Paper

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Q(i) (part - a)

Define total energy head and various forms of energy head with mathematical equations.

Total Energy head

From Bernoulli principal the Total energy at a given point in a fluid in the energy. associated with movement of fluid. plus energy from static pressure in the fluid energy from height of fluid relative to an orbitory datum height.

OR

The sum of pressure head (p.γ) velocity head ($v^2/2g$) and elevation head. is constant along a stream line. this Constant is called Total height H.

Forms of Head:- There are three types of energy head which are given below.

Potential energy:-

It is the 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 fact than a flowing fluid will rise in column.

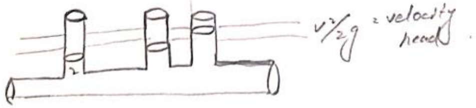
Pressure head:-

It is height of liquid column that corresponds to a particular pressure exerted by liquid column that corresponds a particular pessure exerted by liquid column on the base of contains

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

$HGL = P/\gamma + h$

Where HGL = Hydraulic Grade line.
The hydraulic Grade line lies on velocity head below the energy line.



Energy line :.(EGL)

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

Q1 (Part - b)

Define Hydraulic grade line. Energy line and Hydraulic radius.

Ans

Hydralic grade line :-

HGL is defined as a line joining all the liquid levels indicated by piezometers connected to the pipeline throughout. If HGL is above the center of the pipeline, the pressure is positive and HGL is below the center of the pipeline, the pressure is negative.

Consider a pipeline that is carrying a liquid from one point to the other and the piezometer is attached to this pipe at any random point.

The liquid rises in the tube and represents the pressure head (P/γ) above the center of pipe. The height of the center of the pipe above any selected datum indicates the datum head (z).

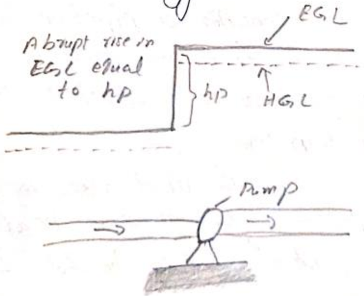
It means, the liquids levels in the piezometer records. the sum of $(P/\gamma + z)$ with respect to the selected datum.

2) 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 streamline.

EL = Energy line



Hydraulic radius :

Hydraulic radius is the area of the water prism in a pipe or channel divided by the wetted perimeter. Thus, for a round conduit flowing full or halffull, the hydraulic radius is D/4. Hydraulic radius measures the flow efficiency of a pipe. In trenchless technology. It is a function of the shape of the pipe in which the liquid is flowing. It does not indicate half of the diameter

$$R = A/P_W \text{ or } R = (\pi D^2/4)/\pi D = D/4.$$

where

R = Hydraulic radius

A = corss sectional area.

P_W = wetted perimeter

D = diameter of pipe.

Q8 (part - a)

Calculate the total energy per unit weight of water if it is flowing with a mean velocity of 2m/s under pressure of 300 kpa. The height above the datum is 5m.

Given Data:-

velocity = $V = 2m/s$

Pressure = $P = 300kpa$

datum = $z = 5m$

Solution:-

$H =$ pressure head + K.E + P.E

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

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

$$H = 35.7849\ m$$

Q(5) (part - b)

A tapering pipe is having diameter 300mm at bottom end and 200mm at top end. The Intensity of pressure at bottom end and top end are 300kpa and 120kpa respectively. Determine the difference in datum head between top and bottom if water flow rate through pipe is 40liter per seconds. Assume that head loss is negligible

Given Data:

Diameter = d_1 = 300mm

Diameter = d_2 = 200mm

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

= p_2 = 120k pa = $120 \times 10^3 \, N/m^2$

Required

Datum = z = ?

Solution

d_1 = 300mm = 0.3m

d_2 = 200mm = 0.2m

Sol:-

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

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

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

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

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

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

We know that

$$Q_1 = V_1 A_1$$

$$V_1 = Q / A_1$$

$$\boxed{Q = \frac{40}{1000} \Rightarrow 0.04}$$

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

$$\boxed{V_1 = 0.566}$$

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

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

$$V_2 = 1.27$$

Now

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

$$Z_2 = 0$$

$$\gamma = 9810.$$

$$\frac{300 \times 10^3}{9810} + \frac{0.566}{2(981)} + Z_1 = \frac{120 \times 10^3}{9810} + \frac{1.2710}{2(981)}$$

$$30.60 + Z_1 = 12.314$$

$$\boxed{Z_1 = -18.286}$$

Ans

Q3)

A 500m long 0.2m diameter pipe transport an oil of specific gravity 0.9 and viscosity 6×10^{-5} N.s/m² at rate of 0.06 m³/s ---
--- where R is reynolds number.

Given Data:

length of pipe = l = 500m.
Specific gravity of oil = 0.4
diamete = d = 0.2m.
flow rate = Q = 0.06 m³/s.
Viscosity = μ = 6×10^{-5} N.s/m²

Required

Pressure loss = ΔP = ?

Solution

As we know that.

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

where R = Reynolds No. and is given as.

$$R = \frac{V \times d}{\nu} \rightarrow (1)$$

and $\nu = \mu/\rho = \frac{6 \times 10^{-5}}{900}$

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

and

$V = Q/A$ ∴ for circular pipe

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

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

$A = 0.031\ m^2$

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

$\Rightarrow V = 1.95\ m/s$

Now eq (1) ⇒

$$R = \frac{1.95 \times 0.2}{6.67 \times 10^{-5}} = 5.73 \times 10^{6}$$

Now

$$f = 0.0032 + \frac{0.221}{(5.73 \times 10^{6})^{0.237}}$$

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

or

$f = 0.00879$

Now from Bernoulli's equation

Head loss = $h_L = \frac{f L V^2}{2D} \rightarrow (ii)$

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

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

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

put values

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

=> $\Delta P = 37602.7$ Pa

=> $\Delta P = 37.602$ kPa