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SUBJECT: Fluid mechanics.

Ques # 01

a) => Define total energy head and various forms of energy head with mathematical equations.

Answer:-

=> **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 head which are as follow:-

1 •> Kinetic Head

2 •> Potential Head.

3 •> Pressure Head.

1 => Kinetic Head:-

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

=> **Mathematical form:-**

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

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

=> This is also Known as velocity Head.

Unit:

Its unit is meter (m)

2 => POTENTIAL HEAD :-

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

=> **Mathematical form:-**

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

3 => 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 exerted by fluid.

⇒ **Mathematical Form:-**

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

OR

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

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

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

X————————X

Question => 1

b) => Define Hydraulic grade Line, Energy line and hydraulic radius.

Answer:

=> **Hydraulic Grade Line (HGL)**:-

=> 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 a small vertical tube connected

OR:

=> "It is the line showing the Pressure Head and the potential head at a point in fluid."

=> **Energy Grade Line (EGL)**:-

=> A line that represents the elevation of energy head (in feet or meter) of water water flowing in a pipe or 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 line joining the total heads along a pipe line.

Represented By:-

It is represented by E.G.L

=> Hydraulic Radius:-

=> The ratio of the cross-sectional area of a channel or pipe in which a fluid is flowing to the wetted perimeter of the ~~conduct~~ conduit.

QUES # 02 a)

⇒ Calculate the total energy per unit weight of water if it is flowing with a mean .... above the datum is 5 m.

⇒ GIVEN DATA:-

velocity, $V = 2\,m/s$

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

datum, $z = 5m$, $\gamma = 9810$

Required = ?

Total energy, $H = ?$

Solution:-

As we know that;

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

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

putting values in above equation.

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

$$H = 30.58 + 0.201 + 5$$

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

QUESTION # 02 B).

=> A tapering pipe is having diameter 300 mm at bottom end and 200 mm .... head loss is negligible.

Given DATA:

Diameter, $d_1 = 300mm = 0.3m$

, $d_2 = 200mm = 0.2m$

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

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

Flow rate, $Q = \frac{400}{1000} m^2/sec = 0.04 m^2/sec.$

Required:

Datum, $z = ?$

Solution:-

As we know that;

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

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

$$A_1 = 0.07065 \, m^2$$

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

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

$$A_2 = 0.0314 \, m^2$$

Now, As we know that;

$$Q = V_1 A_1$$

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

$$V_1 = \frac{0.04}{0.07065}$$

$$V_1 = 0.5661 \, m/s.$$

And,

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

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

$$V_2 = 1.2738 \, m/s$$

Now,

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

where ; $Z_1 = 0$

$\gamma = 9810$

putting values ;

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

$$30.597 = 12.314 + Z_2.$$

$$Z_2 = 30.597 - 12.314.$$

$$Z_2 = 18.282\,m.$$

Result ;

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

QUESTION: #03

=> A 500 m long 0.2m diameter pipe transport an oil of specific gravity 0.9 and viscosity ....
...... where R is reynold's number.

Given Data:-

length of the pipe, $L = 500m$
Diameter, $d = 0.2\,m$
Specific Gravity of oil = 0.9
flow rate, $Q = 0.06\ m^3/sec$
Density, $\rho = 0.9 \times 1000 = 900\ Kg/m^3$
Viscosity, $\mu = 6 \times 10^{-5}\ Ns/m^2$

Required = ?

Pressure loss = ?

Solution:-

As we know that;

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

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

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

Now,

we have to find "v"

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

Now, for circular pipe

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

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

$$\boxed{A = 0.0314 \; m^2}$$

putting values in eq (1)

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

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

Now,

we know that,

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

Putting values ;

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

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

Now,

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

$$f = 0.0032 + (5.5320 \times 10^{-3})$$

$$\boxed{f = 8.73209 \times 10^{-3}}$$

Now, From Bernouli's equation.

Head loss, $H_F = \frac{fLv^2}{2gD}$

Putting values:

$$H_L = \frac{fLv^2}{2gD}$$

$$H_L = \frac{(8.73209 \times 10^{-3})(500)(1.91)^2}{2 \times (9.81)(0.2)} = 4.0590$$

Now, we know by pressure loss and Head loss relation,

$$H_f = \frac{\Delta p}{\gamma}$$

$$H_f = \frac{\Delta p}{\rho g}$$

$$\Delta p = H_f \times \rho g.$$

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

$$\Delta p = 35837.47 \text{ pa}$$

$$\boxed{\Delta p = 35.837 \text{ KPa}}$$

Result:-

Hence Pressure loss,

$$\Delta p = 35.837 \text{ KPa}$$