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Sec : "B"

Subject : Fluid Mechanic

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QNo 1 (Part a)

ENERGY HEAD

It is that sum of all energy head at a point in a fluid.

FORMS OF ENERGY HEAD:-

There are various form of energy head which are as follow.

1) Kinetic head.
2) Potential head.
3) Pressure head.

KINETIC HEAD:-

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

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MATHEMATICAL FORM.

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

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

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:

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

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PRESSURE HEAD:-

The vertical height of the free surface above any point in a liquid at rest is pressure head.

OR

Level of fluid due to pressure enerted by fluid.

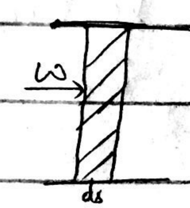
MATHEMATICAL FORM:-

$$\text{Pressure head} = \frac{P.E}{\text{weight}} = \frac{P}{r}$$

OR

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

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



$$= \frac{P.v}{w} \cdot \frac{P}{r}$$ is pressure.

QNo2 Part B

Hydraulic Grade Line:

It is the line showing the pressure head and the potential head at a point in fluid.

OR.

The surface or profile of water flowing in an open channel or pipe flowing partically full. If a pipe is under pressure. The hydraulic grade line is that level water would rise to in a small vertical tube connected to the pipe.

Energy Grade Line:

A line represent the elevation of energy head (in feet or meter), of water flowing in a

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pipe as channel. The line is drawn above the hydraulic grade line a distance equal to the velocity head ($v^2/2g$) of the water flowing at each section or channel.

OR.

It is the ~~unit~~ line joining the total heads along a pipe line.

Represented by E.G.L.

HYDRAULIC RADIUS:-

The ratio of cross sectional area of a channel or pipe in which a it flowing to the wetted permeter of the conduts.

Q NO: 2 (a)

Given Data.

$V = 2 m/sec$

$P = 300 \text{ kPa} = 300 \times 10^3 N/m^2$

$Z = 5m$

$H =$ pressure head + K.E + P.E

$$H = \frac{P}{\gamma} + \frac{v^2}{2g} + Z$$

$$H = \frac{300 \times 10^3}{9810} + \frac{4}{2 \times 9.81} + 5$$

$$H = 30.58 + 0.201 + 5$$

$$\boxed{H = 35.785 \, m}$$

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Q No 2

Part b.

Given Data

Diameter d_1 = 300mm = 0.3m

Diameter d_2 = 200mm = 0.2m

Pressure P_1 = 300 kpa = 300×10^3 N/m^2

Pressure P_2 = 120 kpa = 120×10^3 N/m^2

Flow Rate, Q = $\frac{40}{1000}$ m^3/sec = 0.04 m^3/sec

Required:

Datum, Z = ?

Solution:-

As we know

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

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

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$A_1 = 0.07065\ m^2$

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

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

$A_2 = 0.0314\ m^2$

Now as we know that

$Q = V_1 A_1$

$V_1 = \frac{Q}{A_1}$

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

$V_1 = 0.5661\ m/s$

And

$V_2 = \frac{Q}{A_2}$

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

$V_2 = 1.2738\ m/s.$

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Now

$$\Rightarrow \frac{P_1}{\gamma} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + Z_2$$

Where $Z_1 = 0$

$\gamma = 9810$

Putting values

$$\Rightarrow \frac{300 \times 10^3}{9810} + \frac{(0.566)^2}{2(9.81)} + 0 = \frac{120 \times 10^3}{9810} + \frac{(1.27)^2}{2(9.81)} + Z_2$$

$$\Rightarrow 30.597 = 12.314 + Z_2$$

$$\Rightarrow Z_2 = 30.597 - 12.314$$

$$\Rightarrow Z_2 = 18.282$$

$$\Rightarrow Z_2 = 18.282 m.$$

Hence

$$\boxed{Z_2 = 18.282m}$$

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Q No 3

A 500m — — — — — — -
— — — — — — — -
- — — — - - reynald's number?

Given Data:-

Length of the pipe, $L = 500m$
Diameter, $d = 0.2m$
Specific Gravity of oil $= 0.9$

Flow rate, $Q = 0.06 m^3/s$

Viscosity, $\mu = 6 \times 10^{-5}\ Ns/m^2$

Density, $\rho = 0.9 \times 1000 = 900 kg/m^3$

Required: + Sol:-

Pressure loss.

As we know that

$$\nu = \frac{\mu}{\rho}$$

$$= \frac{6 \times 10^{-5}}{900}$$

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

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Now we have to find "v"

$$V = \frac{Q}{A} \rightarrow (1)$$

Now for circular pipe

$$A = \frac{\pi d^2}{4}$$

$$\Rightarrow A = \frac{3.14(0.2)^2}{4}$$

$$A = 0.0314 m^2$$

Putting values in eq(1)

$$V = \frac{0.06}{0.0314}$$

$$\boxed{V = 1.91 m/s}$$

Now we know that

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

$$R = \frac{1.91 \times 0.2}{6.67 \times 10^{-8}}$$

$$\boxed{R = 5.72 \times 10^{6}}$$

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Now $f = 0.0032 + \frac{0.221}{(5.72\times10^{6})^{0.237}}$

$f = 0.0032 + (5.5320\times10^{-3})$

$$f = 8.73209\times10^{-3}$$

Now from Bernails equation

Head loss, $H_f = \frac{fLV^2}{2gD}$

Putting values

$H_f = \frac{fLV^2}{2gD}$

$= \frac{(8.73209\times10^{-3})(500)(1.91)^2}{2\times(9.81)(0.2}$

$H_f = 4.0590$

Now we know by press loss and head loss relation,

$h_f = \frac{\Delta P}{\gamma}$

$h_f = \frac{\Delta P}{\rho g}$

$\Delta P = h_f \rho g$

$\Delta P = 4.0590 \times 900 \times 9.81$

$\Delta P = 35837.47$ pa

$\Delta P = 35.837$ kpa

<u>Result:</u>

Hence pressure loss,

$\Delta P = 35.837$ kpa.

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