PRESSURE DROP OF KURZ INSERTION MASS FLOW ELEMENTS

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Introduction

Several customers have been interested in the pressure drop caused by the sensor support, sensor and sensor shield of our 1/4", 1/2" and 1" Single-Point and 1" and 1 1/2" Multi-Point Insertion Mass Flow Elements. Because of our design the pressure drop is negligible for most situations, and is usually much less than for competitive thermal mass flow meters, venturi, airfoils, orifices and Pitot tube arrays.

Basic Assumptions and Equations

Assuming 25% pressure recovery of the flow around our sensor support, the pressure drop is proportional to the increase in the average velocity through the pipe caused by sensor support flow blockage.

$$\Delta P = .00225 \left(\frac{\rho_s}{\rho_s} \right) \rho_s V_s^2 \left[\left(\frac{1}{SBCF} \right)^2 - 1 \right] [in \ H_2O]$$

Where:

$$\rho_s = Std.\ density = .0738\ [\#m/FT^3]\ at\ 25\,℃,\ and\ 760\ mm\ Hg$$

$$\rho_a = actual\ density\ [\#m/FT^3]$$

$$V_s = Std.\ velocity\ [SFPS]$$

SBCF is the sensor blockage correction factor:

$$SBCF = \left(1 - \frac{A_S}{A_D} \right)$$

Where:

$$A_S = area\ of\ sensor\ support$$

$$A_D = area\ of\ duct\ or\ pipe$$

As an example, consider a 6" I.D. pipe, at a pressure of 7.5 PSIG, air temperature (T_A) of 200°F ambient pressure (P_A) of 14.7 PSIA, a standard velocity of 100 SFPS a 1/2" diameter sensor support inserted 3" into the pipe and standard conditions of P_S = 14.7 PSIA, T_S = 77°F:

$$\frac{\rho_S}{\rho_A} = \left(\frac{P_S}{P_A} \; x \; \frac{T_A}{T_S}\right) = \left(\frac{147}{14.7 + 7.5}\right)\left(\frac{460 + 200}{460 + 77}\right) = .8138$$

$$A_S = \left(\frac{3'' \; x \; .5''}{144}\right) = .0104 \; [FT^2]$$

$$A_D \left(\frac{\pi \; x \; 6^2}{576}\right) = 0.1963 \; [FT^2]$$

$$SBCF = 0.947 \; (from \;\; DCN \; 364002)$$

$$\Delta P = .00225 \; x \; .0738 \; x \; .8138 \; x \; (100)^2 \left[\left(\frac{1}{.947}\right)^2 - 1\right] = \Delta P = 0.1555 \; [in \;\; H_2O]$$

Conclusion

As can be observed, the pressure drop is very small for a typical Kurz System. The Recommended Sensor Placement Criteria (DCN 364002) is followed. The pressure drop of Kurz equipment is much less than of competitive devices, including Venturis, airfoils, and Pitot tube arrays. This can result in large savings in fan and compression electrical power consumption (See DCN 364014).