ID 7962

Section B

Dep Be(civil)

Paper Fluid mechanic

Q No 1

Part A

Energy head

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

Form of energy Head.

There are various froms of energy Head which are in following

(1) kinetic Head
(2) Potential Head
(3) pressure Head.

Kinetic Head

It is the kinetic energy per unit weight of the fluid.

Mathematical form

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

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

This is also know as velocity Head.

Unit

The unit is meter (m)

Potential Head

It is the potential energy per unit weight of the fluid.

Mathematical form.

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

P3
Φ1
PA

Pressure Head

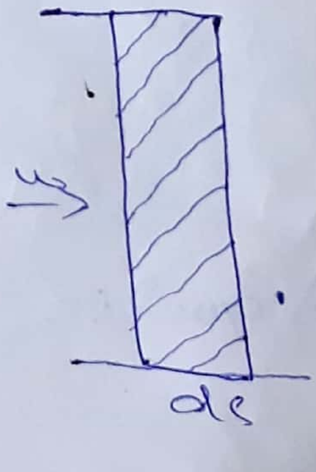
The vertical height of the free surface above any point in a ~~liquid~~ liquid. at rest is Pressure Head.

Mathematical form

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

OR

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



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

$$= \frac{PV}{w} = \frac{P}{\gamma} \text{ is pressure.}$$

Q1 Part = B

Hydraulic grade line

The surface or profile of water flowing in an open channel or a pipe flowing partially but 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 also see energy grade line.

Hydraulic radius

. The ratio of the cross-sectional area of a channel or pipe in which a fluid is flowing to the welled perimeter of the conduct.

Energy Grade Line

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

Question = 2

Part = A

Given data

velocity = $V = 2 m/s$

pressure = $P = 300 kPa$

datum = $Z = 5m$

Sol

H = pressure head + KE + PE

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

$$H = \frac{300\times10^3}{9810} + \frac{2^2}{2\times9.81} + 5$$

$$\boxed{H = 35.7849m}$$

QNo 2 Part = B

Given data

Diameter = d_1 = 300mm.

Diameter = d_2 = 200mm

Pressure = p_1 = 300kpa = $300 \times 10^3 N/m^2$

= p_2 = 120kpa = $120 \times 10^3 N/m^2$

Datum = Z = ?

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

d_1 = 300mm = 0.8m

d_2 = 200mm = 0.2 m

Required

Z = ?

Sol

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

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

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

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

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

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

As we know that

$$Q_1 = v_1 A_1$$

$$v_1 = \frac{Q}{A_1}$$

$$Q = \frac{40}{1000}$$

$$v_1 = \frac{0.04}{0.0706} = 70.04 \quad \boxed{v_1 = 0.566 m^3}$$

$$v_2 = \frac{Q}{A_2}$$

$$v_2 = \frac{0.04}{0.03144}$$

$$\boxed{v_2 = 1.27}$$

Now

$$\frac{p_1}{\gamma} + \frac{v_1^2}{2g} + z = \frac{p_2}{\gamma} + \frac{v_2^2}{2g} + z_2$$

$$z_1 = 0$$

$$\gamma = 9810$$

$$\frac{300\times10^3}{9810} + \frac{0.566}{2(9.81)} + 0 = \frac{120\times10^3}{9810} + \frac{1.27}{2(9.81)} + z_1$$

$$30.60 + 0 = 12.314 + z_2$$

$$\boxed{= z_2 = +18.286\text{m}}$$

Q No 3

Sol

Given data

length of Pipe = l = 500m

dia = d = 0.2m

Specific gravity of oil = 0.9

Flow rate = Q = 0.06m³/s

viscosity = μ = 6×10^{-5} N.s/m²

Required

pressure Loss = ΔP = ?

As we know

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

where R = Reynolds No. and is given as.

$$R = \frac{v \times d}{\nu} \longrightarrow (1)$$ and ⟹

and $\upsilon = \frac{\mu}{\rho} = \frac{6\times10^{-5}}{900}$

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

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

For circular pipe

$A = \pi/4\ d^2$

$\Rightarrow v = \frac{0.06}{0.031} \quad = \frac{\pi}{4}(0.02)^2$

$A = 0.031 m^2$

$\Rightarrow$ $\boxed{v = 1.95 m/s}$

Now eq (1)

$R = \frac{1.95 \times 0.2}{6.67\times10^{-5}} = 5.53\times10^{8}$

Now

$f = 0.0032 + \frac{0.221}{(5.73\times10^{6})^{0.237}}$

$\Rightarrow f = 8.79 \times 10^{-3}$

$$F = 0.00879$$

Now from Bernoulli's equation

Head loss = $h_L = \frac{FLv^2}{2gD}$ → (ii)

Putting values in eq (ii)

$$h_2 = \frac{(0.00879)(500)(1.95)^2}{2(9.81)(0.2)}$$

$$h_2 \; 4.259 m$$

Now to find pressure loss due to friction.

Pressure Head formula is used

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

$\Rightarrow \Delta P = h_2 \times \delta g$

Put values

$\Delta P = 4.259 \times 900 \times 9.81$

$\Rightarrow \Delta P = 37602.7\ Pa$

$\Rightarrow \boxed{\Delta P = 37.602\ kPa}$