PITOT TUBE SELECTION AND SIZING GUIDE

Vibration Calculations

Natural frequency or resonant vibrations can inhibit performance. Checks should be made during sizing. The checks will guide you to the proper probe with a resonant vibration range outside your anticipated operating flow range.

FOR ALL APPLICATIONS, VIBRATION CHECKS MUST BE MADE.

Natural frequency vibration is caused by the force created as vortices are shed by a pitot tube. At a critical point (which is a function of probe geometry, probe material and the velocity of the flowing fluid), a destructive natural frequency vibration is created which can lead to probe failure.

To an extent, we can adjust the point at which this destructive vibration occurs by using varying probe diameters or by improving the probe's resistance to vibration by providing a second mounting support. Ideally, the destructive vibration range should be above the maximum anticipated flowrate. This removes the vibration concern from the flow application. A pitot tube can also be used if the vibration range is well below the anticipated operating flow range. The process flowrate can pass through the vibration range, but the flow should not be allowed to remain within the vibration range continuously.

The equations below yield the flowrate range **which must be avoided** when selecting a pitot tube. The calculated flow range is representative of the point of natural frequency vibration for the probe including a ±20% safety factor. If operated continuously within the calculated danger range, probe failure may result.

AVOID VELOCITY RANGE from:

$$\text{Vel (lower limit)} = \frac{5252.7 \times M \times Pr \times DIA}{L^2}$$

where:

Vel = fluid velocity, feet per second

M = mounting factor (3.52 for single mount)

Pr = probe factor, (see TABLE 1 below)

DIA = probe diameter, (in inches)

L = unsupported probe length (in inches; see TABLE 1 below)

TO

$$\text{Vel (upper limit)} = \frac{7879.0 \times M \times Pr \times DIA}{L^2}$$

The upper and lower limit velocities obtained define the destructive vibration range. Convert velocity into Actual Cubic Feet per Minute

(ACFM) or Standard Cubic Feet per Minute (SCFM) using the equations below. Then compare the calculated vibration range to your anticipated operating flow range and refer to the last column on this page to interpret of your results.

$ACFM = Vel \times I.D.^2 \times 0.3272$

$SCFM = ACFM \times 35.37 \times P/T$

$PPH = ACFM \times \rho \times 60$

where:

ACFM = Actual Cubic Feet per Minute at flowing conditions

SCFM = Standard Cubic Feet per Minute at 14.7 psi and 15°C (60°F)

PPH = Pounds Per Hour

Vel = Velocity, (feet per second)

I.D. = pipe Inside Diameter, (inches)

P = inlet Pressure, (psia)

T = inlet Temperature, °R (°R = 460°F)

ρ = density, (pounds per cubic foot)

COMPARISON OF VIBRATION RANGE TO OPERATING FLOWRATE RANGE

A. Vibration range calculated above is greater than operating flow range; selection is OK.

B. Vibration range falls within operating flow range. Rerun vibration check using double mount, larger probe diameter or both, as necessary.

— If check is OK, then the new selection is OK.

— If vibration range is still within 70% of the minimum operating flow, try a smaller probe and see "C" below.

C. Vibration range is less than 30% of minimum operating flow range. Selection is OK, provided: (1) flowrate is not allowed to remain within calculated vibration range; and (2) requirements of pressure differential are satisfied.

TABLE I

Probe Diameter	Probe Factor (Pr)	Unsupported Probe Length L (inches)
⅜"	0.185	I.D.+ Wall + 1.25*
½"	0.269	I.D.+ Wall + 1.50*
¾"	0.372	I.D.+ Wall + 1.56
1"	0.552	I.D.+ Wall + 1.94

*For FPT-6300 Series, consult Flow Department