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Paper Fluid Mech

Module 2012 Batch

Q.NO 1
Part (a)

Define the energy head and various Form of energy head with mathematical equation?

Ans

Energy head:- It is the sum of all energy head at a point in a Fluid.

From of Energy head:- These are various Forms of energy head which are as follows.

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

1 **Kinetic head:-** It is the Kinetic energy per unit wt of the Fluid.

Mathematical Form:-

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

$$= \frac{1}{2} v^2/g$$

This is also known as velocity head.

→ **Unit:** Unit is meter. (m).

2) **Potential Head:-** It is potential energy per unit wt of fluid.

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

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

3) **Pressure Head:-** The vertical height of the free surface above any point in the liquid at rest is pressure Head.

OR

Level of fluid due to pressure ~~exerted~~ exerted by fluid.

Mathematical Form:-

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

OR.

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

$$\frac{P \cdot A \cdot ds}{W}$$

$$= \frac{P \cdot V}{W} = \frac{P}{\gamma}$$ is pressure.

Q.6b Define Hydraulic grade line, Energy line and hydraulic radius.

Ans:- **Hydraulic grade Line:-** The surface or profile of water flowing in an open channel or a pipe flowing partially 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. Also see energy grade line.

Energy grade line:-

A line that represents the elevation of energy head in feet or meters. of the water flowing in a pipe conduit or channel. The line is draw above the hydraulic grade line (gradient) a distance equal to the velocity head ($v^2/2g$) of the water flowing at each section or point along the pipe or channel.

Hydraulic radius:- Is defined as the cross-sectional area of Flow divided by the wetted perimeter So the Calculation of rectangle and trapezoid area and triangle area will be included along with the perimeter for each.

Q2 part(A)

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

ans Sol:-

Given Data:

velocity = 2m/s.

Pressure = 300 Kpa.

datum = 5m

solution ;→ H = P. Head + K.E + P.E

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

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

$$\boxed{H = 35.7849\ m.}$$ Ans

Q7b A tapering pipe is having diameter 300 mm at bottom end and 200mm a top end. The intensity of pressure of ~~300~~ at bottom end and top end are 300Kpa and 120 ~~bottom. If the water~~ ~~Flow~~ Kpa respectively. Determine the difference in datum head b/w top and bottom if water flow rate through pipe is 40 liters per Second. Assume that head loss is negligible.

Sol

Given data.

Diameter $= d_1 = 300\,mm \Rightarrow 0.3\,m$

Diameter $= d_2 = 200\,mm \Rightarrow 0.2\,m$

pressure $= p_1 = 300\,KPa = 300 \times 10^3\,N/m^2$

$p_2 = 120\,KPa = 120 \times 10^3\,N/m^2$

Datum $= Z = ?$

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

Required

$Z_2 = ?$

Sol

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

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

$$\boxed{A_1 = 0.0706\ m^2}$$

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

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

$$\boxed{A_2 = 0.0314\ m^2}$$

we know that

$$Q_1 = V_1 A_1$$

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

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

$$\boxed{V_1 = 0.566}$$

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

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

$$\boxed{V_2 = 1.27}$$

Now

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

$Z_1 = 0$
$\gamma = 9810$

$$\frac{300 \times 10^3}{9810} + \frac{0.566^2}{2(981)} + 0 = \frac{120 \times 10^3}{9810} + \frac{1.27^2}{2(9.81)} + Z_2$$

$$30.59 = 12.314 + Z_2$$

$$\boxed{Z_2 = 18.276}$$ Ans

Q3 A 500m long 0.2 m diameter pipe transport an oil of specific gravity 0.9 & viscosity 6×10^{-5} N.s/m² at rate of 0.06 m³/s. Find pressure loss due to friction. Use Darcy friction coefficient $F = [0.032 + (0.221/R^{0.237})]$ where R is reynold number.

To find :- pressure loss = ΔP = ?

Given 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 = $\mu = 6\times10^{-5}\ Ns/m^2$

Solution

As we know that

$$\nu = \frac{\mu}{\rho} = \frac{6\times10^{-5}}{900}$$

$$\boxed{\nu = 6.67\times10^{-8}\ m^2/s}$$

And $v = \frac{Q}{A}$

$= \frac{0.06}{0.0314}$

$v = 1.91 \, m/s$

Now

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

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

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

Now As we know that

$f = 0.0032 + \frac{0.221}{(5.72 \times 10^{6})^{(0.237)}}$

$f = 8.7309 \times 10^{-3}$

Now from Bernoulli's Equation.

Head loss.

$H_f = \frac{f l v^2}{2 g D}$

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$$= \frac{(8.73209)(500)(1.91)^2}{2(9.81)(0.2)}$$

$$\boxed{Hf = 4.0590}$$

As we know that from pressure head and head loss relation.

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

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

$$\Delta P = hf \cdot \rho g$$

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

$$\Delta P = 35837.45 \text{ Pa}.$$

$$\boxed{\Delta P = 35.837 \text{ KPa}.}$$

Result:
Hence Pressure Loss = ΔP = 35.837 KPa