CEE 342 Laboratory Exercise: Flow Meter Calibration

A "venturi meter" is a device for determining fluid velocities based on the pressure difference between two closely-spaced locations in a pipe, between which the cross-section of the pipe decreases smoothly. For sufficiently high Reynolds number, Re (a composite parameter that reflects a combination of factors: $\mathrm{Re} = vd\rho / \mu$), the pressure difference across the venturi meter is proportional to the square of the flow rate. Equivalently, the flow rate is expected to be proportional to the square root of the pressure difference. Thus, a plot of flow rate, Q, vs Δp should have a slope of 0.5 on a log-log plot:

$$Q = K\left(\Delta p\right)^{0.5} \qquad (1)$$

At smaller Reynolds numbers (smaller flow rates, for a fixed pipe diameter and fluid temperature), the relationship deviates from the proportionality shown above. As a result, a plot of Q vs Δp might be approximately linear on a log-log plot, but with a slope that is slightly less than 0.5.

Figure 1 shows a schematic of the commercial venturi meter that we will use (a Barco 1-1/2 inch [manufacturer designation] venturi meter). The upstream pressure tap is at a stagnation point, and the downstream tap is at the narrowest point in the constriction. For this laboratory exercise, the meter has been inserted into a 1.5-inch diameter schedule 80 PVC pipe. The objective of the exercise is to calibrate the flow meter, so that the number read on the output device (a digital volt meter) can be translated directly to the fluid flow rate in cubic feet per second.

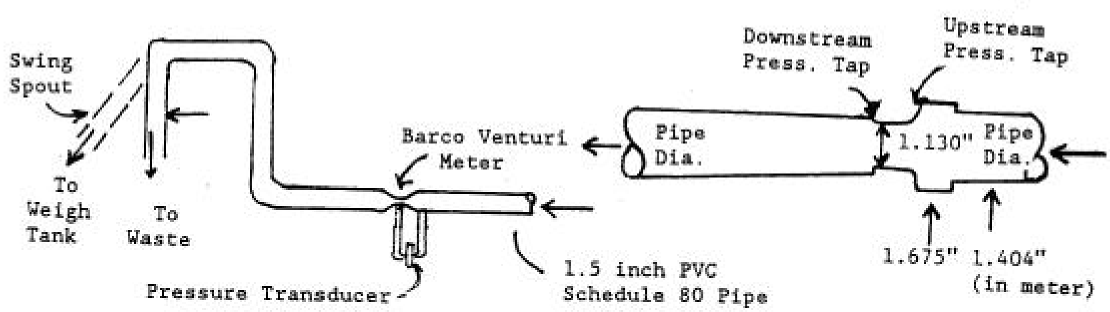

Figure 1. Schematic showing Barco meter location and meter dimensions.

In the system to be calibrated, the two taps of the venturi meter are connected to an Omega PS26-015DV semiconductor differential pressure transducer. This transducer is, in turn, connected to a millivolt meter (Omega DP205-S), which shows a millivolt reading that is proportional to the pressure difference sensed by the transducer. The number shown on the millivolt meter does not have units; however this number is linearly proportional to the piezometric (pressure plus elevation) head difference between the upstream and downstream taps; if the meter is positioned horizontally, the piezometric head difference equals the pressure difference. Thus, when the semiconductor pressure transducer and the millivolt meter are used, the relationship in Equation 1 becomes:

$$Q = K\left(\Delta M\right)^{0.5} \qquad (2)$$

where $\Delta M = M - M_0$, and M_0 is the millivolt reading when $Q = 0$. M_0 accounts for any constant offset reading of the millivolt meter when $Q = 0$.

For this lab, you will collect data for the flow rate and the millivolt reading for at least five different flow rates corresponding to a meter range of 2.5 to 25 mV. Determine the flow rate by recording the time required to collect approximately 200 lb of water in the weighing tank. Record the water temperature (there is a thermometer in the pipeline which supplies the Barco meter) and use standard tables from your text to determine the specific weight of water for each test.

Refer to the grading sheet for items to be included in the lab report. You only need to show one example calculation of Q, but show the results of this calculation for all runs.

CIVE 342B Lab 2 Grading

Report Section	Points Possible
1. Cover sheet	required
2. Table of Contents	required
3. Lab data sheet	required
4. Introduction	2
5. Calculation results for Q (ft^3/s) in all five runs	3
6. Example calculation of Q (one run only)	2
7. Graph of Q vs $(M_1)^{0.5}$	3
8. Graph of log Q vs log M_1 on linear (not logarithmic axes)	
a. Graph	3
b. Slope from graph	3
9. Discussion	
Compare theory vs. observation	4
TOTAL	30