Date:

Day: M T W T F S S

ID: 7379

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Subject: Fluid Mechanics I

Instructor: Sir Abdul Waheed

FINAL TERM.

Q1 (a): Define total energy head and various forms of energy head with mathematical equations.

ENERGY HEAD:

It is the sum of all energy heads at a point in a fluid.

FORMS OF ENERGY HEAD:

There are various forms of energy heads which are as follow:

1. Kinetic Head.
2. Potential Head.
3. Pressure Head.

KINETIC HEAD:

It is the

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Kinetic energy Per unit weight of the fluid.

MATHEMATICAL FORM:

$$\frac{K.E}{W} = \frac{1/2\ mv^2}{mg}$$

$$\frac{K.E}{W} = \frac{1}{2}\frac{v^2}{g}$$

→ This is also known as velocity Head.

UNIT:

Its unit is meter (m).

POTENTIAL HEAD:

It is the potential energy per unit weight of the fluid.

MATHEMATICAL FORM:

$$\frac{P.E}{W} = \frac{mgh}{mg} = h$$

PRESSURE HEAD:

The vertical height of the free surface above any point in a liquid

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at rest is Pressure head.

OR

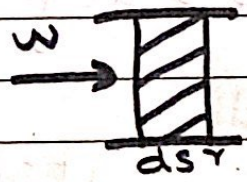
Level of fluid due to Pressure exerted by fluid.

MATHEMATICAL FORM:-

$$\text{Pressure Head} = \frac{\text{PrE}}{\text{weight}} = \frac{P}{\gamma}$$

OR

$$= \frac{F \cdot ds}{w}$$



$$= \frac{P \cdot A \cdot ds}{w}$$

$$= \frac{P \cdot V}{w} = \frac{P}{\gamma} \quad P \text{ is Pressure.}$$

Q1b: Define Hydraulic grade line, Energy line and hydraulic radius.

HYDRAULIC GRADE LINE:-

It is the line showing pressure head and potential head at a point in fluid. The HGL is drawn at top of

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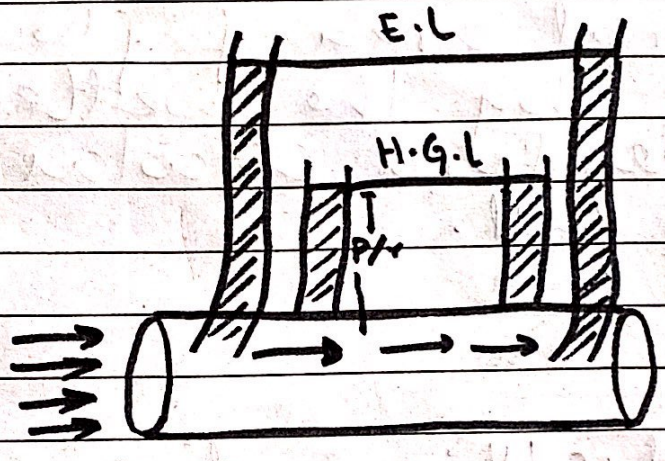
piezometer tube.

The line showing total head of fluid at any point is energy line. Line joining pitot tube is energy line.

$$HGL = \frac{P}{w} + z$$



ENERGY GRADE LINE :-

It is defined as the line which give the sum of pressure head, datum head and kinetic head of flowing fluid w.r.t some reference line

OR

The line which is obtain by connecting the top of all vertical ordinates showing the sum of pressure head & kinectical head.

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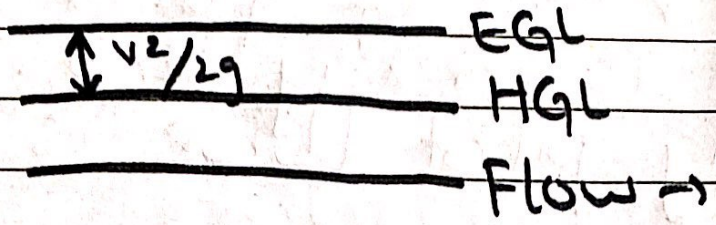
$$EGL = h_o = \frac{P}{w} + \frac{V^2}{2g} + Z$$



HYDRAULIC RADIUS :-

The cross-sectional area of flow divided by the wetted parimeter for a circular pipe flowing full.

$$R_H = \frac{A}{P_w}$$

The hydraulic radius is one fourth of diameter for a side rectangular channel. The hydraulic radius is approximately equal to depth.

