pressure and its measurements

$$\text{pressure} = \frac{\text{Force}}{\text{Area}}$$

Units is N/m^2 or Pascal (Pa)

$1 \text{ bar} = 1000 \text{ KPa} = 10^5 N/m^2$

pressure Variation in a fluid at rest

The pressure at any point in a fluid at rest is obtained by the "hydrostatic law"

Hydrostatic law states that the rate of increase of pressure in a vertically downward direction must be equal to the specific weight of the fluid at the point.

proof

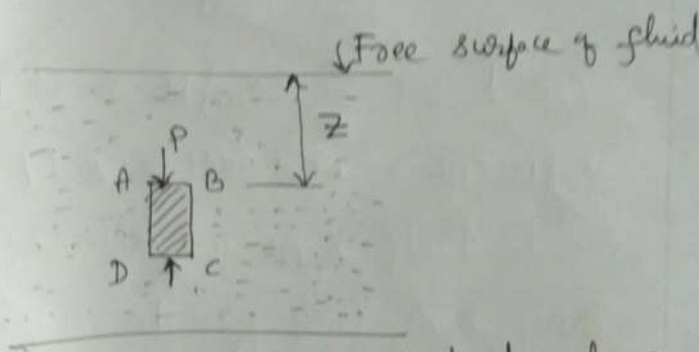
Consider a small fluid element as shown in fig

let ΔA = Cross sectional area of element

ΔZ = Height of fluid element

P = pressure on face AB

Z = Distance of fluid element from free surface



The forces acting on the fluid element are

(1) pressure force on Face AB $= P\Delta A$

(2) pressure force on Face CD $= \left(P + \frac{\partial P}{\partial z} dz\right)\Delta A$

(3) weight of fluid element $= W$

weight of fluid element $=$ mass $\times g$

$=$ Density $\times$ Volume $\times g$

$= \rho g \Delta A \Delta z$

~~pressure forces on~~ + For equilibrium of fluid element, we have

$$p\Delta A - \left(P + \frac{\partial P}{\partial z}\Delta z\right)\Delta A + \rho g \,\Delta A \Delta z = 0$$

$$p\Delta A - \left(P + \frac{\partial P}{\partial z}\Delta z\right)\Delta A + \rho g \,\Delta A \Delta z = 0$$

$$-\frac{\partial P}{\partial z}\Delta z \,\Delta A + \rho g \,\Delta A \Delta z = 0$$

$$\boxed{\frac{\partial P}{\partial z} = \rho g}$$

$$\boxed{\frac{\partial P}{\partial z} = w} \rightarrow (1)$$

~~where w is weight dens~~

where w is weight density of fluid =

$w = \rho g$.

Equation (1) can be states that the rate of increase of pressure in vertical direction is equal to the weight density of the fluid at that point. This is called Hydrostatic law.

By integrating the equation ① we have

$$\int dP = \int \rho g z$$

$$\boxed{P = \rho g z}$$

where P = pressure at that point

ρ = Density of fluid

g = accelleration ~~due~~ of gravity

z = height of point from free surface or pressure head

$$\boxed{z = \frac{P}{\rho g}}$$

z is pressure head

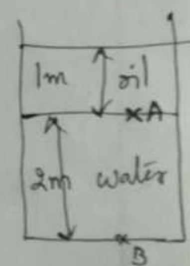
problem

(i) An open tank contains water upto a depth of 2 m and above it an oil of sp gravity 0.9 from a depth of 1 m. Find the pressure intensity

(i) at the interface of the two liquids

(ii) at the bottom of the tank.

solution



Height of Water $= Z_1 = 2\,m$

Height of oil $= Z_2 = 1\,m$

Specific gravity of oil $= 0.9$

Density of oil $= 900\ kg/m^3$

Density of water $= 1000\ Kg/m^3$

pressure intensity at any point is given by $P = \rho g Z$ (Hydrostatic law)

(i) At interface ie A

$$P = 900 \times g \times 1.00$$

$P = 900 \times 9.81 \times 1$

$$\boxed{P = 8829\ N/m^2}$$

(ii) At the bottom ie at B

$P = \rho_{oil}\, g\, z_{oil} + \rho_{water}.g.z_{water}$

$P = 900 \times 9.81 \times 1 + 1000 \times 9.81 \times 2$

$P = 28449\ N/m^2$

H.W

Find pressure intensity at A, B and C. for the given fig.