LAB 7 – FLOWMETER CALIBRATION AND HEAD LOSS

LEARNING OUTCOMES

1. Demonstrate the head loss across different types of flow meters
2. Compute the velocity across a venturi meter, orifice plate, and variable area meter
3. Compute the head loss across these flow measuring devices

In this experiment, we will use the Flow Meter Test Apparatus (shown in Figure 1) connected to the Armfield Hydraulic Bench to measure the flow across different types of flow meters such as the Venturi meter, a variable area meter and an orifice plate. These flow meters are installed in a series configuration to allow for direct comparison.

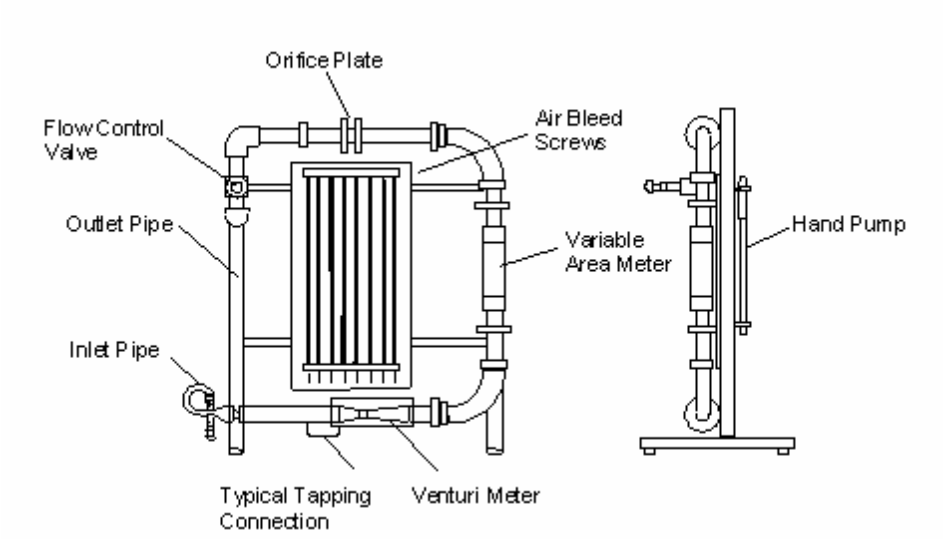

Figure 1. Schematic diagram of the orifice and jet apparatus

EXPERIMENTAL PROCEDURE

1. Ensure that the equipment is horizontal and start the pump
2. At a fixed flow rate, record all manometer heights and the variable area meter reading
3. Measure the flow rate using a stopwatch and collecting the water in a volumetric tank
4. Take four repeat measurements for four different flowrates
5. Switch off the pump and close the main valve.

THEORY AND DATA ANALYSIS

Application of the Bernoulli's equation yields the follow results for Venturi meter and the orifice plate.

$$Q_v = \frac{C_d A_i}{\sqrt{1 - \left(\frac{A_i}{A_1}\right)^2}} \sqrt{2g\Delta h} \quad (1)$$

Where Δh is the head difference in m determined from the manometer readings for the appropriate meter, as given above, g is the acceleration due to gravity, C_d is the discharge coefficient for the meter, A_1 (7.92×10^{-4}) is the area of the test pipe upstream of the meter, A_i is the area of venturi meter (1.77×10^{-4}) or the orifice plate (3.14×10^{-4}). The manometers are connected so that the following pressure differences (Δh) can be obtained using the differences shown in Table 1

Table 1: Pressure difference and the manometer levels for different

Δh	**Parameter**
h_1-h_3	Venturi loss
h_4-h_5	Variable area loss
h_6-h_8	Orifice plate loss

The coefficient of discharge for Venturi meter is 0.98 and the orifice plate is 0.63.

TL;DR

	Parameter	**Equation**
1	Experimental Flowrate (Q)	$\frac{Volume}{Time}$
3	Pressure difference	Table 1
4	Venturi meter flowrate	Eq. 1 with Venturi meter area
5	Orifice plate flowrate	Eq. 1 with Orifice plate area

DELIVERABLES

One team lab report containing the following

1. Letter of Transmittal (example: http://users.rowan.edu/~jagadish/resources/LoT_Example.pdf)
2. Materials and Methods
   a. In paragraph format explain what materials you used
   b. Explain the procedure for collecting data in your own words in paragraph format
   c. Explain the method for analyzing the data collected in lab. Retype all the equations, screenshotting is not permitted. Use subscripts and superscript where necessary
3. Results and Discussion
   a. In a table, reports the flowrates for the venturi meter, variable area meter, and orifice plate for all trials and their percentage errors with respect to the experimental flow rate
   b. Show a figure between Δh and Q^2 for each flow meter
   c. Discuss your results
      i. Comment on the accuracy of each type of the flow meter.
      ii. What is the reason for losses?
   d. All calculations must be included in appendix and should not be presented here
4. Conclusions
   a. Briefly summarize your results and explain what you learned.
5. Appendix
   a. Show one sample calculation here