PRESSURE & HYDROSTATICS

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PRESSURE & HYDROSTATICS

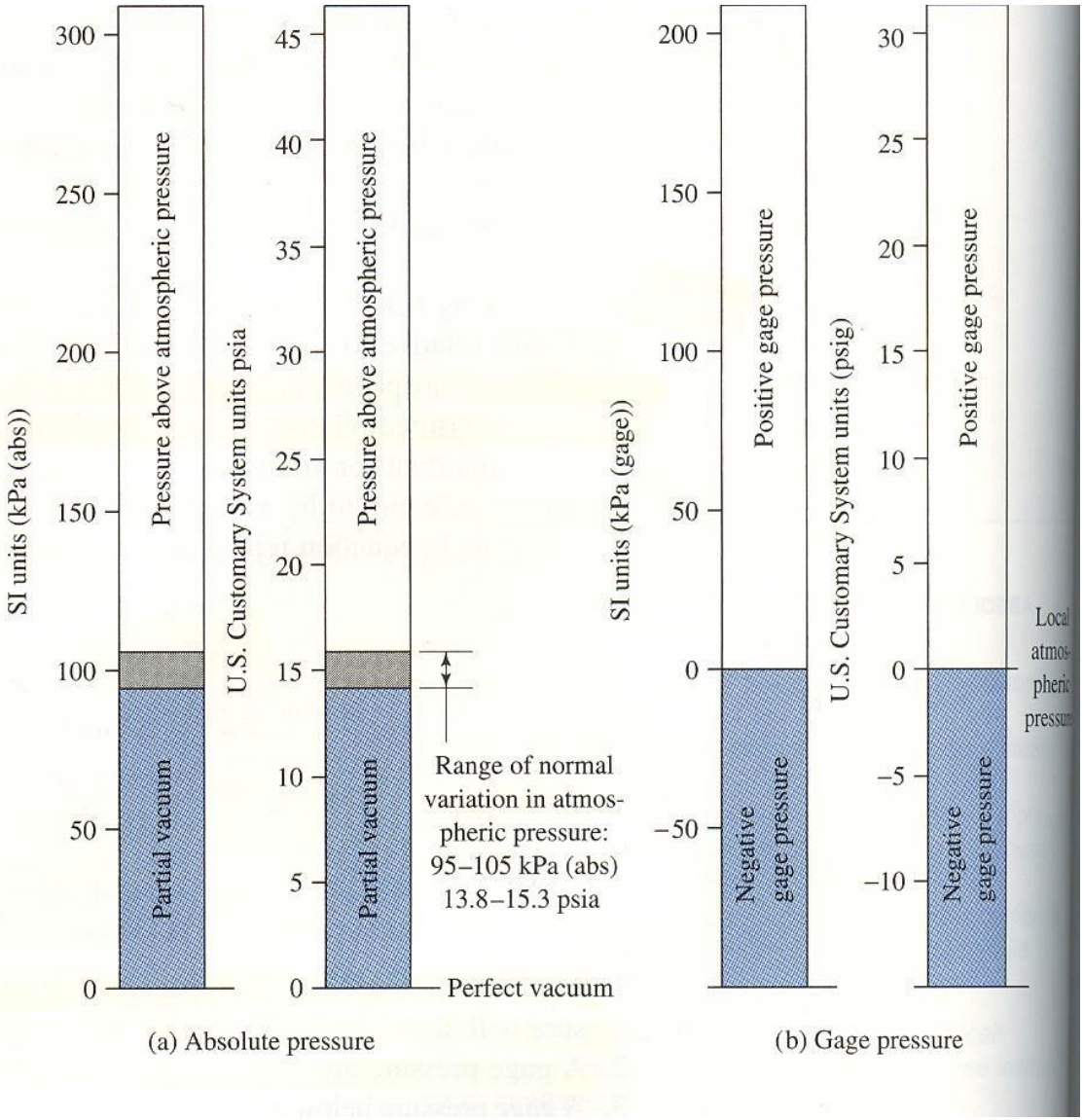
Pressure = F / A

- Pressure is typically measured with respect to a reference level
- Reference could be atmosphere or vaccum.
- The reference level = ***atmospheric pressure (95-105kPa)***
- Pressure measured with respect to atmosphere = ***Gage pressure***
- Pressure measured with respect to perfect vaccum = ***Absolute pressure***

- The three related by the equation –

  $P_{abs} = P_{gage} + P_{atm}$

FIGURE 3.1 Comparison between absolute and gage pressures.



