Al- mustaqbal university college

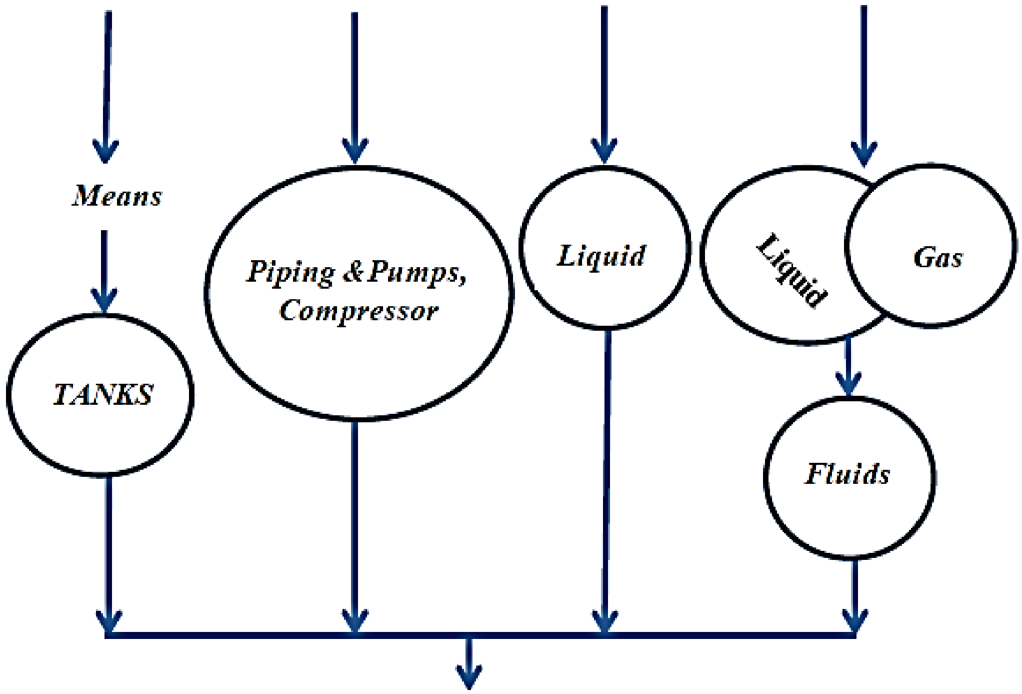
Department of chemical engineering and petrol industries

(Storage and transportation of petroleum products)

M s c Sara Ibrahim m.

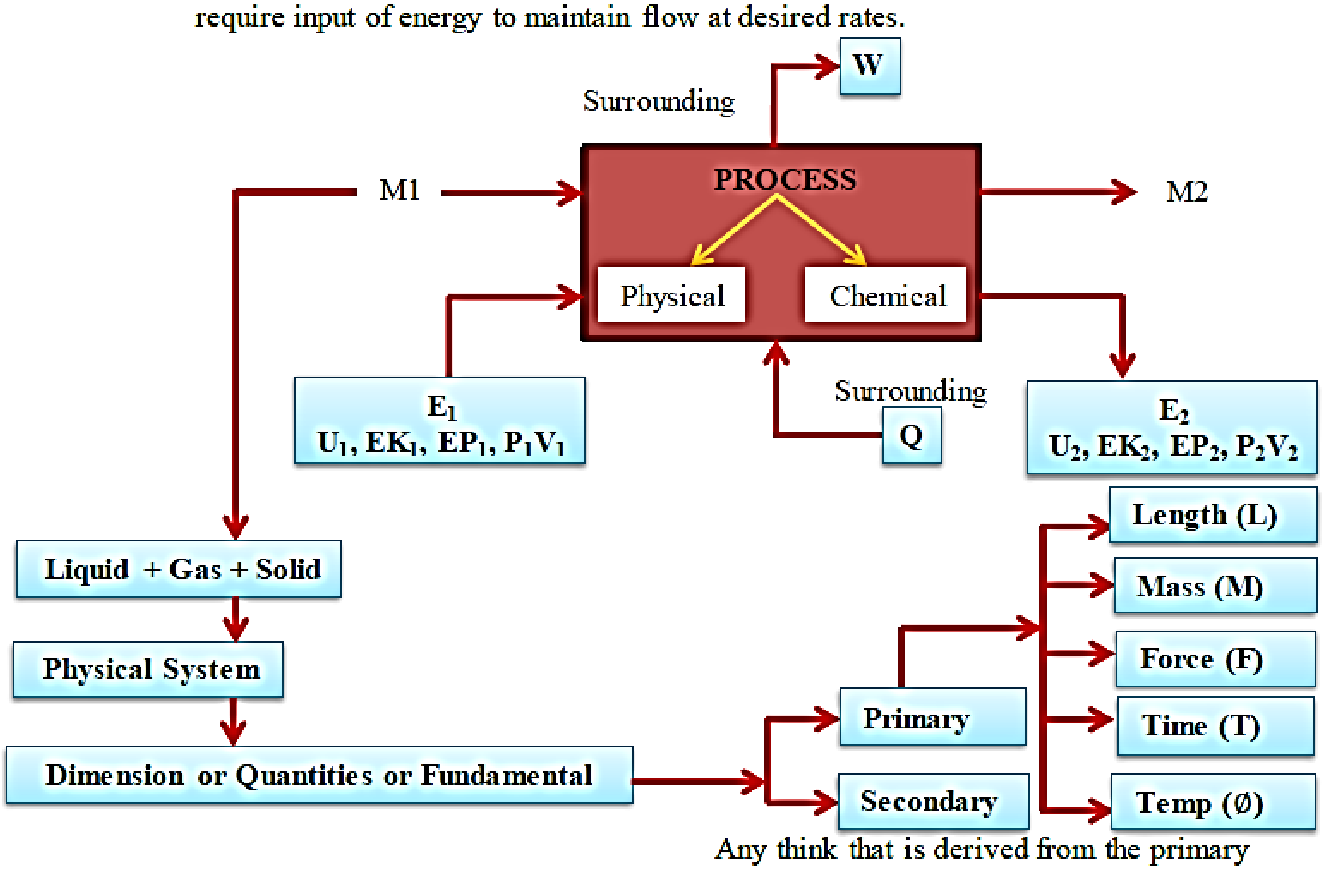
Lecture (1)

