Averaging Pitot Tubes

- **Liquid, Gas and Steam Flow Measurement**
- **Low Installation Costs**
- **Long Term Accuracy**
- **Minimal Unrecovered Pressure Loss**
- **Suitable for Large Pipes and Ducts**
- **'Hot-Tap' Versions Available**
- **Optional Integral Manifold**
- **Flow Transmitters Fitted**
- **Mass Flow Measurement**

General Description

The Averaging Pitot Tube is a differential pressure producer suitable for liquid, gas and steam flow measurement. It offers simple, low cost installation into pipes and ducts, and high energy savings due to its low unrecovered pressure loss. There are no moving parts or sharp edges to wear, so long term accuracy can be maintained.

'Hot-Tap' versions are available which allow the Averaging Pitot Tube to be withdrawn from the process whilst still under pressure.

Versions fitted with an optional manifold allow close mounting of differential pressure transmitters. For true mass flow measurement, a multivariable transmitter may be fitted.

Specification

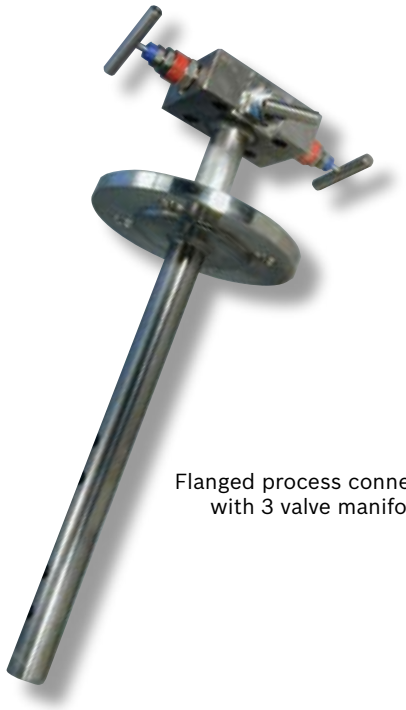
Pipe Sizes
Standard Averaging Pitot Tubes can be provided to suit pipe sizes from 80 mm up to several metres in diameter. Flow in square and rectangular ducts may also be measured by Averaging Pitot Tubes. For small pipe sizes, in-line Pitot devices are available.

Probe Diameter
Depending on pipe size and process conditions, probe diameters may be 13 mm, 25 mm or 60 mm (nominal).

Materials
Averaging Pitot Tubes are provided in 316L Stainless Steel as standard. Other material grades are available to special order, including Duplex Stainless Steel , Monel® 400 and Hastelloy® C-276.

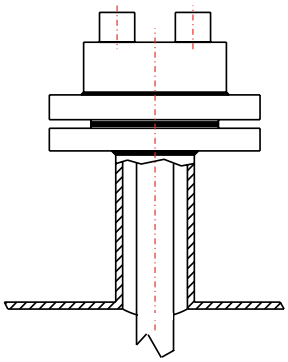
Process Connection
Connections to the pipe may be either flanged or screwed. A wide choice of sizes and ratings are available.

Impulse Connection
Averaging Pitot Tubes may be specified with a variety of impulse connections including threaded, socket weld or flanged. Primary isolation valves may also be supplied, appropriate to the process temperature and pressure.

