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Section "B"

Subject # Fluid Mechanics

Date # 25-6-2020

QUESTION #01

Ans:-

Energy Head:-

"Energy head is the sum of all energy heads at the point in a fluid."

Forms OF ENERGY Head:-

There are various form of energy mentioned as fallow.

- Kinetic Head.
- Potential Head.
- Pressure Head.

:Kinetic Head:

"Kinetic head is the kinetic energy per unit weight of the fluid."

: Mathematical Form:

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

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

* "Kinetic head is also known as velocity Head."

: Unit:

"Meter" (m)

: Potential Head:

"Potential head is the Potential energy per unit weight of the fluid"

Mathematically:

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

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Pressure Head:-

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

Other definition:

"Level of Fluid due to pressure exerted by fluid"

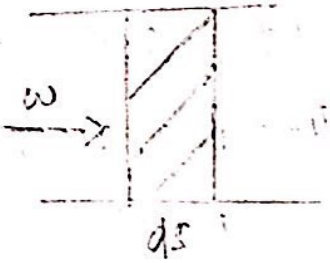
Mathematicaley:

Pressure head

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

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

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



(4) (Part -b)

Ans:-

: Hydraulic grade line:

"Hydraulic grade line refers to the profile of water streaming in an open channel or a pipe streaming in part full."

When a pipe is under pressure, the pressure driven reviewo line is the level to which the water would ascend to in a little, vertical Tube associated with the pipe

: Equation of hydraulic grade line:

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

(5) where, Z is the height above the datum level and distance is $\frac{P}{\gamma}$.

⇒ EGL refer to a line that represent to the height of energy head of water streaming in a pipe, course, or channel. The line is drawn over the pressure hydraulic grade line (inclination) a separation equivalent to the speed head ($V^2/2g$) of water streaming at every area or point along the pipe/channel.

Equation of EGL:

$$EGL = h_0 = \frac{P}{\gamma} + \frac{V^2}{2g} + Z$$

⇒ This equation of energy grade line.

⇒ The hydraulic grade line and energy grade line figure-"a" is shown as below.

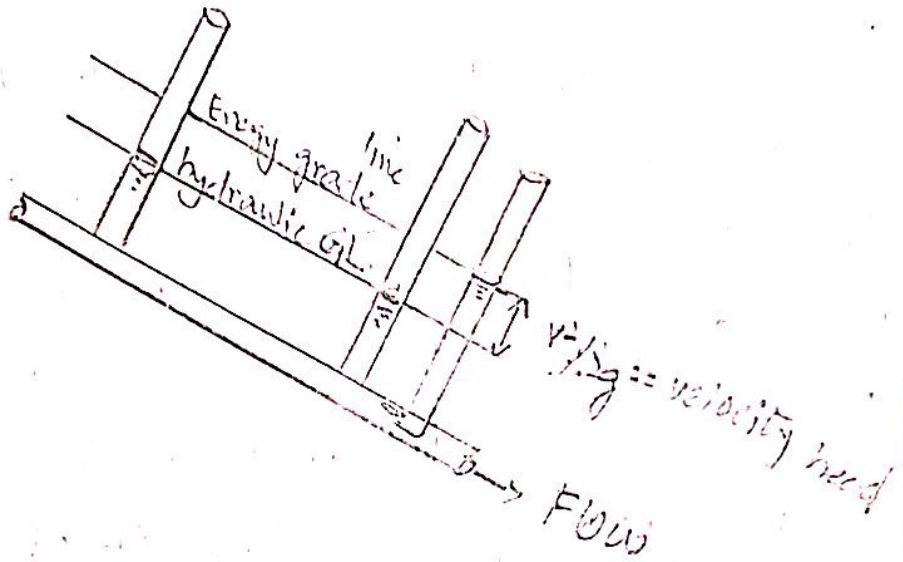


Figure : GL

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QUESTION # 02

Solution :-

Given Data :-

→ Velocity = 2 m/s

→ Pressure = 300 kpa = 300×10^3 N/m²

→ datum = Z = 5 m

→ H = pressure Head + K.E + P.E

Required :-

" Total energy per unit weight of water = ? "

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

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

$$H = 30.58 + 0.101 + 5$$

$$\boxed{H = 35.785 \text{ Nm/N}}$$

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(QUESTION # 02 Part-b)

A tapping pipe ..... negligible

: Solution :

Given Data

Pressure = $P_1 = 300 kPa = 300 \times 10^3 \ N/m^2$

Diameter, $d_1 = 300mm = 0.3m$

Diameter, $d_2 = 200mm = 0.2m$

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

Flow rate, $Q = \frac{400}{1000} \ m^3/sec = 0.04 \ m^3/sec$

Required:

Datum = Z

Now Solution

We know that

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

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

$$A_1 = 0.07065 m^2$$

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

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

$$A_2 = 0.0314 m^2$$

Now As we know that

$$Q = V_1 A_1$$

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

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

$$V_1 = 0.5661 \ m/s$$

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And

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

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

$$V_2 = 1.2738 \text{ m/s}$$

Now

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

where $Z_1 = 0$

$\gamma = 9810$

=> Putting values

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

=> $30.598 = 12.314 + Z_2$

$Z_2 = 30.597 - 12.314$

$Z_2 = 18.282 \text{ m}$

Hence $Z_2 = 18.282 \text{ m}$

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(11) QUESTION #03

Ans.

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

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

=> Required DATA:

Pressure loss, $\Delta P = ?$

=> Solution:

As we know that

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

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

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

Now we have to find "V"

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

Now for circular pipe

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

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

$$\Rightarrow A = 0.0314 \ m^2$$

Put value in eq (1)

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

$$V = 1.91 \ m/s$$

Now we know that

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

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

(13) $R = 5.72 \times 10^{+6}$

Now

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

$$\Rightarrow f = 0.0032 + (5.532 \times 10^{-3})$$

$$\Rightarrow f = 8.732\,09 \times 10^{-3}$$

$\Rightarrow$: Now From Bernoulli's Equation:

$$\text{Head Loss, } HF = \frac{f L V^2}{2gD}$$

putting values

$$HF = \frac{f L V^2}{2gD}$$

$$= \frac{(8.732\,09 \times 10^{-3})(500)(1.91)^2}{2 \times (9.81)(0.2)}$$

(14) $HF = 4.0590$

⇒ Now we know by pressure loss and Head loss relation.

$$\Rightarrow h_f = \frac{\Delta P}{V}$$

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

$$\Rightarrow \Delta P = h_f \rho g$$

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

$$\Rightarrow \Delta P = 35837.47 \text{ pa}$$

$$\Rightarrow \Delta P = 35.837 \text{ kpa}$$

Result:

Hence pressure loss

$$\boxed{\Delta P = 35.837 \text{kpa}}$$