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Fluid Mechanics.

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25 June, 2020.

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(1)
Q No (a)

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.

OR

The Sum of Pressure head (P/γ), Velocity head ($V^2/2g$) and elevation head h is Constant along a stream line. This Constant is called Total head H.

Forms of Energy Head.

There 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 Container.

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

Q No ① (b)

Hydraulic Grade line :-

It is that level water that would rise to in a Small, Vertical tube Connected to the Pipe if the pipe is under pressure.

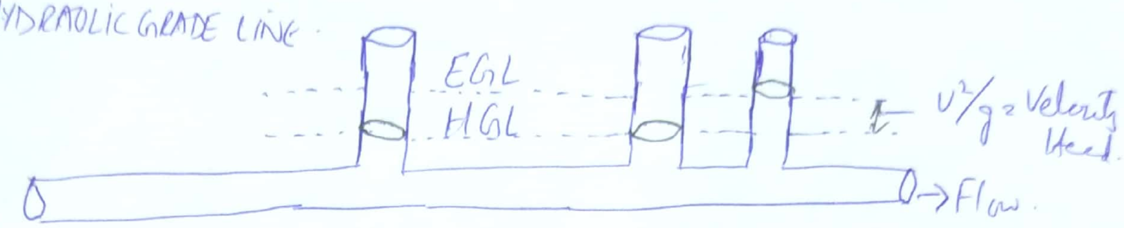
It is denoted by HGL.

It is the line representing the total head available to the fluid minus the Velocity head.

Hydraulic grade line lies one Velocity head below the energy line.

$HGL = P/\gamma + h.$

EGL → ENERGY GRADE LINE
HGL → HYDRAULIC GRADE LINE.



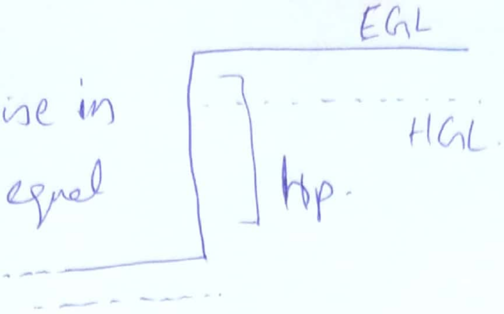
ENERGY GRADE LINE:-

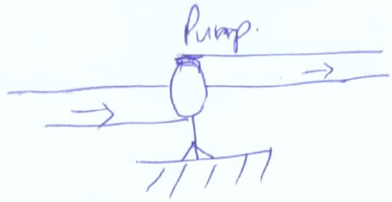
It is the line which represent the elevation of Energy head of water flowing in a pipe. This line is drawn above the hydraulic grade line. The Separation between the HGL and EGL is known as Velocity Head. $\left(V^2/2g\right)$. of water streaming at every area or point along the pipe.
We know that
Mathematically.

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

along a stream line.

Abrupt rise in EGL is equal to hp

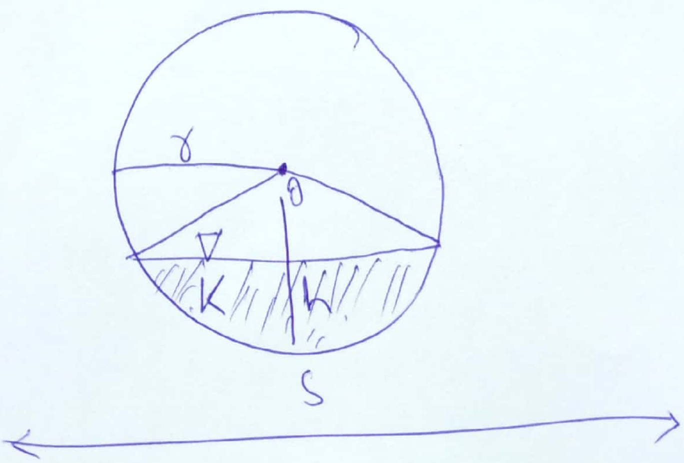




Hydraulic Radius:

It is defined as the Cross-Sectional area of flow divided by wetted Perimeter, So the Calculation of rectangle and trapezoid area and triangle area will be included along Perimeter of each.

It measures the efficiency of Pipe. It is the function of shape of Pipe in which the liquid is flowing.



Q No (2) (a)

Given Data:

$V = 2 m/sec$

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

$Z = 5m$

$\gamma = 9810$

Required:

H = Total energy Per unit Weight = ?

Solution:

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

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

$$H = 30.581 + 0.20 + 5$$

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

Answer.

Q No ② ⓑ :

Given Data:

Diameter $= d_1 = 300mm$

Diameter $= d_2 = 200mm$.

Pressure $= P_1 = 300\ KPa = 300\times10^3\ N/m^2$.

Pressure $= P_2 = 120\ KPa = 120\times10^3\ N/m^2$.

Required:

Datum $= Z = ?$

Solution :-

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

$d_1 = 300mm = 0.3m$

$d_2 = 200mm = 0.2m$.

$$A_1 = Area_1 = \frac{\pi d^2}{4} = \frac{3.14\times(0.3)^2}{4}.$$

$A_1 = Area_1 = 0.7065m^2$.

$$Area_2 = A_2 = \frac{\pi d^2}{4} = \frac{(3.14)(0.2)^2}{4} = 0.0314m^2$$

Hence $Q = V_1 A_1$

$$V_1 = \frac{Q}{A_1} = \frac{0.04}{0.0706} = 0.566m^3.$$

$$V_2 = \frac{Q}{A_2} = \frac{0.04}{0.0314} = 1.27 m^3.$$

Therefore

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

Putting $Z_1 = 0$.

$\gamma = 9810$.

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

$$30.596 = 12.31 + Z_2$$

2) Z_2 18.286 m.

Datum = 18.286 m

Q 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 = $\mu = 6\times10^{-5} N.S/m^2$.

Required:-

Pressure loss = ΔP = ?

Solution:-

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

Where.

R = Reynold's Number and is given by

$$R = \frac{V\times d}{\upsilon} \quad \text{—— (a)}$$

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

$$\upsilon = 6.67\times10^{-8} m^2/sec.$$

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

For Area of Circular Pipe.

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

$A = 0.0314 \, m^2$.

rough work.

$A = \pi r^2$

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

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

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

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

$V = 1.935$ m/sec

Putting the Values in eq (a).

eq (a) $\Rightarrow$ $R = \frac{1.935 \times 0.2}{6.67 \times 10^{-5}} \Rightarrow \frac{0.387}{6.67 \times 10^{-5}}$

$R = 5.802 \times 10^3$.

Now $f = 0.0032 + \frac{0.221}{(5.802 \times 10^3)^{0.237}}$

$f = 0.3154$.

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From Bernoulli's Equation..

Head loss $= h_L = \frac{fLV^2}{2gD}$ — (5)

Putting the Values in eq (5)

eq (5) =>

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

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

$$h_L = 150.475 \text{ m}$$

Now Pressure loss due to friction.

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

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

Putting the Values.

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

$$\Delta P = 1328543.775$$

$\Delta P = 1.328$ MPa → Pressure loss.