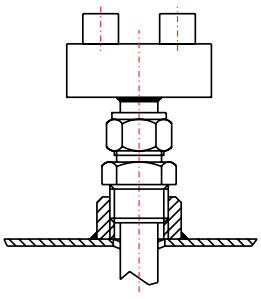


Flanged process connection with 3 valve manifold

Averaging Pitot Tube



Flanged Process Connection



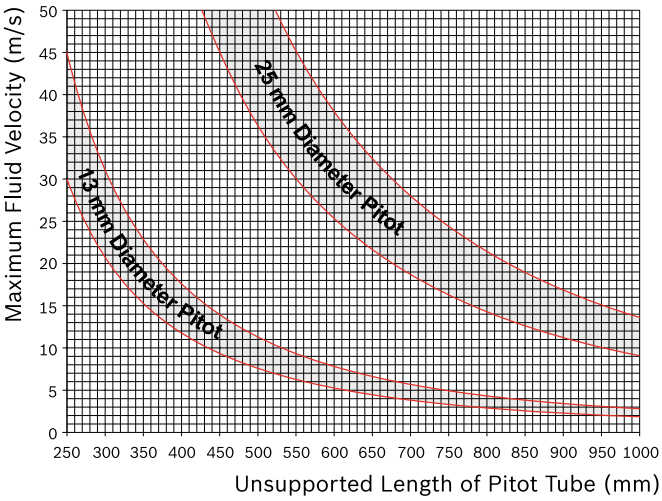
Screwed Process Connection

Opposite Supports

When fluid flows past an Averaging Pitot Tube, vortices form at both sides of the probe. These vortices detach, first from one side, and then from the other. This phenomenon is known as the Von Karmann effect. The frequency of shedding of these vortices is a function of the diameter of the Pitot Tube, the fluid velocity and, to a lesser extent, the Reynolds number. The vortex shedding subjects the Pitot Tube to a periodic transverse force. As the vortex shedding frequency approaches the natural frequency of the Pitot Tube, it will oscillate, and is liable to snap off. This effect is taken into account when designing the Pitot Tube.

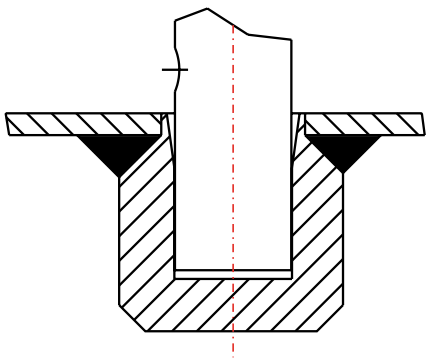
When the natural frequency of the Averaging Pitot Tube coincides with the vortex shedding frequency a lower support may be used to counteract these effects. Opposite supports can be provided in any material in line with the pipe specification.

The graph below gives some general guidance as to the flowing velocities to be avoided. All Averaging Pitot Tubes are provided with a wake frequency calculation as standard.



Method of Fixing Opposite Support

The method of welding the opposite support into the pipe is shown in the figure below.



Flow Calculations

Flow rate and differential pressure are related by a square root law of the form

$$\Delta P = \frac{1}{2}\frac{\rho \times v^2}{K^2}$$

where ΔP is the generated differential pressure in Pascals, ρ is the density of the fluid at the operating conditions in kg/m3, v is the fluid velocity in m/s and K is the flow coefficient.
K is constant over a wide Reynolds number range, and so the square root law is obeyed over a wide flow range.

Meter Accuracy

Ideally installed in turbulent flowing conditions an accuracy of better than ±1.5% is achievable over a flow range of 4:1. The flow turn-down is limited by the operating range and accuracy of the differential pressure transmitter. Repeatability is typically ±0.1%, dependent on secondary instrumentation.

Unrecovered Pressure Loss

Averaging Pitot Tubes present only a small obstruction to the flow, particularly when compared to orifice plates. Consequently, unrecovered pressure loss is low. The table below shows approximate values of unrecovered pressure loss, as a percentage of the measured differential pressure.

Line Size	Probe Diameter 25 mm	Probe Diameter 13 mm
50 mm	N/A	20
150 mm	10	5
250 mm	6	3
450 mm	4	1
750 mm	3	
1000 mm	Negligible	

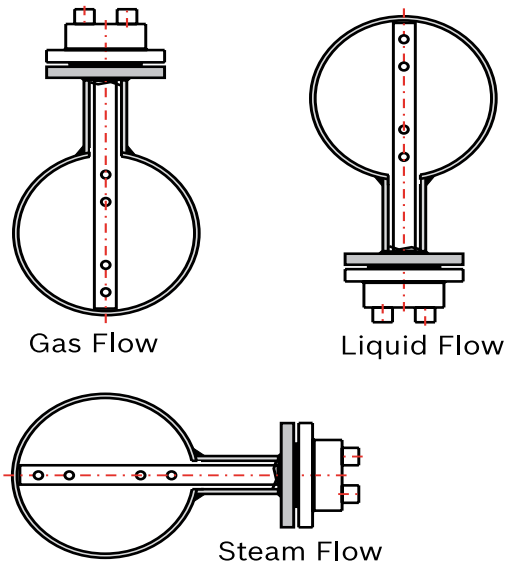
Installation

Averaging Pitot Tubes must be installed at right angles to the pipe diameter.

