INU

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Section:

B

Subject:

Fluid Mechanics

Que:no1

Define Total Energy Head And Various forms of Energy Head with Mathematical Equation:-

Answer:- Energy of Flowing Fluid:-

Energy of a system is its capacity for doing work. According to law of Conservation of energy. The energy Contained by a system remains constant. There is energy addition to or extraction from the System.

Energy Head:- *

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

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Kinetic Head:- *

* It is the Kinetic energy per unit weight of fluid.

Mathematically:-

$$\frac{K.E}{w} = \frac{\frac{1}{2}mv^2}{mg} = \frac{1}{2}\frac{v^2}{g}.$$

This is also know as velocity head.

Unit:- Meter, m.

Potential Head:- *

It is the potential energy per unit weight of fluid.

Mathematically:-

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

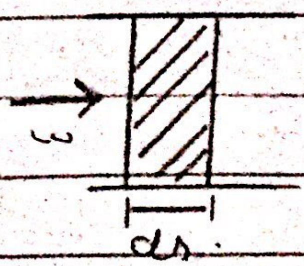
or for a perfect frictionless incompressible fluid flowing in continous stream, the total energy of fluid particles remain same, if loss of energy is neglected.

Pressure Head :- *

The vertical Height of a free surface above any point in a liquid at rest is pressure head or level of fluid due to pressure exerted by fluid.

Now.

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



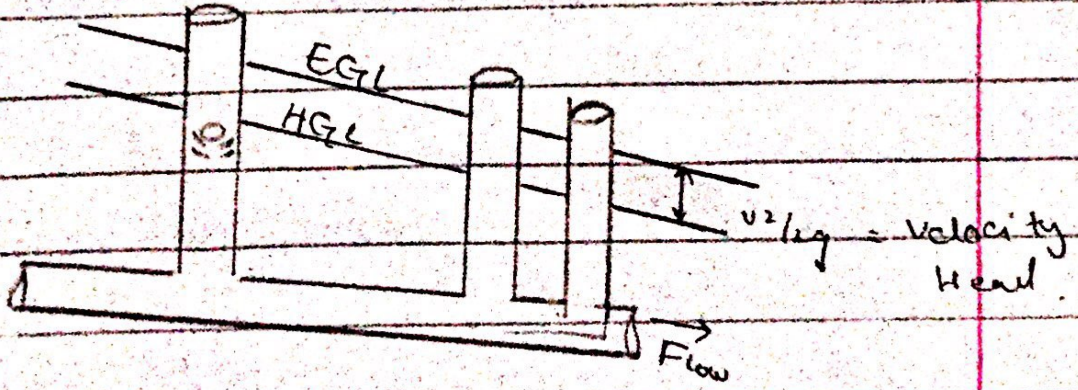
$$= \frac{P.A\ ds}{w}$$

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

Que: no 1
(b)

Answer:: **Hydraulic Grade line:-**

It is the line showing the pressure head and potential head at a point in fluid. The term $\frac{P}{\gamma} + Z$ is static head or piezometric head because it represent the level to which liquid will rise in piezometer tube. The HGL is line drawn through top of piezometer columns.



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Energy Line:*

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

OR

The Energy Line is a line that represent the total head available to the fluid and can be expressed as

EL = $H = p/\gamma + v^2/2g + h$ = Constant along a stream line

Hydraulic Radius:

Another term sometime used for this quantity is hydraulic mean depth.

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Hydraulic radius is the area of the water prism in a pipe or channel divided by wetted perimeter. Thus, for a round conduit flowing full or half full, the hydraulic radius is d/4.

The equation used to derive the hydraulic radius for a circular sewer flowing full is

$$R = A/P_w \quad \text{or} \quad R = \pi D^2/4 = \frac{D}{4}$$

R = Hydraulic Radius.

A = Cross Section Area.

P_w = Wetted perimeter.

D = Diameter of pipe.

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Que: no 2 (a) Calculate the total Energy per Unit Weight of water

Given, Data:

Velocity, $V = 2 m/s$

pressure, $P = 300 kpa$

$Z = 5m$

$g = 9.8 ms^{-2}$

$\gamma = \rho g = 1000 \times 9.81$

$= 9810 N/m^3$

Required :-

Total Energy per unit weight, $H = ?$

Solution :- As we know that

$$H = Z + \frac{1}{2} V^2/g + \frac{P}{\gamma}$$

putting the values:

$$H = 5 + \frac{1}{2} \times \frac{(2)^2}{9.81} + \frac{300 \times 10^3}{9810}$$

$H = 35.784$ Nm/N or Joule/N

***: Resut: ***

Que: no2 (b) A tapering pipe is having . . . . head loss negligible.

Given, Data:

Diameter, $d_1 = 300mm = 0.3m$

" , $d_2 = 200mm = 0.2m$

Pressure, $P_1 = 300$ Kpa $= 300 \times 10^3$ N/m²

$P_2 = 120$ Kpa $= 120 \times 10^3$ N/m²

Flow Rate, $Q = \frac{400}{1000}$ mt/sec $= 0.04$ m²/sec

Required:-

Datum, $Z = ?$

8 Solution: $\rightarrow$ As we know that

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

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

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

Now:

$$A_2 = \pi d_2^2 / 4 \quad = \frac{(0.2)^2 \times 3.14}{4}$$

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

As: $Q = V_1 A_1$

By Cross Multiplication.

$$V_1 = \frac{Q}{A_1} = \frac{0.04}{0.0706}$$

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

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

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

$$V_2 = 1.2738\ m/s$$

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

where, $Z_1 = 0$

$\gamma = 9810$

put all values in the above equation.

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

$$30.597 = 12.314 + Z_2$$

$$Z_2 = 30.597 - 12.314$$

$$Z_2 = 18.282\ m$$

Hence $Z_2 = 18.282\ m$ Ans

Que: no 3

A 500m long pipe of diameter 0.2 transport an oil of specific Gravity . . . . ?

Given, Data:

Length, $L = 500m$

Diameter, $D = 0.2m$

Specific Gravity of oil $= 0.9$

Rate of Flow, $Q = 0.06 \, m^3/s$

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

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

Required:-

pressure loss = ?

Solution: ⟶ As we know

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

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

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

Now Find $V = ?$

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

For Circular pipe.

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

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

$$A = 0.0314 m^2$$

putting values in eq (A).

$$V = \frac{0.06}{0.0314} = 1.91 m/s$$

$$V = 1.91 m/s$$

we know that.

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

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

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

Now,

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

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

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

From Bernoulli's Equation:

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

put all values.

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

$$H_f = 4.0590.$$

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

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

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$$\Delta p = h_f \rho g$$

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

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

$$\Delta p = 35.837 \text{ Kpa.}$$

Result:

$$\boxed{\begin{array}{l}\text{Pressure Loss.} \\ \Delta p = 35.837 \text{ Kpa}\end{array}}$$

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