Storage & Transport of Crude Oil and Petroleum Products



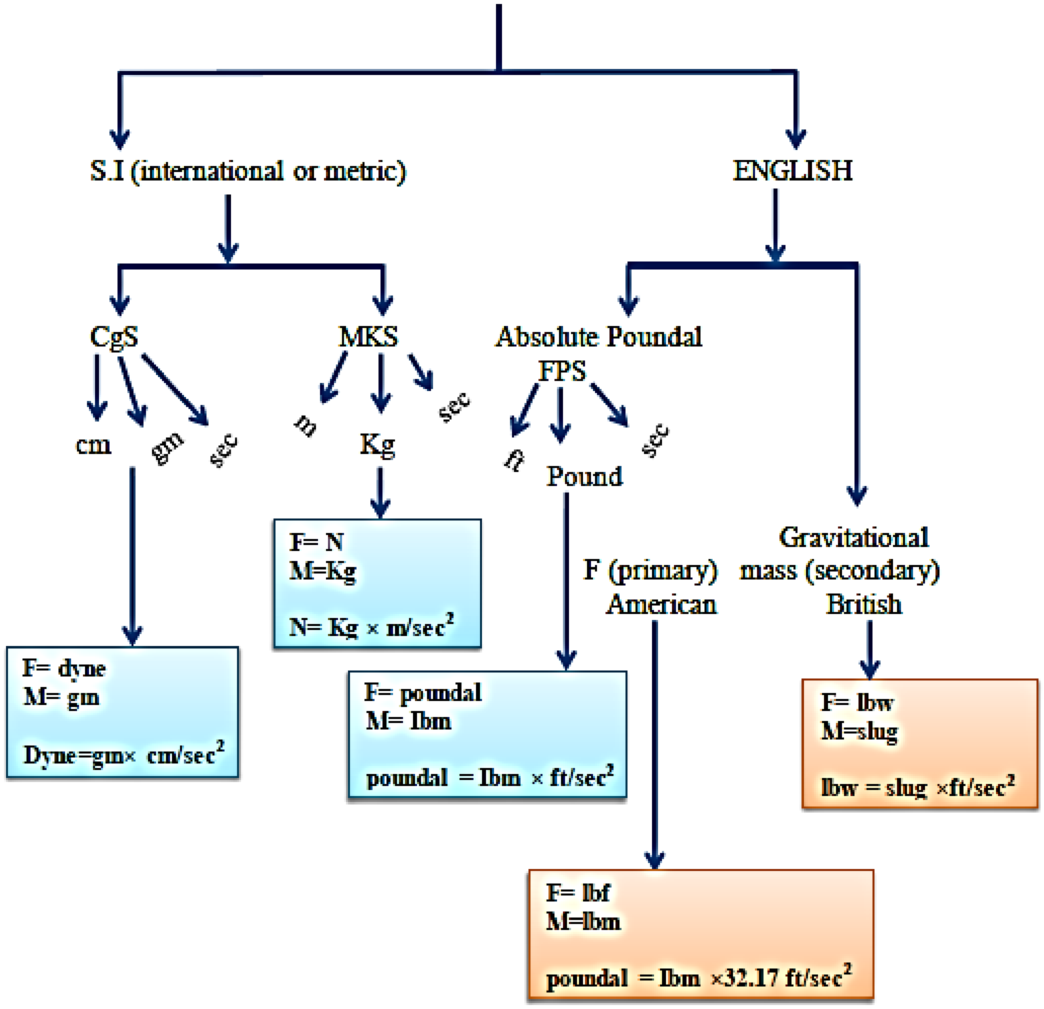
Process

The transfer of fluids through piping and equipment is accompanied by friction and may result in changes in pressure, velocity, and elevation. These effects require input of energy to maintain flow at desired rates.



