

# Fluid Mechanics Problems and Solutions

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## Problem 1: Venturi Meter Flow Measurement

Given:

- Diameter at section 1 ( $D_1$ ) = 0.15 m
- Diameter at section 2 ( $D_2$ ) = 0.10 m
- Pressure at section 1 ( $P_1$ ) = 200 kPa
- Pressure at section 2 ( $P_2$ ) = 150 kPa
- Density of water ( $\rho$ ) = 1000 kg/m<sup>3</sup>
- Discharge coefficient ( $C_d$ ) = 0.98

Find: The flow rate through the Venturi meter.

**Solution:**

Step 1: Use Bernoulli's equation between sections 1 and 2:

$$P_1 + (1/2) * \rho * v_1^2 = P_2 + (1/2) * \rho * v_2^2$$

Rearrange to get:  $v_1^2 - v_2^2 = (2 * (P_1 - P_2)) / \rho$

Since velocity at section 1 is smaller, we approximate  $v_1 = 0$ .

$$\text{Thus: } v_2 = \sqrt{(2 * (P_1 - P_2)) / \rho}$$

Step 2: Use the Continuity Equation to relate the velocities:

$$A_1 * v_1 = A_2 * v_2 \rightarrow v_2 = (A_1 / A_2) * v_1$$

Step 3: Substitute and solve for  $v_1$  and  $v_2$ .

Finally, use  $Q = A_1 * v_1$  to calculate the flow rate  $Q$ .

## Problem 2: Orifice Plate Flow Measurement

Given:

- Diameter of the orifice ( $D_o$ ) = 0.05 m
- Pressure difference across the orifice ( $\Delta P$ ) = 20 kPa
- Discharge coefficient ( $C_d$ ) = 0.62
- Fluid density ( $\rho$ ) = 1000 kg/m<sup>3</sup>

Find: The flow rate  $Q$  through the orifice.

**Solution:**

Step 1: Use the orifice flow rate formula:

$$Q = C_d * A_o * \sqrt{(2 * \Delta P) / \rho}$$

Where  $A_o$  is the area of the orifice,  $A_o = \pi * (D_o)^2 / 4$

Step 2: Calculate the area of the orifice:

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