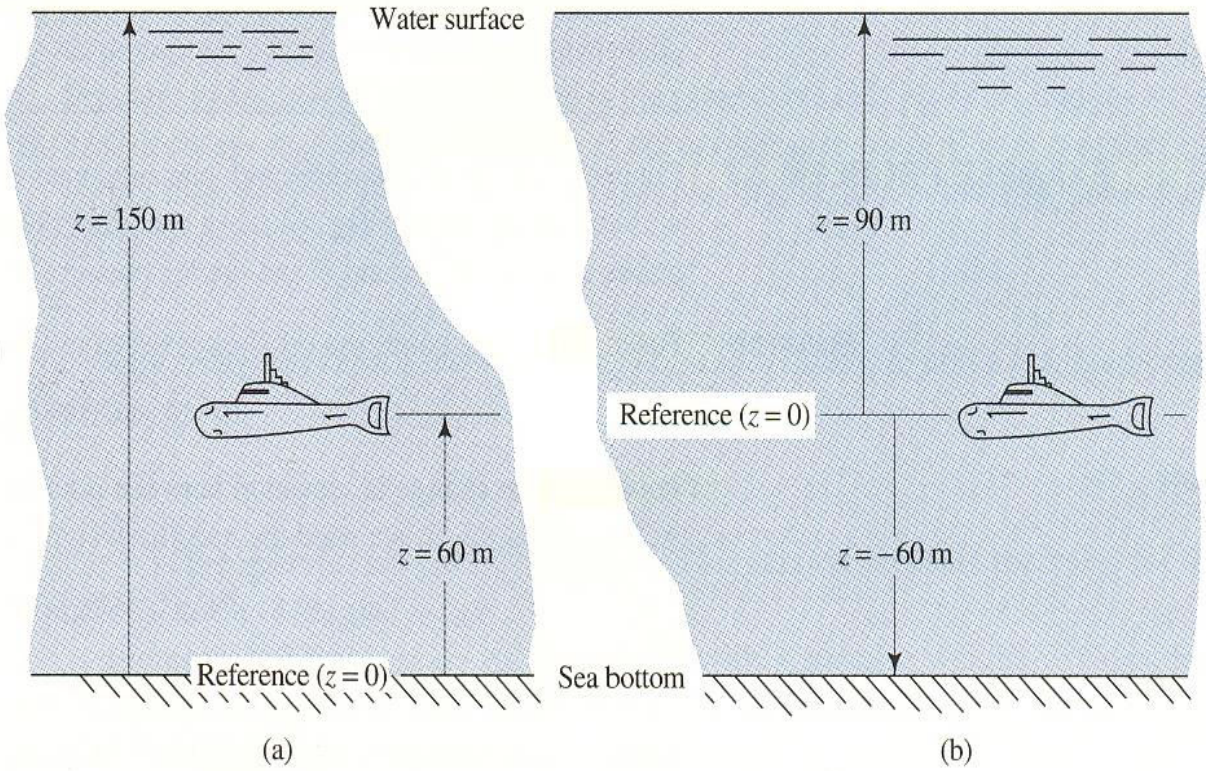
- Points –
- Perfect vacuum = lowest possible pressure
- Absolute pressure will always be positive
- Gage pressure above atmospheric is +ve
- Gage pressure below atmospheric will be –ve
- Units = Pa (abs) or Pa (gage) – always mention what the reference is!
- Range of atmospheric pressure = 95 kPa to 105 kPa
- Assumed as 101 kPa in the text.
- Or 14.7 psi(a)

- Problem 1
- Given Pressure (gage) = 155 kPa
- Atmospheric Pressure = 98 kPa
- What is the Absolute Pressure?????
- Absolute pressure =

Pressure and Elevation

- *Pressure is directly related to elevation and changes with elevation*
- - example – swimming pool or diving deep into a water body
- The greater the depth/elevation of fluid – the greater the pressure
- Elevation in water – measured with respect to a reference;
- positive upwards; negative downwards

FIGURE 3.2 Illustration of reference level for elevation.



It is advisable to choose the lowest point for a reference level so that you don't have to deal with negative elevation values!

