Thermodynamics (ESC-S202)

Lecture- 4 & 5

Introduction of Thermodynamics

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Pressure

- Pressure is defined as force per unit area.
- It has the unit of newtons per square meter (N/m2), which is called a pascal (Pa).

$$1 \text{ Pa} = 1 \text{ N/m}^2$$

$$1 \text{ bar} = 10^5 \text{ Pa} = 0.1 \text{ MPa} = 100 \text{ kPa}$$

$$1 \text{ atm} = 101{,}325 \text{ Pa} = 101.325 \text{ kPa} = 1.01325 \text{ bars}$$

$$1 \text{ kgf/cm}^2 = 9.807 \text{ N/cm}^2 = 9.807 \times 10^4 \text{ N/m}^2 = 9.807 \times 10^4 \text{ Pa}$$

$$= 0.9807 \text{ bar}$$

$$= 0.9679 \text{ atm}$$

$$1 \text{ atm} = 14.696 \text{ psi}$$

Absolute Pressure

- The actual pressure at a given position is called the absolute pressure, and it is measured relative to absolute vacuum (i.e., absolute zero pressure).

Gauge Pressure

- Most pressure-measuring devices, however, are calibrated to read zero in the atmosphere and so they indicate the difference between the absolute pressure and the local atmospheric pressure. This difference is called the gage pressure.

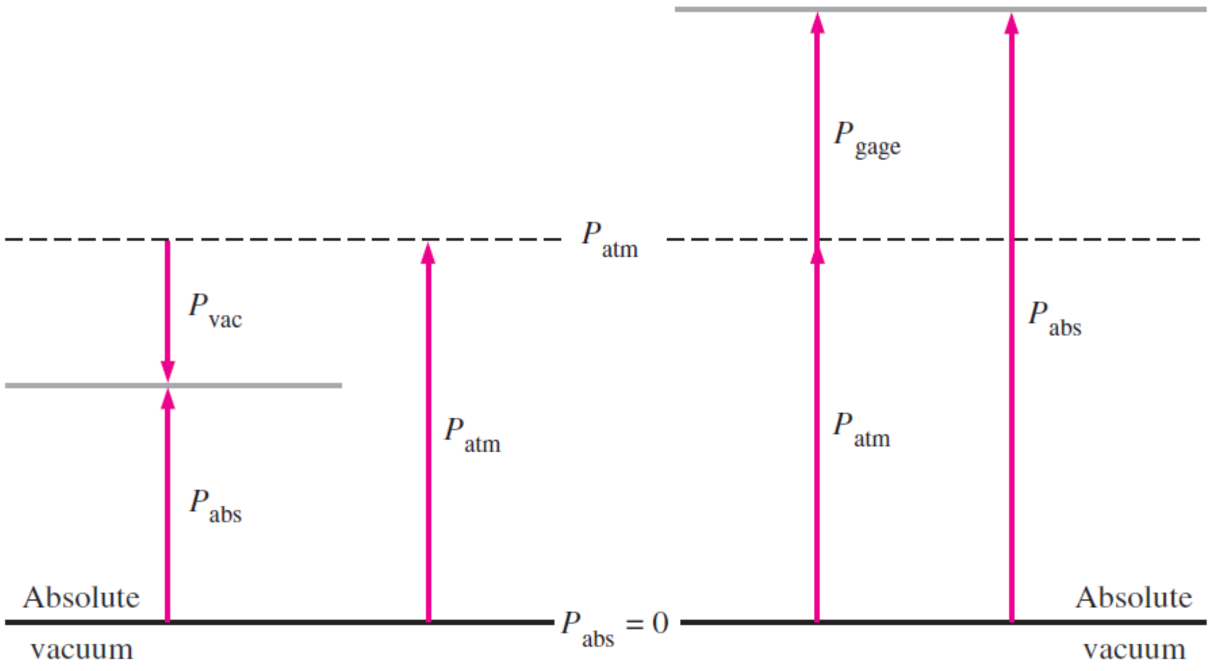
Vacuum Pressure

- Pressures below atmospheric pressure are called vacuum pressures and are measured by vacuum gages that indicate the difference between the atmospheric pressure and the absolute pressure.

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

$$P_{vac} = P_{atm} - P_{abs}$$

Pressure



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

$$P_{vac} = P_{atm} - P_{abs}$$

Some Numerical Problems on Pressure

Q.1 Convert the following readings of pressure to kPa, assuming that the barometer reads 760 mm of Hg.
(a) 40 cm Hg vacuum
(b) 90 cm Hg gauge
(c) 1.2 m of H_2O gauge

Q.2 Assume that the pressure p and the specific volume v of the atmosphere are related according to the equation $PV^{1.4} = 2.5 \times 10^5$, where p is in N/m^2 abs and v is in m^3/kg. The acceleration due to gravity is constant at 9.81 m/s^2. What is the depth of atmosphere necessary to produce a pressure of 1.033 bar at the earth's surface? Consider the atmosphere as a fluid column.

Q.3 The acceleration of gravity is given as a function of elevation above sea level by

$$g = 980.6 - 3.086 \times 10^{-6} H$$

Where g is in cm/s^2 and H is in cm. If an aero plane weighs 90,000 N at sea level, what is the gravity force upon it at 10,000 m elevation? What is the percentage difference from the sea-level weight?