thus, actual flow of steam in lbs/hr. would be the observed scale reading times 2.267.

VISCOSITY CONSIDERATIONS:

Each Series TVF liquid flowmeter has a so-called "Viscosity Immunity Ceiling" (V.I.C.). Usually, if the viscosity of the metered liquid is less than the V.I.C. of the meter, the accuracy will not be influenced by changes in viscosity. When greater than the V.I.C., the meter will be influenced significantly, and must be calibrated for that viscosity. Effects of viscosity on a given flowmeter are not always predictable. Two apparently similar liquids with comparable densities and viscosities may impact meter calibrations quite differently. The table below provides general guidelines for the typical maximum viscosity for meter models without affecting accuracy.

AVERAGE V.I.C., CENTISTROKES, FOR STANDARD SERIES TVF FLOWMETERS

100% GPM, 3/4" SIZE	CTS	100% GPM, 1-1/2" SIZE	CTS
0.54 - 0.80	3	11.0 - 15.0	50
1.20 - 2.60	7	21.0 - 35.0	100
3.80 - 7.00	15	50.0	250
10.0 - 23.0	25	70.0 - 120	500

CAUTION: BE SURE PRESSURE IS FULLY VENTED AND FLUIDS COMPLETELY DRAINED BEFORE DISASSEMBLING THE FLOWMETER. WEAR SAFETY GLASSES AND PROTECTIVE CLOTHING IF THERE IS ANY CHANCE OF EXPOSURE TO HAZARDOUS CHEMICALS!!!

DISASSEMBLY

The sight tubes of all standard Series TVF Flowmeters may be removed by, depending on model type: (a) removing the cotter pins and pulling the lock rings out horizontally; (b) removing the bolts from the body/sight tube flange; or (c) removing the internal snap ring with retaining ring pliers. Using hands only, pull the sight tube straight up out of the body with a slight twisting motion, lifting it clear of the body and snorkel or guide rod. Remove the float assembly by lifting it up and away from the snorkel/guide rod. The core tube assembly may then be lifted out — if stuck, CAREFULLY pry up at the top of the slot with a brass rod, taking care not to damage the body or core tube. On Series TVF models, the spider ring, O-ring, will come out with the core tube. If the core tube is stuck, try removing the metal spider ring first.

INSPECTION & CLEANING

Inspect parts for nicks, scratches, chips, wear, and contaminant build-up. The edges of the core tube slot, ID of the core tube, and OD of the piston (largest section at the float assembly bottom) are precision machined. Damage to these areas can destroy the meter's accuracy. Also inspect the O-ring, the bottom section of the sight tube, and the inside of the upper body section. Damage to these areas may result in leaking. Clean, rinse, and dry all parts carefully, including the O-ring, preferably with a mild detergent and water and a soft cloth or soft tube brush. If solvents are used, make sure they are compatible with all meter parts (plastic sight tubes may be attacked by chemical vapors or solvents —consult the factory).

CAUTION: DO NOT SCRAPE OR USE ABRASIVE MATERIALS FOR CLEANING!!!

ASSEMBLY

Replace all parts in reverse order of disassembly. Note the small key on the core tube that must be aligned with a corresponding keyway in the meter body. Seat the O-ring on the sight tube before assembly. Lubricate the O-ring with a small amount of service compatible silicone grease or petroleum jelly to facilitate replacement.

After replacing the internals, using hands only, press the sight tube firmly down into the meter body with a twisting motion. Be careful not to rock the sight tube side to side and bend the snorkel tube/guide inward where it might interfere with float movement. Rotate sight tube as necessary for scale visibility and/or alignment of slots for lock ring tabs. Reinsert lock rings and cotter pins, lower flange and snap ring (be sure snap ring engages groove in body), or flange bolts (do not over tighten).

If reassembled correctly, the top edge of the indicator disk should line up with the scale "zero". If it does not, disassemble the meter completely and carefully reassemble it, making sure core tube is completely seated in the body.

REPLACEMENT PARTS

Parts only need to be replaced if damaged. Any visible damage to the entire surface of the O-ring or sight tube (particularly from the bottom edge) indicates need for replacement. To insure accuracy, the inside surface of the meter core tube, slot edges, and OD of the float piston should be free of nicks, chips, with no visible erosion of any surfaces.

STORAGE REQUIREMENTS

There are no special requirements for Series TVF flowmeters and parts. They should be kept in a reasonably clean location away from excessive heat (over 120°F, 48°C.) or chemical or solvent fumes and vapors.

MAINTENANCE

Upon final installation of the Series TVF Flowmeters, no routine maintenance is required. A periodic check of the system calibration is recommended. The Series TVF Flowmeters are not field serviceable and should be returned if repair is needed (field repair should not be attempted and may void warranty). Be sure to include a brief description of the problem plus any relevant application notes. Contact customer service to receive a return good authorization number before shipping.

