Experiment No. :05  
Name of the Experiment : Flow through an external cylindrical mouthpiece

4.1 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.

The pressure at outlet is atmospheric but as the velocity of the vena contracta is greater than the velocity at outlet, the pressure at vena contracta will be less than atmospheric

Flow through an orifice cannot represent the flow through a pipe properly. Also in orifice, coefficient of discharge is only 0.62. So to increase discharge from a reservoir and represent the flow through pipe mouthpiece is used.

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,

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

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

Then, the theoretical discharge is given by, $Q_t = A\sqrt{2gH}$

Where $A$ is the area of the mouthpiece, $g$ is the acceleration due to gravity. Let, $Q_a$ be the actual discharge then the coefficient of discharge $C_d$ is given by

$$C_d = \frac{Q_a}{Q_t}$$
4.2 APPARATUS:

Constant head water tank, Orifice, Discharge measuring tank, Stop watch, Point gauge.

4.3 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) $C_d$.

4.4 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?

4.5 DISCUSSION:

Comments on the results, sources of error, nature of the curves etc.

Note:

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

$\Rightarrow \log Q_a = \log K' + n \log H$

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

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

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

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

$K' = C_d A\sqrt{2g}$

$\Rightarrow C_d = \frac{K'}{A\sqrt{2g}}$
**EXPERIMENTAL DATA SHEET**

Diameter of the mouthpiece, \( d = \) ____________ cm  
Area of the mouthpiece, \( A = \) ____________ cm\(^2\)  
Cross sectional area of the measuring tank = ______________ cm\(^2\)  
Head correction, \( h' = \) ______________ 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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<th>Volume of Water, ( V ) (cm(^3))</th>
<th>Actual Discharge, ( Q_s = \frac{V}{t} ) (cm(^3)/s)</th>
<th>Theoretical Discharge, ( Q_t ) (cm(^3)/s)</th>
<th>Coefficient of Discharge, ( C_d )</th>
<th>Average ( C_d )</th>
<th>( C_d ) From graph</th>
<th>( n ) From graph</th>
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