Preferred mounting arrangements for gas, liquid and steam flow applications in horizontal pipes are shown below.

Averaging Pitot Tubes may also be used in vertical lines. In this instance, the location of the Pitot head may be at any angular position. Pitot tubes for installation in vertical lines may be specified with a head which is rotated through 90 degrees. This ensures that the DP connections are at the same level.

Recommended Orientation



Straight Pipe Lengths

In common with other differential pressure primary flow elements, Averaging Pitot Tubes require a well developed flow profile. Disturbances created by various pipe configurations can reduce measurement accuracy. Recommended upstream and downstream straight pipe lengths are shown below, in terms of multiples of the pipe diameter.

Averaging Pitot Tubes installed with shorter pipe lengths can still provide a repeatable flow measurement.

Upstream Disturbance	Upstream Diameters Pitot in Plane	Upstream Diameters Pitot out of Plane	Downstream Diameters
	5	7	3
	8	11	3
	12 In plane of last bend	18	4
	6	7	3
	15	18	4

Integral Manifold Version

For applications requiring close mounting of the differential pressure transmitter, Averaging Pitot tubes may be provided with an integral 3 or 5 valve manifold. No impulse lines are required, reducing installation costs and improving response times.

Close mounting of the transmitter is not always possible, because of the temperature limitations of the transmitter (typically about 85ºC). In such cases a remote mounting configuration is required.

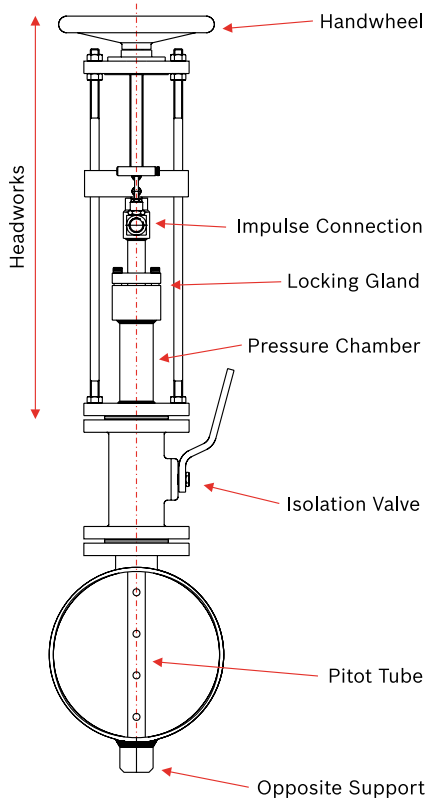
Hot-Tap Version

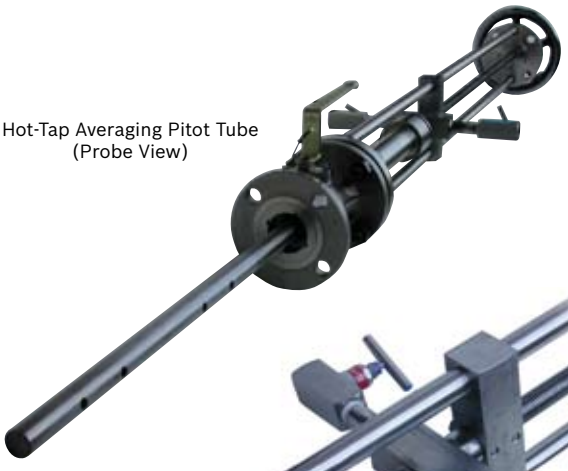
The 'Hot-Tap' versions allow the Averaging Pitot Tube to be withdrawn from the fluid under flowing conditions.

A gate or ball valve is used to allow sealing after removal. A pressure chamber prevents fluid leaking to atmosphere during removal through the averaging Pitot ports.

Flanged fitting is the preferred option for Hot-Tap Pitots.

The headworks are manufactured in stainless steel as standard, and handwheel operation is provided. Typically, at least three times the pipe diameter of headroom is required for clearance during removal.





Hot-Tap Averaging Pitot Tube (Probe View)

Locking Gland & Impulse Connection detail

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