TROUBLESHOOTING

SYMPTOM	USUAL CAUSE	SUGGESTED REMEDY
FLOAT HANG-UP	Caused by particles, sludge, etc. (including failure to remove the plastic tubing used to block meter float during shipment) inside the core tube and/or sight tube holding float. A bent snorkel tube/guide rod (usually caused by careless disassembly or violent surges) may also be causing float to stick. Violent surges may also unseat the internals in extreme cases.	Remedies include tapping the meter gently to temporarily dislodge the float, but if problem reoccurs, meter should be disassembled & cleaned, and/or snorkel/guide rod straightened. If hang-up caused by sludge or pipe scale, clean lines & install a filter or other form of cleaner in supply line. If surges have caused the internals to unseat, install a de-surger, accumulator, etc. You may also wish to order a buffer kit — the buffer serves as a resilient cushion for the float, and prevents unseating.
FLOAT BOUNCE	Caused by pumping/compressor surges or other pulsation sources, loose valve disks or similar mechanical components, extreme violation of inlet piping recommendations, or for gas applications, harmonics commonly found in systems with low pressure, low density gas.	Modification of piping, such as addition of a de-surger, receiver, accumulator, vibration eliminators, loops, hoses, etc. between the source and meter should remedy the problem. Severe vibration may ultimately damage the meter, and should be avoided. If "bounce" seems to be from some other source, or shocks such as "water hammer" (a potentially dangerous condition), discontinue using the meter and contact factory.
APPARENT FALSE READINGS, GAS METERS	Gas density not according to calibration data (different pressure, temperature, gas, etc.), high water vapor content, saturated gas going into vapor or condensation phases, partially clogged core tube slot or foreign matter interfering with float movement, and/or violation of piping recommendations at high flow velocities.	Remedies include checking meter pressure & temperature, determining actual gas mixture density & correcting with appropriate formulae in this bulletin. Modifying inlet piping, relocating meter to point of higher temperature and/or lower pressure to eliminate vapor or condensation phase effects, and/or cleaning the meter (install filter or other form of cleaner if dirt repetitive problem) may also be required. If accuracy still questioned, return core tube/float assembly for calibration check.
APPARENT FALSE READINGS, LIQUID METERS	Liquid density not according to calibration data (different temperature or new liquid or liquid mixture), excessive dissolved or suspended solids or gases, partial clogging of core tube slot or foreign matter interfering with float movement, or viscosity levels above the meter's immunity index (V.I.C.). Note: If the meter is suspected of giving false readings, and none of the causes mentioned is found, please advise as to the method used in determining the suspected flow "error." Each flowmeter is individually calibrated by traceable methods, and carefully inspected. There may be some error in checking the meter against another standard.	By determining the actual density (due to changes in mixture, temperature, etc.), the correction formulae may be applied. If dissolved gases are in the liquid, some elimination means should be provided on the supply side (also recheck all piping, as improper seals at connection points are common sources of air in the liquid). If the metered liquid is near the boiling point producing partial "flash gas" at the meter, relocate the meter to point of lower temperature and/or higher pressure, or cool lines and/or increase system pressure. Note: It is potentially dangerous to meter near the "flash point" of any fluid, and this practice should be avoided. Consult the factory for recommendations. The previous recommendations regarding cleaning the meter and/or filtration will also solve problems due to dirt. If metering liquids with high viscosities, consult the factory (may require special calibration). If none of these causes seem to be present, return meter core tube/float assembly along with application data.

<p>APPARENT METER READING MIGRATION (reading changes but flow appears constant)</p>	<p>Frequently caused by use of soft disc type valves, which may need to be replaced with a valve more suited to flow control. Can also be indicative of changing fluid conditions (density, viscosity, etc.). Problems with other elements of the flow system, including leaks, clogged filters, pump/compressor wear, etc. may first appear as a change in meter reading — one of the functions of a flowmeter.</p>	<p>Verifying the proper fluid conditions are known and applying correction formulae as needed will remedy problems associated with changing fluids. Cleaning, servicing, and replacement and/or repair of other system components may be required.</p>
<p>LEAKAGE</p>	<p>If at the junction of the body and sight tube, it is indicative of either (a) damaged O-ring (most common); (b) damaged sight tube; or (c) damage to the gland section of the body. It may also be caused by improper reassembly of the flowmeter in the field. If there is leakage at the pipe connections to the meter, it is probably caused from over-tightening pipes on a prior installation (or the initial installation).</p>	<p>Replace any damaged parts immediately; using the proper assembly procedures indicated in this instruction and the assembly detail drawings. Remove the body and inspect for damage — if none is visible, check pipe threads, reapply proper thread lubricant/sealant, and reinstall. If leak persists, replace meter body.</p>

Note: All Series TVF flowmeters are hydrostatically pressure tested before they are shipped. Dwyer Instruments, Inc. encourages you to contact the factory with any questions regarding proper installation and operation of Series TVF flowmeters.

