NATIONAL INSTITUTE OF TECHNOLOGY CALICUT

FLUID MECHANICS AND FLUID MACHINERY LABORATORY

Printed Lab Record

For

FRICITION FACTOR IN PIPE
Aim

To determine head loss due to friction in the specified pipe section and hence determine the friction factor.

Introduction

The major head loss in the pipe flow is due to frictional resistance. The generalised equation relating head loss and velocity is given as,

\[ h_f = f'P.lV^n \frac{A}{w} \]

where, \( h_f \) is head loss, \( f' \) is frictional resistance per unit area at unit velocity, \( P \) is the wetted perimeter, \( l \) is the length of the pipe, \( V \) is the velocity of flow, \( A \) is the area of cross section and \( w \) is the specific weight of the fluid flowing through the pipe. If \( n=2 \) and the circular pipe is running full, then the equations transform to Darcy’s formula given by:

\[ h_f = \frac{4fV^2}{2dg} \]

where, \( d \) is the diameter of the pipe and \( f \) is the Darcy’s coefficient of friction.

Specifications

1) Diameter of pipe:
2) Area of measuring tank:
3) Specific gravity of mercury :
4) Length of the pipe section =

Experimental Set-up

The experiment set up consists of section of pipe held between two pressure tappings. A manometer having mercury as a manometric fluid is connected to the tappings. This will measure the head difference between inlet & outlet of the pipe.
Working formulae

1. Head loss due to friction in meters of water, $h_f$

$$h_f = H(\delta_m - 1)$$

Where,

- $H$ = the height difference between two limbs of manometer in m
- $\delta_m$ = the specific gravity of manometer fluid.

2. Discharge rate, $Q$ (in m$^3$/s),

$$Q = \frac{Ax}{t}$$

Where

- $A$ = the area of cross section, in m$^2$
- $t$ = time taken for ‘$x$’ m rise in tank, in s
3. Reynolds number, \( Re \)

\[
Re = \frac{Vd}{\nu}
\]

Where,
- \( V \) = velocity of liquid, in m/s
- \( \nu \) = the kinematic viscosity, in m\(^2\)/s
- \( D \) = the diameter of the pipe, in m.

4. Velocity of liquid, \( V \)

\[
V = \frac{Q}{A}
\]

Where,
- \( Q \) = the discharge in m\(^3\)/s
- \( A \) = the cross sectional area of the pipe in m\(^2\).

5. Friction factor, \( f \)

\[
f = \frac{2gDh_f}{lV^2}
\]

Where,
- \( l \) = the length of the pipe in m
- \( D \) = the diameter of the pipe in m
- \( h_f \) = difference in pressure heads in meters of water.

6. A pipe friction calibration equation of the form, \( h_f = kV^n \) is obtained from regression analysis.

### Experimental procedure

- **Turn on flow control valve & set it for particular flow rate**
- **Close the drain valve & measure the time required for 5 cm rise in water level in measuring tank by stopwatch.**
- **Now change the flow rate and repeat the experiment**
- **Note down the manometric readings (for particular flow rate)**
Sample Calculation
## Observation Table

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Manometric readings</th>
<th>$h_f$ (m of water)</th>
<th>Time required for 5 cm rise in water level (s)</th>
<th>$Q_a$ ($m^3/s$)</th>
<th>$V$ (m/s)</th>
<th>$Re$</th>
<th>Friction factor $f$</th>
<th>$\ln Re$</th>
<th>$\ln h_f$ (y)</th>
<th>$\ln V$ (x)</th>
<th>$x^2$</th>
<th>$x^*y$</th>
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$$\sum y = \quad \sum x = \quad \sum x^2 = \quad \sum xy =$$
Graphs

- $f$ vs $\ln Re$
- $\ln h_f$ vs $\ln V$
- $h_f$ vs $V$

Result

<table>
<thead>
<tr>
<th>Average friction factor</th>
<th>$f =$</th>
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<tbody>
<tr>
<td>Calibration result by regression method</td>
<td>$h_f = _____ V^{----}$</td>
</tr>
<tr>
<td>Calibration result by graphical method</td>
<td>$h_f = _____ V^{----}$</td>
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Inference