ID

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7964

Section

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B

Paper

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Fluid Mechanics

Submitted To

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Date

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Question 01 Part 'A'

Energy Head :-

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

Forms of Energy Head:-

There are various forms of energy head which are as follow

⇒ Kinetic Head
⇒ Potential Head
⇒ Pressure head

⇒ Kinetic Head :-

It is the kinetic energy per unit which 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 :-

It, 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.

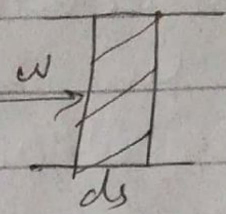
Mathematical Form:-

Pressure Head

$$\frac{P.E}{weight} = P/\gamma$$

or

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



$$\Rightarrow \frac{P.A \cdot ds}{w}$$

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

Question of Part 'B'

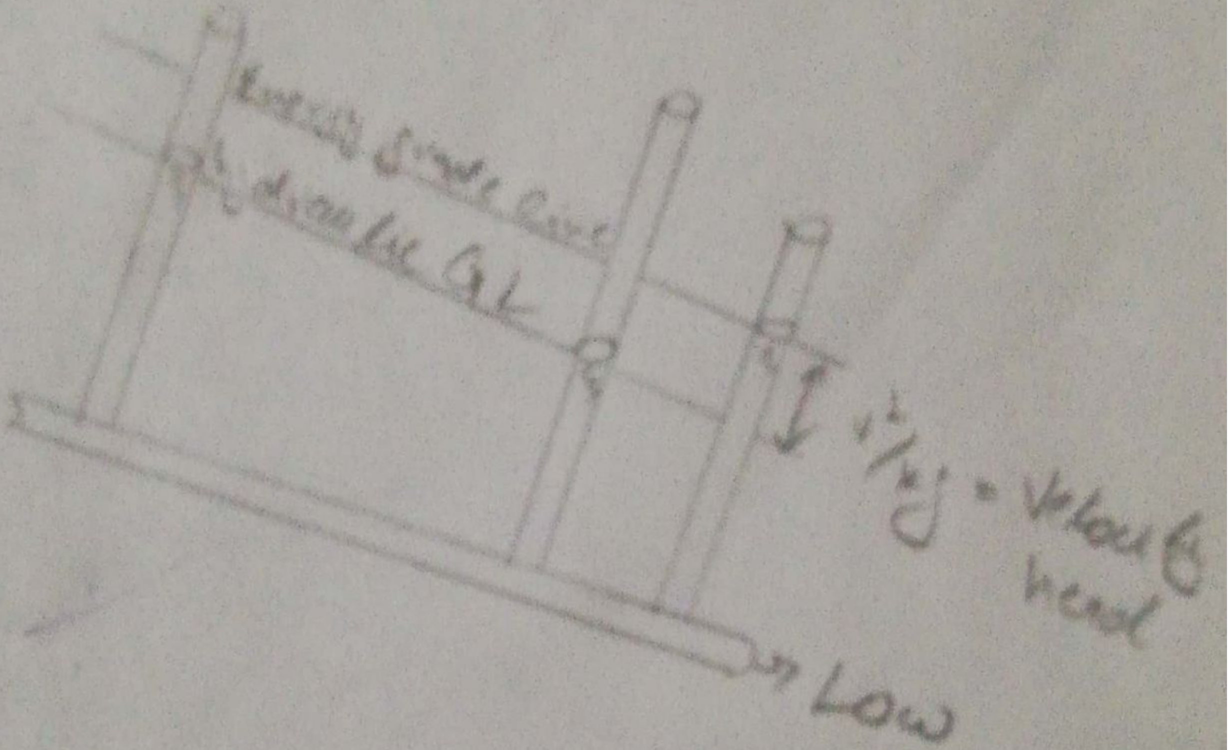
Hydraulic grade line (HGL)
The Surface or profile of water flowing in an open channel or a pipe flowing partially full. If a pipe is under pressure the hydraulic grade line is that level water would rise to in a small vertical tube connected

to the pipe

Energy grade line (EGL)

A line that represents the elevation of energy head (in feet or meter) of water flowing in a pipe conduit or channel. The line is drawn above the hydraulic grade line (gradient) a distance equal to the velocity head ($v^2/2g$) of the water flowing at each section or point along the pipe or channel.

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 conduit.


hydraulic GL
$v^2/2g$ = velocity head
Low

Question 02 Part 'A'

Given Data:

velocity, $V = 2 m/s$

Pressure, $P = 300 kPa$

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

datum, $z = 5 m$

$\gamma = 9810$

Required:

Total energy, $H = ?$

Solution:

As we know that

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

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

Putting values in above equation

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

$$H = 30.58 + 0.201 + 5$$

$$H = 35.785 \ Nm/N$$

Question 02 Part B

Given Data:-

Diameter $= d_1 = 300mm$
$= d_2 = 200 mm$
P_1 = pressure $= 300 kPa$
$= 300 \times 10^3 N/m^2$

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

Datum $= Z = ?$

$Q = \frac{40}{1000} m^3/sec = 0.04 m^3/s$

$d_1 = 300mm = 0.3 m$
$d_2 = 200 mm = 0.2 m$

Required:-
$Z_2 = ?$

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

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

$$A_1 = 0.0706\ m^2$$

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

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

$$A_2 = 0.0314\ m^2$$

We know that

$$Q_1 = V_1 A_1$$

$$V_1 = Q/A_1$$

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

$Q = 40/1000$

$\Rightarrow 0.04$

$$V_1 = 0.566\ m/s$$

$V_2 = Q/A_2$

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

$V_2 = 1.27$ m/s

Now

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

$Z_1 = 0$, $\gamma = 9810$

$$\frac{300\times10^3}{9810} + \frac{0.566^2}{2(981)} + 0 = \frac{120\times10^3}{9810} + \frac{127^2}{2(981)} + Z_2$$

$30.59 = 12.314 + Z_2$

$Z_2 = 18.276$ m

(10)

Question 03

Given Data:-

Length of pipe = 500m
dia d = 0.2m
Specific gravity of oil = 0.8

Flow rate = Q = 0.06 m³/s
Viscosity = $\mu = 6\times10^{-1}$ Ns/m³

Required = ?

Pressure Loss = ΔP = ?

we know that

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

where R = Reynolds No &
is given as

$$R = \frac{V \times d}{\nu} \rightarrow (i)$$

&

$$\nu = \frac{\mu}{\rho} = \frac{6\times10^{-1}}{800}$$

(ii)

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

$v = \frac{Q}{A}$

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

$V = 1.935 \, m/s$

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

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

$A = 0.314 \, m^2$

puting value in (i)

$R = \frac{1.935 \times 0.2}{6.67 \times 10^{-5}}$

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

$R = 5.802 \times 10^{3}$

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$$f = 0.0032 + \frac{0.221}{(5.802\times10^{3})^{0.237}}$$

$$f = 0.0315$$

From Bernoli's equation
Head Loss $h = \frac{fLv^2}{2gD} \rightarrow (ii)$

puting value in (ii)

$$h_2 = \frac{(0.0315)\times(500)\times(1.935)^2}{2(9.8)(0.2)}$$

$$h_2 = \frac{590.464}{3.924}$$

$$h_2 = 150.475\ m$$

Now pressure loss due to friction.

$$h_2 = \frac{\Delta P}{\rho g}$$

$$\Delta P = h_2 \times \rho g$$

Putting the value

$$\Delta P = (150.475 \times 900 \times 9.8)$$

$$\Delta P = 1328543.75$$

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