THERMATEL®
Enhanced Model TA2
Probe Location

PROBE INSTALLATION

The insertion probe used with Magnetrol's TA2 measures the mass flow at the point the sensor is located. Therefore, the measured flow is affected by the flow profile in the pipe or duct.

The recommended location of the probe is at the center line of the pipe. With a fully developed turbulent flow profile, the velocity profile at this point is relatively flat as shown in Figure 1. For the majority of gas flow applications a turbulent flow profile condition will exist.

Theoretically, the velocity at the wall of the pipe is zero and the velocity at the center line is 20 % higher than the average velocity. However this flow profile will change slightly with changes in flow rate and pipe roughness (Figure 1). Our recommendations for placing the sensor at the center line is because the flow profile at this location is relatively flat and is less effected by changes in flow profile. This location is also used as it establishes a reference for calculation of the probe blockage factor.

A fully developed turbulent flow profile is obtained with sufficient length of straight run. The amount of straight run is dependent upon the upstream conditions. As the gas flows around an elbow, the momentum causes the gas velocity on the outside of the elbow to increase and the velocity on the inside to decrease (Figure 2). A double elbow further complicates the flow profile.

In addition to changing the flow profile, as the gas flows around an elbow, a rotational component or swirl is introduced into the flow (Figure 3). Given sufficient length, the swirl pattern will dissipate and the flow profile will redevelop.

Historically it has been considered that the flow meter should be located 10 diameters downstream and 5 diameters upstream from an elbow to obtain a developed flow profile. Recent investigations by NIST (National Institute for Standards and Technology) have shown that these dimensions are not adequate, especially in cases where there is a double out of plane elbow (Figure 4).

Based upon this and other data, Magnetrol has developed the following recommendations for the optimum location of the probe for several common installation configurations. These are shown in Figure 4.

Most process flow measurement requires repeatability in flow measurement. Despite the fact that today's process plants often do not provide sufficient straight run to obtain optimum flow profile, an insertion probe with less straight run than indicated can still provide desirable, repeatable flow measurement.

The TA2 Mass Flow Transmitter permits the user to enter correction factors via the software which will adjust the measured flow for the flow profile. This can easily be done and the procedure is included in the instruction manual. We have seen applications where users have inserted the probe directly in a large air duct for combustion air control. The probe is located a short distance from a 90° bend. A repeatable flow measurement is obtained to permit the user to optimize the operation of the boiler (Figure 5).

In other cases where the probe is installed in a non-ideal location, users have used the probe supplied with the instrument to determine the flow profile and establish the relationship between the average flow and the measured flow at the point the probe in inserted. A correction factor is determined and entered into the software.

The TA2 with insertion probe will provide excellent repeatable flow measurement based upon the flow profile in the pipe. The user has the ability to adjust the flow measurements. The above suggestions serve as a guide for optimum conditions, however, it must be recognized that optimum conditions rarely exist and repeatability in flow measurements is generally accepted.

