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Sec ~ A

Subject ~ Fluid Mechanics

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Question No 1

Part A:~

Ans:~

TOTAL ENERGY HEAD:~

From Bernoulli 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.

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The Sum of Pressure height head (P/g), velocity head ($V^2/2g$) and elevation head H is constant along a stream line. This constant is called total head H.

FROM OF ENERGY HEAD:

These are three types of energy head which are given below.

POTENTIAL HEAD:

It is potential energy per unit weight. It is due to position above some datum line.

Pressure head + velocity Head

Potential Head = Total Head

Potential Head = Total Head - velocity Head - Pressure head.

KINETIC HEAD:-

→ It represent kinetic energy of fluid. It is height in feet that a flowing fluid will rise in column.

Kinetic head = Total head - Potential head - Pressure Head.

PRESSURE HEAD:-

It is height of liquid column that corresponds to a particular pressure exerted by liquid column that corresponds a particular pressure exerted by liquid

Column on the base of containes.

Pressure Head = Total Head - Kinetic Head - potential head.

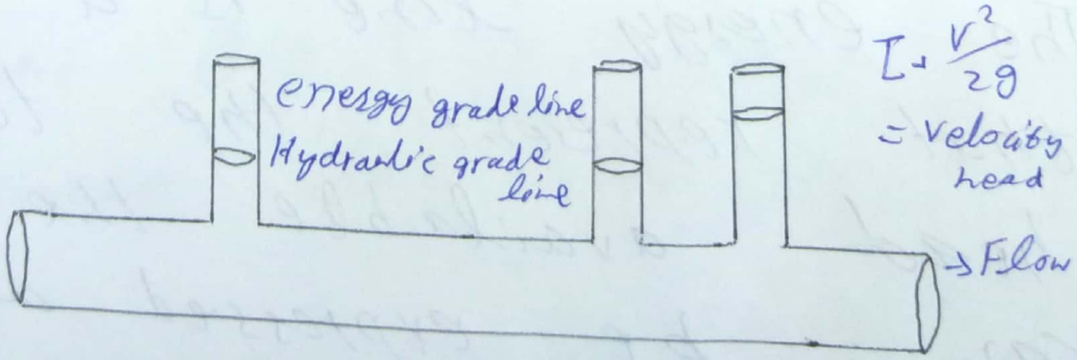
Part B

HYDRAULIC GRADE LINE

Hydralic grade line refers to the profile of water streaming in an open channal or a pipe straming in a part full when pipe is under pressure, the pressure driven reveiw line is the level to which the water would assend to a little Vertical tube associated with a pipe.

It is denoted as (HGL)
The hydraulic grade line is line representing the total head available to the fluid - mines 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

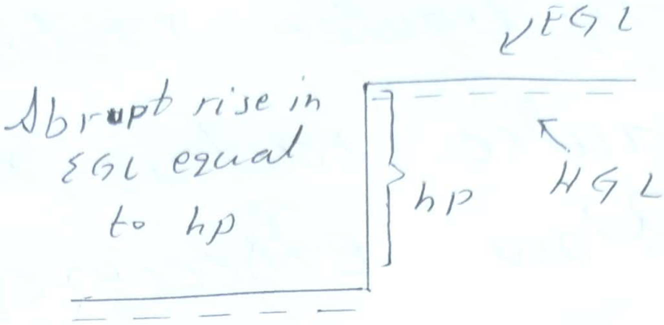
Energy Grade line refers to a line that represent to the height of energy head of water, streaming in a pipe, course, or channal. The line is drawn over the pressure Hydraulic grade line (inclination)

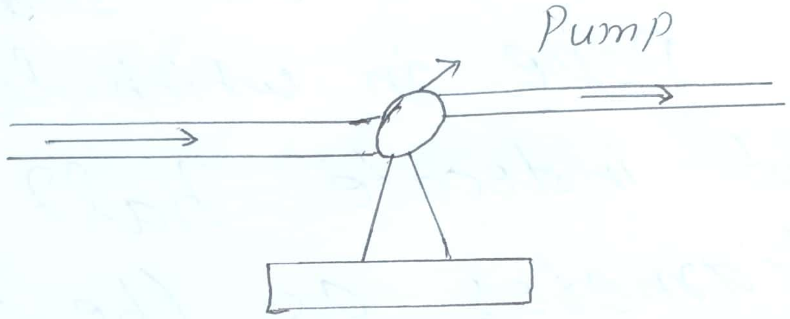
The Separation equalent to speed head $\left(\frac{V^2}{2g}\right)$ of the water streaming at every area or a point along the pipe or channal.

