Experiment No. : 5
Name of the Experiment : Flow through an external cylindrical mouthpiece

APPARATUS:
- Constant head water tank,
- Orifice,
- Discharge measuring tank,
- Stop watch,
- Point gauge
THEORY

- If a small tube is attached to an orifice, it is called mouthpiece.
- The standard length of a mouthpiece is 3d, where d is the diameter of the orifice.
- If the length is less than 3d, jet after passing the vena contracta does not occupy the tube fully and thus acts as orifice.
- If the length is greater than 3d, it acts as pipe.
- The effect of adding a mouthpiece to an orifice is to increase the discharge.
- The pressure at vena contracta is less than atmospheric, so a mouthpiece decreases the pressure at vena contracta and increases the effective head causing the flow, hence, discharge is increased.
Consider an external cylindrical mouthpiece of area $A$ discharging water under a constant head $H$ as shown in the Figure 4.1. Applying the Bernoulli’s equation at point 1 and 3,

$$0 + H = \frac{V^2}{2g}$$

$$\Rightarrow V = \sqrt{2gH}$$

$$Q_t = A\sqrt{2gH}$$

$$C_d = \frac{Q_a}{Q_t}$$

For all practical purposes, the value of coefficient of discharge is taken as 0.855.
\[ A = \pi r^2 \]

\[ h_2 = 180 \]

\[ h_1 = 175 \]

\[ h = \frac{h_1 + h_2}{2} \]
OBJECTIVES
i) To find the value of $C_d$ for the mouthpiece.
ii) To plot $Q_a$ vs. $H$ in log-log graph paper and to find the value of (a) the exponent of $H$ and (b) $C_d$.

ASSIGNMENT
i. Explain why the discharge through an orifice is increased by fitting a standard short tube to it.
ii. What will happen to the coefficient of discharge if the tube is shorter than the standard length or the head causing the flow is relatively high?
iii. What is the effect of rounding the entrance of the mouthpiece?
iv. What is a submerged tube? Does the coefficient of the tube change due to submergence?
Discharge Measuring tank

Point Gauge

Constant head water tank

Discharge Measuring tank

Initial reading $t=0$

Final reading $t=30$ sec
**EXPERIMENTAL DATA SHEET**

Diameter of the mouthpiece, \( d = \) \[ \text{cm} \]
Area of the mouthpiece, \( A = \) \[ \text{cm}^2 \]
Cross sectional area of the measuring tank = \[ \text{cm}^2 \]
Head correction, \( h' = \) \[ \text{cm} \]

<table>
<thead>
<tr>
<th>No. of Obs.</th>
<th>Observed Head, ( h ) (cm)</th>
<th>Point Gauge Reading (cm)</th>
<th>Collection Time (Sec)</th>
<th>Actual Head ( H = h - h' ) (cm)</th>
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<td>Initial</td>
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<th>Volume of Water, ( V ) (cm³)</th>
<th>Actual Discharge, ( Q_a = \frac{V}{t} ) (cm³/s)</th>
<th>Theoretical Discharge, ( Q_t ) (cm³/s)</th>
<th>Coefficient of Discharge, ( C_d )</th>
<th>Average ( C_d ) From graph</th>
<th>( C_d ) From graph</th>
<th>( n ) From graph</th>
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Note:

\[ Q_a = C_d A \sqrt{2gH} = K'H^n \]

\[ \Rightarrow \log Q_a = \log K' + n \log H \]

\[ \log Q_{a1} = \log K' + n \log H_1 \]

\[ \log Q_{a2} = \log K' + n \log H_2 \]

\[ n = \frac{\log Q_{a2} - \log Q_{a1}}{\log H_2 - \log H_1} \]

\[ K' = \frac{Q_{a1}}{H_1^n} \]

\[ K' = C_d A \sqrt{2g} \]

\[ \Rightarrow C_d = \frac{K'}{A \sqrt{2g}} \]