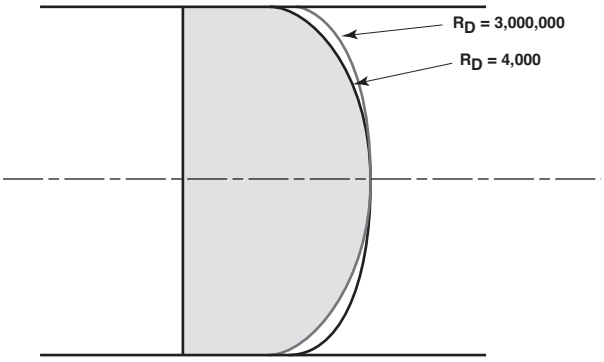


Figure 1
Turbulent flow profile

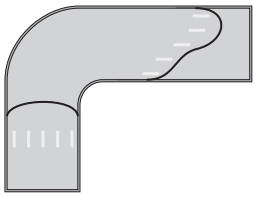
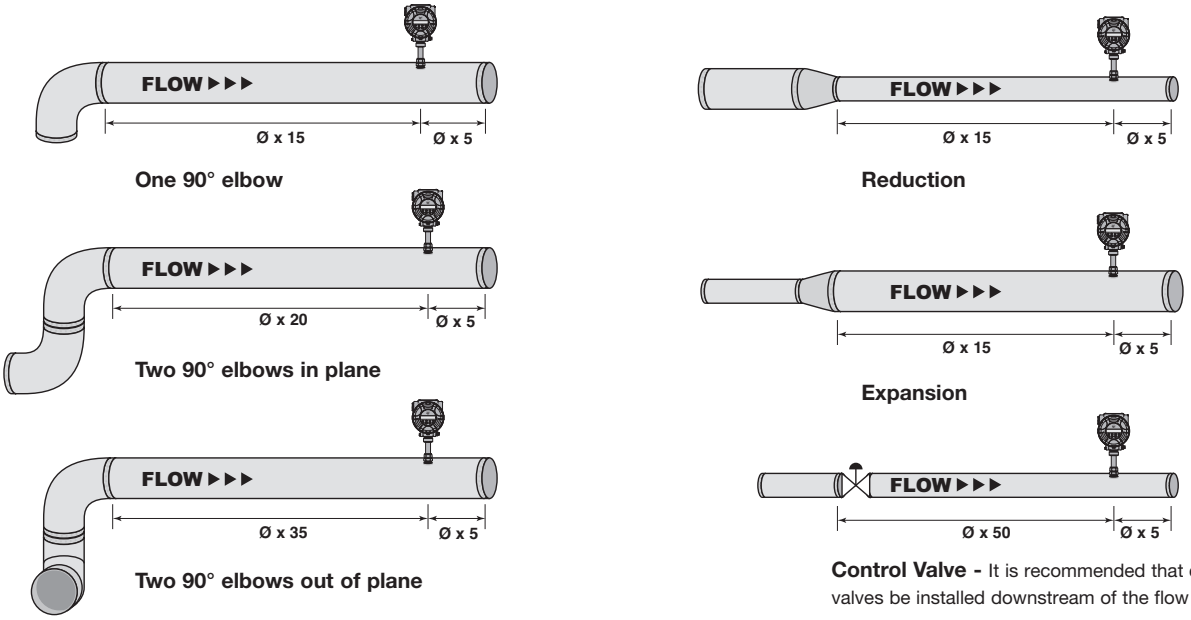


Figure 2
Flow profile following single elbow



Control Valve - It is recommended that control valves be installed downstream of the flow meter

Figure 4 – Probe Installations

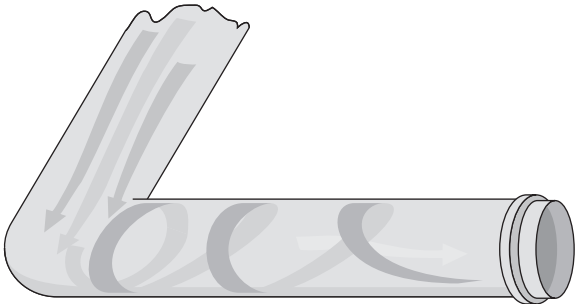


Figure 3

Swirl patterns in a pipe

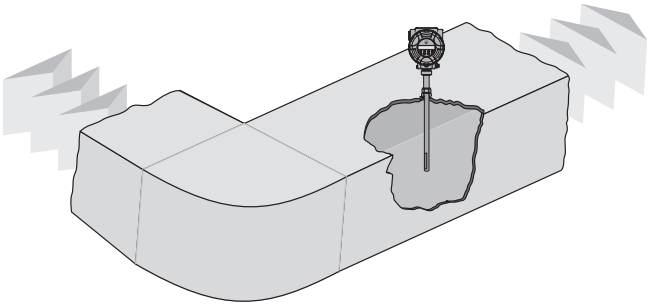


Figure 5

Probe in a duct downstream of elbow

References:

Richard W. Miller, Flow Measurement Engineering Handbook, Second Edition, 1989, McGraw-Hill Book Company

"Flowmeter Installation Effects Due to Several Elbow Configurations", G. E. Mattingly and T. T. Yeh, National Institute of Standards and Technology, 1992

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