SCHOOL OF NUCLEAR ENGINEERING

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NUCL 355

Experiment #3

Basic Flow Measurement

Objective: To study the measurement of air flow rate in a circular tube using the following measuring devices:
1. Flow Nozzle
2. Pitot-Static Probe
3. Orifice plate
4. Venturi Tube

Specifically:

1. Using standard ASME correlation for C_d , calculate flow rate for venturi, nozzle and orifice plate.
2. Using pitot tube plot velocity distribution in the pipe. Integrate your local measurement to obtain flow rate and compare with venturi flow rate.

Experimental Apparatus: Fully assembled experimental apparatus is shown in Fig. 1. The apparatus
consist of a honey comb structure (1), at the inlet of pipe to reduce the entrance effect. The flow device attached upstream of the pipe is a venturi tube (2) with throat to main diameter ratio: 1.25 to 2.00 in inches. Following venturi tube in series is , ASME flow nozzle (3) with throat to main diameter ratio: 1.25 to 2.00 in inches. Following flow nozzle is a pitot-static probe (4) for local velocity measurement. The pitot probe is attached to a traversing mechanism with a micrometer (5) to obtain different radial locations. The last device is an orifice meter (7) 1.25 inch. A number of pressure taps (8) are provided along the orifice meter to study the pressure drop across orifice, total pressure loss and pressure recovery.

All measuring devices are connected in series as shown in Fig.1, along the length of 2.0 inch ID plexiglass tube (10), with the help of couplings (9). The air flow is provided by a suction pump system (11) at the exit of the plexiglass tube. The bulk velocity range in the pipe will be of the order of 5 to 20 meters per second. Venturi tube, orifice meter and nozzle are provided with appropriate pressure sense lines to measure pressure drop due to air flow. These flow meters are provided with manometers to facilitate measurement of pressure drop across each meters and to estimate pressure drop along the length of the pipe. In figure 2 and 3 the

manometers used for static probe and venturi, nozzle and orifice meters are shown.

Procedure:

1. Turn air pump on and find maximum and minimum flow rate for the reading range of manometer (12), so that about 5 sets of different flow rates can be obtained.

2. For each flow rate wait until the flow is stabilized (2-3 minutes) which can be seen from the steady level of the manometers.

3. Take measurements with manometers (13,14,15) for pressure drop across venturi meter, orifice meter and ASME nozzle respectively. Using pitot-static probe and traversing mechanism, measure the pressure drop for different radial locations. Choose at -least 5-8 radial locations from pipe center to pipe wall each flow rate, so that a smooth radial velocity profile of the flow in the pope can be obtained.

4. Change air flow to next setting. Repeat the above steps for all each settings.

References:

1. White F., “Fluid Mechanics”, 3rd Ed,chapter 6, Mc Oraw Hill Book Company, 1986.

2. Benedict, Robert P., “Fundamentals of Temperature, Pressure and Flow Measurements”, Wiley Intrescience, 1984.

3. Streeter, Victor L. and Wyke, E. Benjamin, “Fluid Mechanics”, McGraw Hill Book Company, 1985, Chap. 5 and 9.

4. Bean, H.S., “Fluid Meters”, 6th Ed, ASME,1971.

Precautions:

1. Do not disturb the experimental apparatus during the experiment.

2. Make sure that experimental setup is leveled horizontally.

3. Make sure there is no leaks in the pressure sense line and test pipe.

4. Make sure manometer levels are steady before taking reading.

5. Take special care while replacing orifice plate.

Write-up:

1. Use venturi measurements as standard to calibrate the rest of the flow meters against (i.e.: obtain the ratio of the measured flows to the venturi flow).

2. Discuss the difference between integral and local measurements.

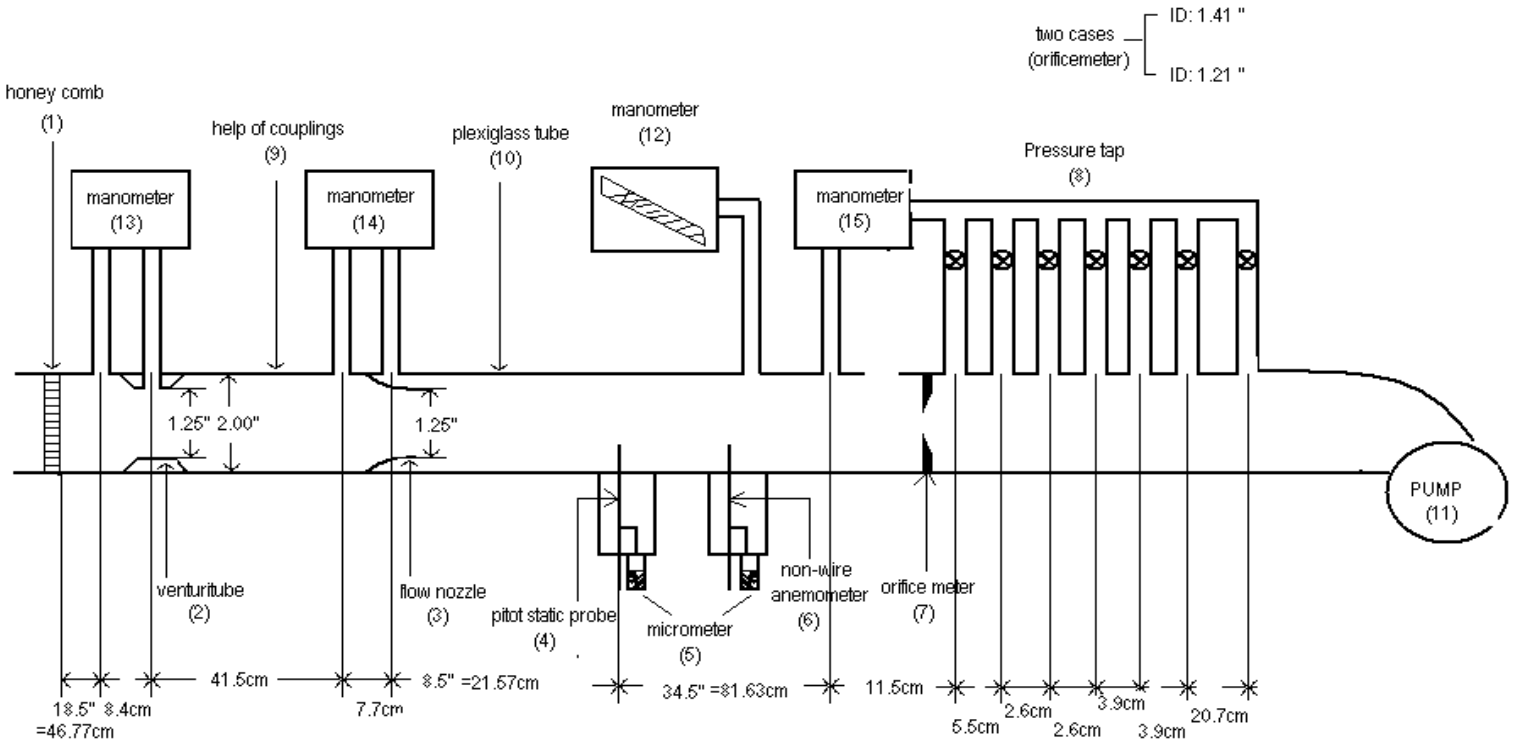

Figure 1: Flow Measurement