§2.2 BASIC CONCEPTS OF THERMODYNAMICS

- Thermodynamic System: a thermodynamic system or simply a 'system' is defined as a quantity of matter or a region in space chosen for the interest of analysis or study. Two types of systems are considered.

  - Open System: a system which may exchange matter (mass) and energy with surroundings

    ie - compressors, pumps, turbines.

  - Closed system: a system which does not exchange matter with its surroundings, but it may exchange energy with the surroundings.

    ie - piston/cylinder devices.

REMARK: a closed system that does not allow transfer of energy is called an isolated system.

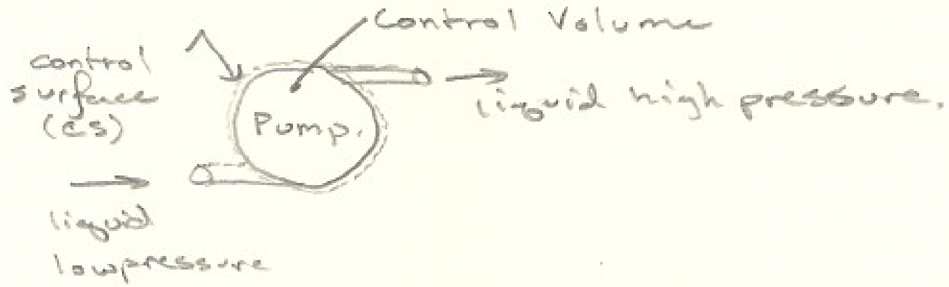
- Control Volume: (CV) In many cases, an analysis is simplified if attention is focused on a volume in space into which or from which, a "substance" flows. Such a volume is a control volume.

REMARK: a control volume is normally equivilent to the concept of an open system.

- Control Surface (CS): It is the surface that completely surrounds the control volume and seperates it from it surroundings, it is also referred to as a "boundry" for cases when no matter (mass) crosses the system. Mathimatically, the boundry or control surface has zero thickness, and thus it can neither contain any mass, nor occupy any volume in space.

- Surroundings: All matter or region outside or external to a system.

EX. Open System.



EX. fig 2-1 is an example of a closed system.

PRESURE: (P) pressure is the force exerted by a fluid per unit area. At every point in a static fluid a certain pressure density exists. It is defined as

$$P = \lim_{\Delta A \to 0} \frac{\Delta F}{\Delta A} = \frac{dF}{dA} \quad \ldots (2\text{-}2)$$

where F is the normal force acting over an area.

$$P = F/A.$$

REMARK: we speak of pressure only when we deal with a fluid (gas, liquid). The counterpart of pressure in solids is stress.

pressure is a scaler quantity; that it has a magnitude only and acts equally in all directions.

pressure, has the unit pascal (Pa) where

$$1\,Pa = 1\,N/m^2$$

The other units of pressure are "bar" and the standard atmospheric

$$1\,bar = 10^5\,Pa = 0.1\,MPa.$$

$$1\,atm = 101{,}325\,Pa = 101.325\,kPa.$$

note: that in the english system of units

$$1\,\frac{lb}{ft^2} = 1\,psi = 14.69\,psi$$

DIFFERENT KINDS OF PRESURE

- Absolute pressure: it is the acutal presure at a given position and it is measured relative to absolute vaccum (absolute zero pressure) Mathimatically it is referred to as P_{ABS}.

- Gage Pressure: it is the pressure above atmospheric

$$P_g = P_{ABS} - P_{ATM} \qquad (2\text{-}3)a$$

- Vacoum Pressure: it is the pressure below atmospheric

$$P_{VAC} = P_{ATM} - P_{ABS} \qquad (2\text{-}3)b$$

note: $P_g = -P_{VAC}$

EX. A vacuum gage connected to a chamber to a chamber reads 5.8 psi at a location where $P_{ATM} = 14.5$ psi, what is P_{ABS}?

$$P_{VAC} = P_{ATM} - P_{ABS}$$

$$5.8\,psi = 14.5\,psi - P_{ABS}$$

$$P_{ABS} = 8.7\,psi$$

TEMPERTURE (T):

- temperature can be defined in the context of the zeroth law of thermodynamics. It states that two bodies are in thermal eqauilibrium if both have the same temperture reading even if they are not in contact

REMARK: The temperture scale used is SI is and the english system.

Celsius & Fehrenheit

The absolute temperture scale in the SI is the Kelvin scale

$$°K = °C + 273.15 \qquad (2\text{-}4)a$$

In the english system the absolute tempurture is the Rankine scale,

$°R = °F + 459.67$ (2-4)b

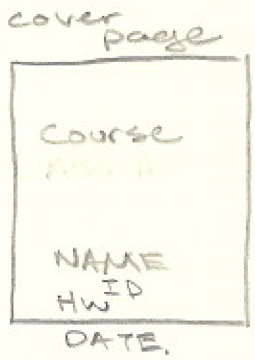
note: $°F = 1.8 \cdot °C + 32$

HW ASSIGNMENT #1 (DUE TUES)

Textbook Chapter 2

16, 25, 30, 32, 62

FORMAT FOR HW.



problem (2-16):

givens: - - - -

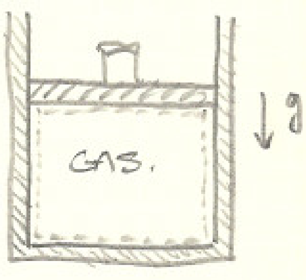
schematic: □

Required: $T_2 = ?$

§2.4 NUMERICAL EXAMPLES.

EX.

Consider the piston cilinder device shown in figure



$P_{ATM} = 0.97$ bar.

$A_p = 400\ cm^2$

$m_p = 60$ kg.

Required: determine the pressure of the gas inside the device.

Analysis: Here P in the piston-cylinder device depends on the atmosphere pressure P_{ATM} and the weight of the piston that exerts force on the gas inside the cylinder.

Balancing the forces in the vertical direction (the piston cylinder is at equlibrum), gives.

$\uparrow \oplus \; \Sigma F_y = 0 = F_{gas} - F_{ATM} - W_P$ eq 1

F_{gas} is the force of the gas on the piston.

$\therefore \; F_{gas} = P \cdot A_P$. eq 2.

$\therefore \; F_{ATM} = P_{ATM} \cdot A_P$ eq 3

$\therefore \; W_P = m_P \cdot g$ eq 4.

substituting Eq. 2,3,4 into eq 1 gives.

$$P A_P = P_{ATM} A_P + W_P$$

$$P = P_{ATM} + \frac{W_P}{A_P} = P_{ATM} + \frac{m_P \, g}{A_P}$$

$$P = 1.117 \text{ bar.}$$