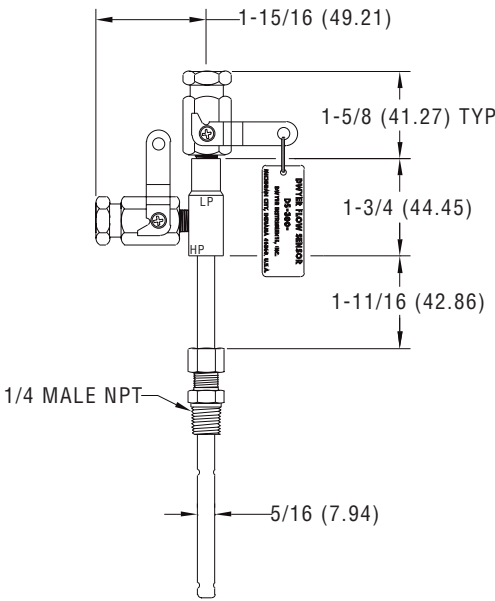




Series DS-300 Flow Sensors

Installation and Operating Instructions Flow Calculations



**Series DS-300 Flow Sensors** are averaging pitot tubes that provide accurate, convenient flow rate sensing. When purchased with a Dwyer Capsuhelic® for liquid flow or Magnehelic® for air flow, differential pressure gage of appropriate range, the result is a flow-indicating system delivered off the shelf at an economical price. Series DS-300 Flow Sensors are designed to be inserted in the pipeline through a compression fitting and are furnished with instrument shut-off valves on both pressure connections. Valves are fitted with 1/8" female NPT connections. Accessories include adapters with 1/4" SAE 45° flared ends compatible with hoses supplied with the Model A-471 Portable Capsuhelic® kit. Standard valves are rated at 200°F (93.3°C). Where valves are not required, they can be omitted at reduced cost. Series DS-300 Flow Sensors are available for pipe sizes from 1" to 10".

**INSPECTION**

Inspect sensor upon receipt of shipment to be certain it is as ordered and not damaged. If damaged, contact carrier.

**INSTALLATION**

**General** - The sensing ports of the flow sensor must be correctly positioned for measurement accuracy. The instrument connections on the sensor indicate correct positioning. The side connection is for total or high pressure and should be pointed upstream. The top connection is for static or low pressure.

**Location** - The sensor should be installed in the flowing line with as much straight run of pipe upstream as possible. A rule of thumb is to allow 10 - 15 pipe diameters upstream and 5 downstream. The table below lists recommended up and down piping.

**PRESSURE AND TEMPERATURE**

Maximum: 200 psig (13.78 bar) at 200°F (93.3°C).

Upstream and Downstream Dimensions in Terms of Internal Diameter of Pipe *			
Upstream Condition	Minimum Diameter of Straight Pipe		
	Upstream		Downstream
	In-Plane	Out of Plane	
One Elbow or Tee	7	9	5
Two 90° Bends in Same Plane	8	12	5
Two 90° Bends in Different Plane	18	24	5
Reducers or Expanders	8	8	5
All Valves**	24	24	5

\* Values shown are recommended spacing, in terms of internal diameter for normal industrial metering requirements. For laboratory or high accuracy work, add 25% to values.  
\*\* Includes gate, globe, plug and other throttling valves that are only partially opened. If valve is to be fully open, use values for pipe size change. **CONTROL VALVES SHOULD BE LOCATED AFTER THE FLOW SENSOR.**

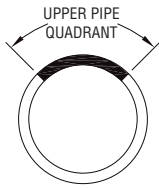
## POSITION

Be certain there is sufficient clearance between the mounting position and other pipes, walls, structures, etc, so that the sensor can be inserted through the mounting unit once the mounting unit has been installed onto the pipe.

Flow sensors should be positioned to keep air out of the instrument connecting lines on liquid flows and condensate out of the lines on gas flows. The easiest way to assure this is to install the sensor into the pipe so that air will bleed into, or condensate will drain back to, the pipe.

### For Air or Gas Flow

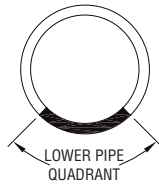
Install in upper quadrant of pipe



Condensate drains back to pipe

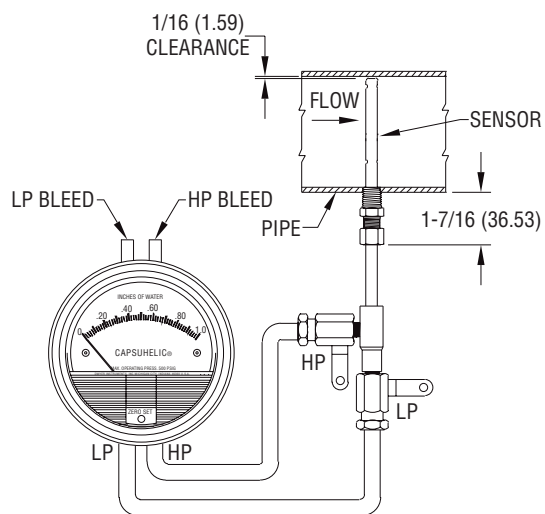
### For Liquid or Steam Flow

Install in lower quadrant of pipe



Air bleeds back to pipe

## Water Flow



## INSTALLATION

1. When using an A-160 thred-o-let, weld it to the pipe wall. If replacing a DS-200 unit, an A-161 bushing (1/4" x 3/8") will be needed.

2. Drill through center of the thred-o-let into the pipe with a drill that is slightly larger than the flow sensor diameter.