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Q2(a): Calculate the total energy per unit weight of water if it is flowing with a mean velocity of 2m/s under a pressure of 300 kpa. The height above the datum is 5m.

DATA:

$V = 2 m/sec$

$p = 300 kpa = 300 \times 10^3 N/m^2$

$z = 5m$

$H = pressure\ Head + K.E + P.E$

Solution:

$$H = \frac{P}{\gamma} + \frac{x^2}{2g} + z$$

$$H = \frac{300 \times 10^3}{9810} + \frac{2}{2 \times 9.81} + 5$$

$$H = 30.58 + 0.101 + 5$$

$$H = 35.785\ Nm/N$$

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Q2 (b): A tapering pipe is having ---------- head loss is negligible.

Given Data:

Diameter = d_1 = 300 mm

= d_2 = 200 mm

P_1 = pressure = 300 kpa

= $300 \times 10^3 N/m^3$

P_2 = 120 kpa = $120 \times 10^3 N/m^2$

Datum = Z = ?

$Q = \frac{40}{1000}$ m^2/sec

d_1 = 300 mm = 0.3 m

d_2 = 200 mm = 0.2 m

Required:

Z_2 = ?

Solution:

$$A_1 = \frac{\pi d_1^2}{4}$$

$$A_1 = \frac{3.14 \times (0.3)^2}{4}$$

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$$A_1 = 0.0706 m^2$$

$$A_2 = \frac{\pi d_2^2}{4}$$

$$A_2 = \frac{3.14 \times (0.2)^2}{4}$$

$$A_2 = 0.0314 \ m^2$$

We know that

$$Q_1 = V_1 A_1$$

$$V_1 = Q / A_1$$

$$V_1 = \frac{0.04}{0.0706}$$

$$Q = \frac{40}{1000}$$

$$\Rightarrow 0.04$$

$$V_1 = 0.560$$

$$V_2 = Q / A_2$$

$$V_2 = \frac{0.04}{0.0314}$$

$$V_2 = 1.27$$

Now

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2$$

$z_1 = 0$, $\gamma = 9810$

$$\frac{300 \times 10^3}{9810} + \frac{0.566^2}{2(981)} + 0 = \frac{120 \times 10^3}{9810} + \frac{127^2}{2(981)} + z_2$$

$$30.59 = 12.314 + z_2$$

$$\boxed{z_2 = 18.276}$$

Q3: A 500 m long 0.2 m diameter pipe transport
- - - - - - - - - - - - - - - - - - - -
R is reynold's number.

DATA :-

Length of pipe = l = 500m
diameter = d = 0.2m
specific gravity of oil = 0.9
flow rate = $Q = 0.06 m^3/s$
Viscosity = $\mu = 6 \times 10^{-5}$ N.s/m^3

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Solution :-

Pressure loss = DP = ?

As we know

$$f = \left(0.0032 + \left(\frac{0.221}{R^{0.237}}\right)\right)$$

where R = Reynolds No. and is given as :-

$$R = \frac{V \times d}{\nu}$$

and $\nu = \frac{\mu}{\rho} = \frac{6 \times 10^{-5}}{900}$

$$\nu = 6.67 \times 10^{-8} \ m^2/s$$

and $V = \frac{Q}{A}$ ∴ for Circular pipe $A = \frac{\pi}{4} d^2$

$$= \frac{\pi}{4} (0.2)^2$$

$$A = 0.031 \ m^2$$

$$\Rightarrow V = \frac{0.06}{0.031}$$

$$\Rightarrow V = 1.95 \ m/s$$

Now eq (1) $\Rightarrow$

$$R = \frac{1.95 \times 0.2}{6.67 \times 10^{-5}} = 5.73 \times 10^6$$

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Now

$$f = 0.0032 + \frac{0.221}{(5.73 \times 10^6)^{0.237}}$$

$$\Rightarrow f = 8.79 \times 10^{-3}$$

$$\text{or } f = 0.00879$$

Now from Bernoulli's equation:

$$\text{Head loss} = h_L = \frac{f l v^2}{2gD} \longrightarrow ii$$

Putting values in eq — ii

$$h_L = \frac{(0.00879)(500)(1.95)^2}{2(9.81)(0.2)}$$

$$h_L = 4.259 m$$

Now, to find pressure loss due to friction

$$h_L = \frac{DP}{\delta g}$$

$$\Rightarrow Dp = h_L \times \delta g$$

put values

$$Dp = 4.259 \times 900 \times 9.81$$

$$\Rightarrow DP = 37602.7 pa$$

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=) $\Delta p = 37.602 \text{ Kpa}$