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SECTION: B

SUBMITTED TO: Engr. Abdul Waheed

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DEPARTMENT: B.E (civil)

EXAM: Final

"FLUID MECHANICS"

QUESTION No 1 PART—a

Define total energy head and various form of energy head with mathematical equations

ANSWER:

ENERGY HEAD:

Sum of all energy heads at a piont in fluid is called energy head.

MATHEMATICALLY:

Total energy head = kinetic head + Potential head + Pressure head

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

i, KINECTIC HEAD:

kinetic energy per unit weight. It is also known as velocit-y head.

MATHEMATICALLY:

kinetic head = K.E / weight

$$= \frac{\frac{1}{2} m V^2}{mg} \quad \because \text{weight} = mg$$

$$\text{kinetic head} = \frac{V^2}{2g}$$

POTENTIAL HEAD:

Potential energy per unit weight.

MATHEMATICALLY:

$$\text{Potential head} = \text{P.E / weight}$$

$$= \frac{mgz}{mg}$$

$$\boxed{\text{Potential head} = z}$$

PRESSURE HEAD:

The vertical distance from a free surface above any point in liquid at rest is called pressure head. OR level of fluid due to pressure exerted by fluid.

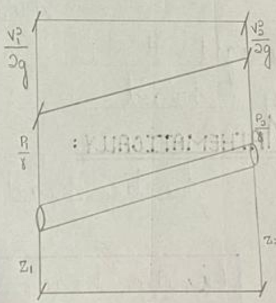
MATHEMATICALLY:

$$\text{work / weight} = F \cdot ds / W$$

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

$$= \frac{P \cdot V}{W}$$

$$\boxed{\text{Pressure head} = \frac{P}{\gamma}}$$



QUESTION No 1 PART-b

Define hydraulic grade line, Energ-
-y line and hydraulic radius.

ANSWER:

HYDRAULIC GRADE LINE:

It is the line joining all the liquid level in piezometers. It is the sum of pressure head and Potential head. [(P/γ)+Z]

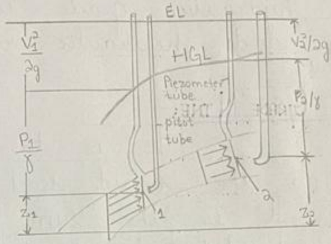
The term [(P/γ)+Z] is static head or piezometric head because it represent the level to which liquid will be rise in Piezometer tube.

ENERGY LINE:

It is the line that joins all the points that represent the sum of kinetic head and Piezometric head. Line joining level of pitot tube is energy line.

$E \cdot L = z + \frac{P}{\gamma} + \frac{V}{2g}$

$H \cdot G \cdot L = z + \frac{P}{\gamma}$



HYDRAULIC RADIUS:

Hydraulic radius is the area of the water prism in a pipe or channel divided by the wetted perimeter.

MATHEMATICALLY:

The equation of hydraulic radius for a circular sewer flowing full is;

$R = A / P_w$

$R = (\pi D^2/4) / \pi D$

$\boxed{R = D/4}$

R = hydraulic radius

A = Cross-sectional area

Pw = Wetted perimeter

D = diameter of pipe

QUESTION No 2 PART – a

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

GIVEN DATA:

velocity, $v = 2 m/s$

Pressure, $P = 300 KPa$

datum, $z = 5m$

$\gamma = \rho g = 1000 \times 9.81 = 9810 N/m^3$

REQUIRED DATA:

Total energy per unit weight, z = ?

SOLUTION:

As we know

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

Putting the values

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

$$H = 35.785 \ Nm/N$$

RESULT:

Total energy per unit weight, H = 35.78 Nm/N

Question No 2 Part-b

A tapering pipe ---------- loss is negligiable

Given Data:

diameter, $d_1 = 300mm = 0.3m$

diameter, $d_2 = 200mm = 0.2m$

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

Pressure, $P_2 = 120\,KPa = 120 \times 10^3\, N/m^2$

Flow rate, $Q = 4/1000\, m^3/sec = 0.04\, m^3/s$

Required Data:

difference in datum head between top and bottom, $Z_2 - Z_1 = ?$

Solution:

As we know

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

For velocities:

we know $A_1V_1 = A_2V_2 = Q$

$$A_1V_1 = A_2V_2 = 0.04\,m^3/s$$

For V_1:

$A_1V_1 = 0.04 \Rightarrow V_1 = 0.04/A_1$ $\quad\because A_1 = \pi d_1^2/4$

$V_1 = 0.04/0.07065$ $\quad A_1 = 3.14(0.3)^2/4$

$\boxed{V_1 = 0.5661\, m/s}$ $\quad A_1 = 0.07065\, m^2$

For V_2:

$A_2V_2 = 0.04 \Rightarrow V_2 = 0.04/A_2$ $\therefore A_2 = \pi d_2^2/4$

$V_2 = 0.04/0.0314$ $A_2 = (3.14)(0.2)^2/4$

$\boxed{V_2 = 1.273 \text{ m/s}}$ $A_2 = 0.0314 m^2$

Putting the values in eq i
where $Z_1 = 0$ & $\gamma = 9810 \text{ N/m}^3$

$$\frac{300 \times 10^3}{9810} + \frac{0.566^2}{2 \times 9.81} + 0 = \frac{120 \times 10^3}{9810} + \frac{1.273^2}{2 \times 9.81} + Z_2$$

$$30.597 = 12.315 + Z_2$$

$$Z_2 = 30.597 - 12.315$$

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

now

$$Z_2 - Z_1 = 18.282 - 0$$

$$\boxed{Z_2 - Z_2 = 18.282}$$

RESULT:

difference of bottom and top datum head,
$Z_2 - Z_1 = 18.282$ m

QUESTION No 3

A 500m long 0.2m diameter --- number.

GIVEN DATA:

length, $l = 500$m
diameter, $d = 0.2$m

Specific gravity of oil = 0.9
Flow rate, Q = 0.06 m^3/s
Viscosity, μ = 6×10^{-5} Ns/m^2

REQUIRED:

Pressure loss, ΔP = ?

SOLUTION:

As $\gamma = \mu/\rho = 6\times10^{-5}/900 =$ ∵ ρ = density of oil

$\boxed{\gamma = 6.67\times10^{-8}\ m^2/s}$

For velocity:

$V = Q/A = 0.06/0.031$ ∴ $A = \pi d^2/4 = 3.14\times0.2^2/4$

$\boxed{V = 1.935\ m/s}$ $A = 0.031\ m^2$

For reynold's number:

$R = V\times d/\gamma \Rightarrow 1.935\times0.2/6.67\times10^{-8}$

$\boxed{R = 5.80\times10^{6}}$

For f:

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

$f = 0.0032 + \frac{0.221}{(5.80\times10^{6})^{0.237}}$

$f = 8.713\times10^{-3}$

$\boxed{f = 0.008713}$

Now from Bernoulis equation

Head loss:

$$h_f = fLv^2 / 2gD$$

$$h_f = \frac{(0.00871) \times 500 \times (1.95)^2}{2(9.81)(0.2)}$$

$$h_f = 4.215$$

Pressure loss:

As $h_f = \Delta P / \rho g \Rightarrow \Delta P = h_f \times \rho g$

$$\Delta P = 4.215 \times 900 \times 9.81$$

$$\Delta P = 37216.9 \text{ Pa}$$

$$\Delta P = 37.216 \text{ KPa}$$

RESULT:

Pressure loss, $\Delta P = 37.216 \text{ KPa}$