→ The energy line is a line that represent the total head available the fluid can be expressed as

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

along a stream 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.

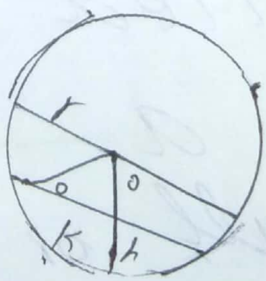
the hydraulic radius is d/4.

⇒ Hydraulic radius measure the flow efficiency of a pipe.

→ In trenchlen technology, it is a function of the shape of the pipe in which liquid.

→ It doesnot indecate half of the diameter as the name suggents.

→ Another term sometimes used for this quantity is hydrulic mean depth.



Q No 2 (a)

Given Data

$V = 2m/sec$

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

$Z = 5m$

$\gamma = 9810$

Required:

H = Total energy Per unit weight = ?

Soln

As we know that

H = Pressure Head + kinetic Energy (Head) + Potential Energy (Head)

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

Putting the values in the above equation

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

$$H = 30.581 + 0.20 + 5$$

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

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Question No 2

Part (B)

Given data:

Diameter $d_1 = 300mm$

Diameter $d_2 = 200mm$

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:

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

$d_1 = 300mm = 0.3m$

$d_2 = 200mm = 0.2m$

Required

$Z = ?$

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

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

$A_1 = 0.0706 m^2$

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

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

$A_2 = 0.0314 m^2$

We know that

$Q = V_1 A_1$

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

$V_1 = 0.566$

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

$V_2 = \frac{0.04}{0.031}$

$V_3 = 1.27$

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

Put

$Z_1 = 0$

$\gamma = 9810$

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

$$+ \frac{(1.27)^2}{2(9.81)} + Z_2$$

$$30.597 = 12.314 + Z_2$$

$$Z_2 = +30.597 - 12.314$$

$$Z_1 = +18.283$$

Now Datum $Z = +18.283$

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Question No 3

Given Data:-

Length of pipe = 500m

Diameter $d = 0.2m$

Specific gravity of oil = 0.9

Flow rate $Q = 0.06 m^3/sec$

Viscosity $\mu = 6 \times 10^{-5} N \cdot s/m^2$

Required:-

Pressure loss = $\Delta P = ?$

$$f = \left(0.0032 + \left(\frac{0.221}{0.237}\right)\right.$$

where

R = Reynolds Number & is given by

$$R = \frac{N \times d}{u} \rightarrow (a)$$

$$v = \frac{\mu}{g} = \frac{6 \times 10^{-5}}{900}$$

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

and $V = \frac{Q}{A}$

For Area of Circular pipe

$A = \pi/4\ d^2 = \pi/4 (0.2)^2$

$A = 0.0314 m^2$

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

$V = 1.935\ m/sec$

Putting the values in eq (a)

$$\text{eq (a)}\quad R = \frac{1.935 \times 0.2}{6.67 \times 10^{-5}}$$

$$\Rightarrow \frac{0.387}{6.67 \times 10^{-5}}$$

$R = 5.802 \times 10^3$

Now

$$F = 0.0032 + \frac{0.221}{(5.802\times10^{?})^{0.237}}$$

$$F = 0.3154$$

From Bernolis Equation

$$\text{Head loss } h = \frac{F l v^2}{2gD} \quad \text{— (b)}$$

Putting the values in eq (b)

$$h_L = \frac{(0.3154)\times(500)\times(1.935)^2}{2(9.8)\;(0.2)}$$

$$h_L = \frac{590.464}{3.924}$$

$$h_L = 150.475\,m$$

Now Pressure loss due to Friction

$$h_L = \frac{\Delta P}{\delta g}$$

$$\Delta P = h_L \times \delta g$$

Putting the values

$$\Delta P = 150.475 \times 900 \times 9.81$$

$$\Delta P = 1328543.775$$

$$\boxed{\Delta P = 1.328 \text{ MPa}}$$

Pressure loss