3. Install the packing gland using proper pipe sealant. If the packing gland is disassembled, note that the tapered end of the ferrule goes into the fitting body.

4. Insert sensor until it bottoms against opposite wall of the pipe, then withdraw 1/16" to allow for thermal expansion.

5. Tighten packing gland nut finger tight. Then tighten nut with a wrench an additional 1-1/4 turns. Be sure to hold the sensor body with a second wrench to prevent the sensor from turning.

## INSTRUMENT CONNECTION

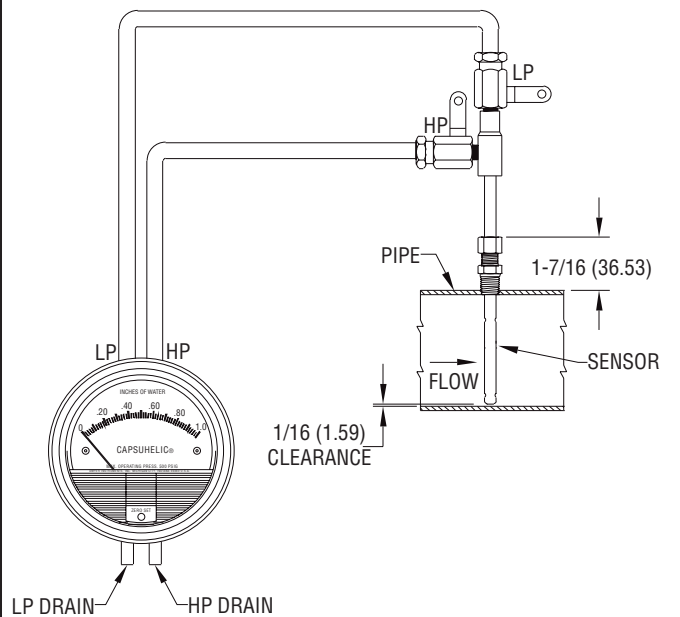
Connect the slide pressure tap to the high pressure port of the Magnehelic® (air only) or Capsuhelic® gage or transmitting instrument and the top connection to the low pressure port.

See the connection schematics below.

Bleed air from instrument piping on liquid flows. Drain any condensate from the instrument piping on air and gas flows.

Open valves to instrument to place flow meter into service. For permanent installations, a 3-valve manifold is recommended to allow the gage to be zero checked without interrupting the flow. The Dwyer A-471 Portable Test Kit includes such a device.

## Air or Gas Flow





## FLOW EQUATIONS

1. Any Liquid

$$Q \text{ (GPM)} = 5.668 \times K \times D^2 \times \sqrt{\Delta P / S_f}$$

2. Steam or Any Gas

$$Q \text{ (lb/Hr)} = 359.1 \times K \times D^2 \times \sqrt{p \times \Delta P}$$

3. Any Gas

$$Q \text{ (SCFM)} = 128.8 \times K \times D^2 \times \sqrt{\frac{P \times \Delta P}{(T + 460) \times S_s}}$$

## DIFFERENTIAL PRESSURE EQUATIONS

1. Any Liquid

$$\Delta P \text{ (in. WC)} = \frac{Q^2 \times S_f}{K^2 \times D^4 \times 32.14}$$

2. Steam or Any Gas

$$\Delta P \text{ (in. WC)} = \frac{Q^2}{K^2 \times D^4 \times p \times 128,900}$$

3. Any Gas

$$\Delta P \text{ (in. WC)} = \frac{Q^2 \times S_s \times (T + 460)}{K^2 \times D^4 \times P \times 16,590}$$

## Technical Notations

The following notations apply:

$\Delta P$  = Differential pressure expressed in inches of water column

Q = Flow expressed in GPM, SCFM, or PPH as shown in equation

K = Flow coefficient— See values tabulated on Pg. 3.

D = Inside diameter of line size expressed in inches.

For square or rectangular ducts, use:  $D = \sqrt{\frac{4 \times \text{Height} \times \text{Width}}{\pi}}$

P = Static Line pressure (psia)

T = Temperature in degrees Fahrenheit (plus 460 = °Rankine)

p = Density of medium in pounds per square foot

$S_f$  = Sp Gr at flowing conditions

$S_s$  = Sp Gr at 60°F (15.6°C)

## SCFM TO ACFM EQUATION

$$\text{SCFM} = \text{ACFM} \times \left( \frac{14.7 + \text{PSIG}}{14.7} \right) \times \left( \frac{520^*}{460 + ^\circ\text{F}} \right)$$

$$\text{ACFM} = \text{SCFM} \times \left( \frac{14.7}{14.7 + \text{PSIG}} \right) \times \left( \frac{460 + ^\circ\text{F}}{520} \right)$$

$$\frac{\text{POUNDS PER STD. CUBIC FOOT}}{\text{POUNDS PER ACT. CUBIC FOOT}} = \left( \frac{14.7}{14.7 + \text{PSIG}} \right) \times \left( \frac{460 + ^\circ\text{F}}{520^*} \right)$$

$$\frac{\text{POUNDS PER ACT. CUBIC FOOT}}{\text{POUNDS PER STD. CUBIC FOOT}} = \left( \frac{14.7 + \text{PSIG}}{14.7} \right) \times \left( \frac{520^*}{460 + ^\circ\text{F}} \right)$$

1 Cubic foot of air = 0.076 pounds per cubic foot at 60° F (15.6°C) and 14.7 psia.

\* (520° = 460 + 60°) Std. Temp. Rankine