- Change in pressure = $\Delta p = \gamma h$,where γ is the specific weight of the fluid and h is the elevation
- Equation is only valid for homogenous liquids at rest
- Points on the **same horizontal level have the same**
- **pressure**
- Pressure **varies linearly with change in elevation/depth**
- Change in pressure is **proportional to the specific weight** of the fluid
- Above equation does not apply to gases because the specific
- weight of gas changes with elevation –
- However the change in gas pressure with elevation is small!
- An increase in elevation of 300 m changes gas pressure by only 3.4kPa

- Problem :Determine the pressure at a depth of 5m for water.

$$\Delta p = \gamma h$$

Specific wt of water = 9.81 kN/m3

Therefore,

$\Delta p = 9.81 \times 5 = 49.05$ kN/m2 = 49.05 k Pa

Problem (SI units):

Compute the gage pressures at pts. A, B, C, D, E and F.

Specific gravity of Oil = 0.9

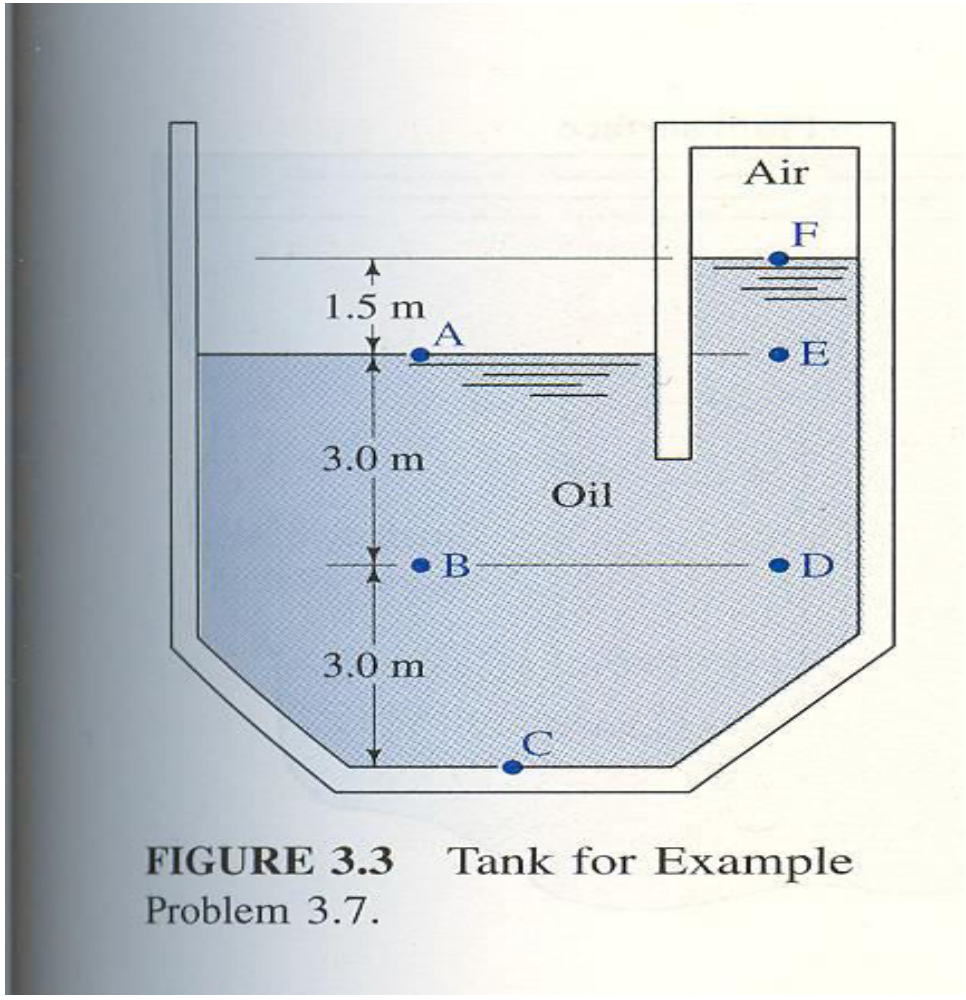


FIGURE 3.3 Tank for Example Problem 3.7.

- Answers:
- Pa = 0 (gage) – atmospheric pressure
- γ oil = 0.9 x 9.81 = 8.83 kN/m2
- Pb = 3.0 x 8.83
- Pb = 26.5 kN/m2 = 26.5 kPa
- Pc = 6.0 x 8.83
- Pc = 53 kN/m2
- Pd = Pb (same level)
- Pd = 26.5 kN/m2
- Pe = Pa – same level as A
- Pe = 0 kN/m2
- Pf = 0 – 1.5*8.83
- Pf = -13.2 kN/m2

Key observations from example above –

- Pressure increases with depth
- Pressure changes linearly
- Points at the same elevation have the same pressure
- Pressure decreases at higher elevations