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Section : A

Subject : Fluid Mechanics

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Part A:- Q#1:-

Total Energy Head:-

It is the sum of all energy head at a Point in a fluid-

OR

From Bernouli Principle the total energy at a given Point in a fluid is the energy associated with movement of fluid, Plus energy from static Pressure in the fluid. energy from height of fluid relative to an arbitrary datum height-

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:-

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

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

→ 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:-

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

Pressure Head:-

The vertical height of the free surface above any Point in a liquid at rest is Pressure Head-

OR

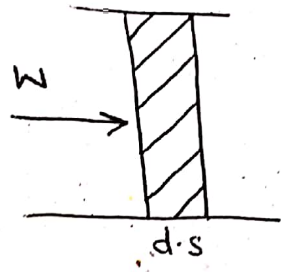
Level of Fluid due to Pressure exerted by Fluid-

Mathematical Form:-

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

OR

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



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

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

Q#1 :- [Part B]

~~Hyd~~

Hydraulic Grade Line:-

Hydraulic grade line refers to the Profile of water streaming in an open channel or a pipe streaming in a Part full - when Pipe is under Pressure, the Pressure driven review line is the level to which the water would ascend to in a little, verticale tube associated with a Pipe.

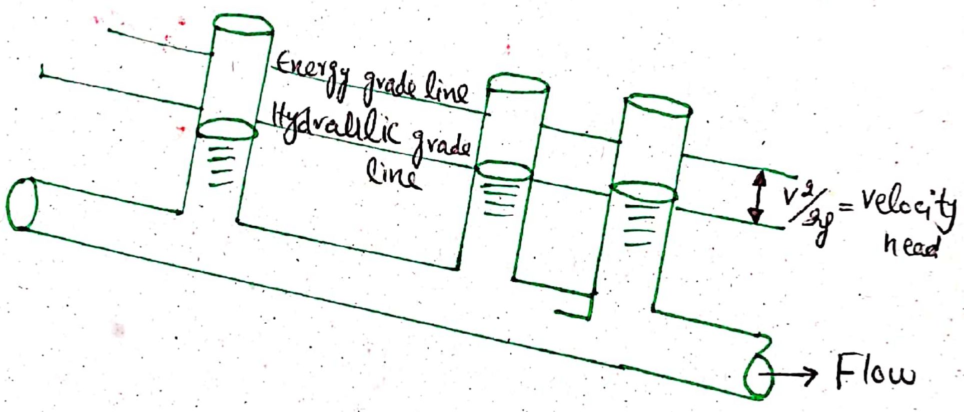
It is denoted as (HGL).

→ The Hydraulic grade line is a line representing the total head avaliable to the fluid-minus velocity head and Can be expressed as

$$HGL = P/\gamma + h$$

Where HGL = Hydraulic Grade line

The Hydraulic Grade line lies on velocity head below the Energy line.



* **Energy Line:- (EGL)**

Energy Grade line refer to a line that represents 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)

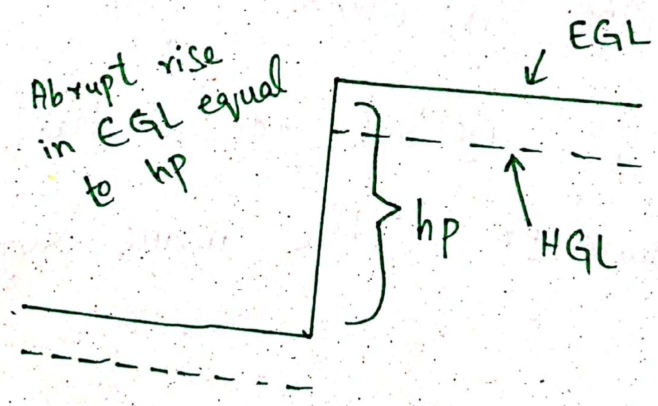
The Separation equalent to speed head $(V^2/2g)$ of the water streaming at every area or a Point along the Pipe or Channel-

