King Abdulaziz University   MEP 365
College of Engineering   Thermal Measurements
Mechanical Engineering Department   Fall 2022
                                                    HW. # 11
                                                    Ch. 10 Flow measurement 2

1-Laminar elements are used to make sure the flow is laminar. Starting with the relation $f = 64/\text{Re}$, and using the Bernoulli's equation for the major losses in pipe, show that the appropriate equation for flow measurement using laminar element is given by:

$$Q = \frac{\pi d^4}{128\mu}\frac{(p_1 - p_2)}{L} \qquad \text{Re}_d < 2000$$

where p_1 and p_2 the pressures at location 1 and 2 (before and after the laminar elements), L is the distance between location 1 and location 2, and d is the tube inside diameter.

2-For each of the following flow meters, describe the idea of operation, draw sketches and explain how the meter is used to measure the volume flow rate
        i-Electro-magnetic flow meter
        ii-Rotameter
        iii-Turbine flow meter
        iv-Positive displacement flow meter
State the uncertainty and the turndown for each.

3-A vortex flow meter having a profile of a forward facing equilateral triangle (See Table 10.1) (St=0.19) with a characteristic length of 10 mm. Estimate the shedding frequency developed for 20°C air at 25 m/s in a 10 cm inside diameter pipe. Estimate the meter constant and the measured flow rate. **[10.33 m]**

4-A rotameter is to be designed to measure a maximum flow of 40 l/min of water at 25°C. The bob (float) has a 2.5 cm diameter and a total volume of 16.5 cm^3. The bob is constructed so that the density of bob is related to the fluid density by $\rho_b = 2\rho_f$. The total length of the meter is 33 cm, and the diameter of the tube at the inlet is 2.5 cm. Determine the tube taper (slope) (i.e. a=?) for the drag coefficient C$_d$=0.4. Determine the meter constant C$_1$ in the equation $\dot{m} = \frac{C_1 y \rho_b}{2}$?

5-Describe and draw a sketch for time transient flow meter. How this flow meter differ in operational idea than Doppler flow meter?

6-A thermal mass flow meter is used to meter air in a 1 cm inside diameter tube. The meter adds 15 W of energy to the air passing through the meter from which the meter senses a 3°C temperature gain. What is the mass flow rate? Take C$_{p=}$1.006 kJ/kg.K for air. **[10.32]**

7-A flow of air is measured to be 40 m^3/min at 50 mm Hg gage and 25°C. What is the flow rate in SCMM? **[10.34]**