

MEMO

From: F. Baneyx
Subject: Air Flow Measurements

Our plant has been using a combination of orifice meters, thermal mass flow meters and Venturi meters to measure the average velocity and flow rate of air through our piping system. However, the plant is now interested in measuring the maximum velocity in the center of the pipes but does not want to replace all of the meters. In one section of piping a Pitot tube has been added to allow you to measure the maximum velocity and to compare those measurements with those from the upstream Venturi meter and the orifice meter. Please provide a plot showing a comparison of the average velocities obtained with all flow meters over a range of Reynolds numbers. Figure 10-13 (Perry's Handbook, 8th Edition) provides a correlation between the maximum velocity and the average velocity for a pitot tube. Each plot should span the widest range of Reynolds numbers possible and include at least five Re values in between maximum and minimum. For three flow conditions, determine the velocity profile across the pipe using the Pitot traverse and determine how it is affected by the downstream elbow.

A variable speed fan controls the flow rate of air throughout the piping system, and an electrical heater control the energy input into the gas. Before taking measurements a short amount of time is needed to reach a steady state. Consider this when planning your experiment setup.

When measuring flow rates with the Pitot tube, you may wish to use the electronic differential pressure sensor to measure pressure difference. The sensor provides a linear voltage output varying from 2 to 10 volts as the pressure difference varies from 0 to 0.25 inches of water. The sensor's voltage output can be read on a computer display. The value is "filtered" (by averaging a specified number of sequential measurements) to reduce the impact of "noise", i.e., rapid pressure fluctuations caused by fan blade rotation and turbulence. The other option is to use the manometer system (equipped with micrometers for measurement of small pressure differences). In either case, describe and justify your procedures.