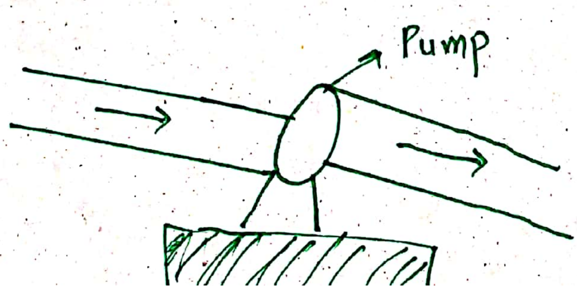
→ The Energy line is a line that represent the total head avaliable the fluid Can be expressed as-

$$EL = H = P/\gamma + \frac{V^2}{2g} + h = \text{Constant}$$

along a Stream line

EL = Energy line





⇒ Hydraulic Radius:-

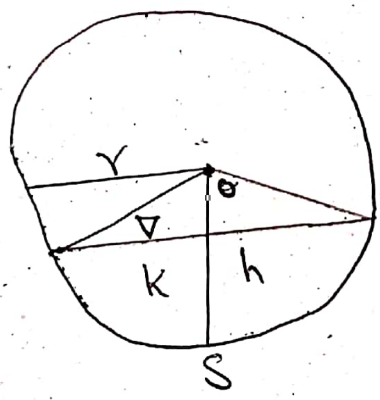
Hydraulic Radius is the area of water Prism in a Pipe or channel divided by the wetted Perimeter. Thus for a Round Conduct flowing full or half full the hydraulic radius is d/4.

→ Hydraulic radius measure the flow efficiency of a Pipe.

→ In tranchlen technology, it is a function of the shape of the Pipe in which liquid.

→ It doesnot indicate half of the diameter as the name Suggests.

→ Another term Sometimes used for this quantity is hydraulic mean depth-



Q# 2:- Part A

Given data:-

$V = 2 m/sec$

$P = 300 kps = 300 \times 10^3 N/m^2$

$Z = 5 m$

$\gamma = 9810$

Required:-

H = total energy Per weight = ?

Solution:-

As we know that

H = Pressure Head + kinetic energy (Head) + Potenial Energy (Head).

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

Putting the values in the above equation

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

$$H = 30.581 + 0.20 + 5$$

$$\boxed{H = 35.784\ m}$$

Q# 2 [Part B] :-

Given data:-

Diameter = d_1 = 300mm

Diameter = d_2 = 200 mm

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 = ?

Sol:-

$$Q = \frac{40 \; m^2/sec}{1000} = \boxed{0.04}$$

d_1 = 300 mm = 0.3m

d_2 = 200 mm = 0.2m

Required :-

Z = ?

Sol:-

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

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

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

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

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

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

We know that

$$Q = V_1 A_1$$

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

$$\boxed{V_1 = 0.566}$$

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

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

$$\boxed{V_2 = 1.27}$$

Now

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

Put

$Z_1 = 0$

$\gamma = 9810$

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

$$30.597 = 12.314 + Z_2$$

$$Z_2 = 30.597 - 12.314$$

$$\boxed{Z_2 = +18.283}$$

Now Datum = $\boxed{Z = +18.283}$

Q# 3:-

Given Data:-

Length of Pipe = L = 500m

Dia = D = 0.2m

Specific gravity = g = 0.9

Flow rate = Q = 0.06 m^3/s

Viscosity = μ = 6×10^{-5} Ns/m^2

Required:-

Pressure loss = ΔP = ?

Solution:-

We know

$$f = \left[0.0032 + \frac{0.221}{R^{0.237}}\right] \rightarrow (1)$$

Here !

R = Reynolds number

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

and $\upsilon = \frac{\mu}{\delta} = \frac{6 \times 10^{-5}}{900}$

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

and $V = \frac{Q}{A}$ $\because A = \frac{\pi D^2}{4}$

$\Rightarrow V = \frac{0.06}{0.031}$

$\Rightarrow \boxed{V = 1.9356 \ m/s}$

$\Rightarrow R = \frac{1.9356 \times 0.2}{6.67 \times 10^{-5}} = 5.8 \times 10^3$

Hence

eq ① $\Rightarrow f = 0.0032 + \frac{0.221}{(5.8 \times 10^3)^{0.237}}$

$\Rightarrow \boxed{f = 0.0664}$

According to Bernouli's equation

head loss $= h_2 = \frac{fLV^2}{2gD} \rightarrow$ ②

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Putting value in equation (II)

$$hL = \frac{(0.0664)(500)(1.9356)^2}{2(9.81)(0.9)}$$

$$\boxed{hL = 31.786}$$

To find Pressure loss

$$hL = \frac{\Delta P}{\rho g} \Rightarrow \Delta P = hL \times \rho g$$

Putting values

$$\Delta P = 31.786 \times 900 \times 9.81$$

$$\Rightarrow \Delta P = 280638 \text{ Pa}$$

$$\Rightarrow \boxed{\Delta P = 280.638 \text{ kPa}}$$