Units: Can be defined as the means of expressing dimensions according to the systems of measurements.

MEASUREMENTS SYSTEMS



g_c: Correction Factor (for Newton's law)

$F \alpha\, m \times a \longrightarrow F = c \times m \times a \longrightarrow C = F/m \times a$, In (SI unit) $C = N \times sec^2 / Kg \times m$

In (English unit) $C = lbf \times sec^2 / 32.17.\ lbm.ft$ [$g_c = 1/c$] = Kg. m/N. sec or 32.17 lbm .ft / lbf.sec^2, $F = (m/g_c).a$

Note: $$g/g_c = \frac{ft/\sec^2}{lbm \times ft / lbf \times \sec^2} = \frac{ft}{\sec^2} \times \frac{lbf \times \sec^2}{lbm \times ft} \rightarrow \frac{g}{g_c} = 1\frac{lbf}{lbm}$$

Note: $$\frac{m^2}{\sec^2} = \frac{J}{kg}$$

Prove: $$\frac{J}{Kg} = \frac{N \times m}{Kg} = \frac{kg \times m}{\sec^2} \times \frac{m}{Kg} = \frac{m^2}{\sec^2}$$

For example: $E_K = \dfrac{m \times \Delta V^2}{2g_c} \rightarrow E_K = K_g \times \dfrac{m^2}{\sec^2} = J = N \times m$

Note: Btu→Cal→ft. lbf→J

1 Btu = 778 ft.lbf   1 Cal = 4.184 J   KW = 737.56 ft.lbf/sec

1 Btu = 252 Cal   1hp = 550 ft.lbf/sec

PROCESS

Unsteady State
d parameter/ d time ≠ zero

H,T,P,U,S,V

Steady Stat
d parameter/ d time = zero

Reversible

It's the process that doesn't Take into consideration the Loss of energy fraction and Its imaginary process and the Efficiency may be equal 100%

Irreversible

that takes in consideration the loss by energy due to fraction

Throttling   Adiabatic

Reversible
Open system, flow, continuous

Turbine   Boiler   Condenser   Pump

Reversible
closed, non-flow

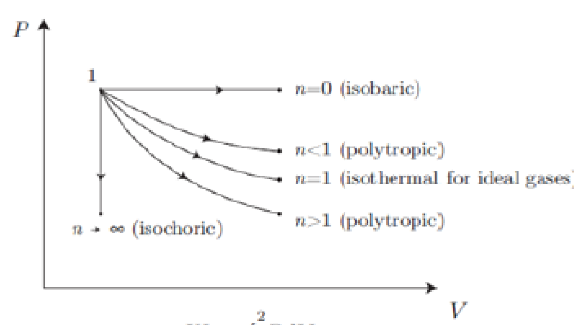
T=constant
isochoric

polytrophic
Isothermal
Insulated system

Q= 0
adiabatic

V=constant
isometric

p=constant
isobaric



$_1W_2 = \int_1^2 P\,dV$

1-Definition of Fluids

A fluid is defined as a substance that deforms continuously whilst acted upon by any force tangential to the area on which it acts. Such a force is termed a shear force, and the ratio of the shear force to the area on which it acts is known as the shear stress (see fig. 1). The characteristic that distinguishes a fluid from a solid is its inability to resist deformation under an applied shear stress (a tangential force per unit area). When a fluid is at rest neither shear forces nor shear stresses exist in it. A solid, on the other hand, can resist a shear force while at rest. In a solid, the shear force may cause some initial displacement of one layer over another, but the material does not continue to move indefinitely and a position of stable equilibrium is reached.

Definition 1 Fluid is any substance that deforms continuously when subjected to a shear stress, no matter how small. Shear forces are possible only while relative movement between layers is taking place. Fluids may be sub-divided into liquids and gases. A fixed amount of a liquid has a definite volume which varies only slightly with temperature and pressure. If the capacity of the containing vessel is greater than this definite volume, the liquid occupies only part of the container, and it forms an interface separating it from its own vapor, the atmosphere or any other gas present. Gas- a fixed amount of a gas, by itself in a closed container, will always expand until its volume equals that of the container. Only then can it be in equilibrium. In the analysis of the behavior of fluids an important difference between liquids and gases is that, whereas under ordinary conditions liquids are so difficult to compress that they may for most purposes be regarded as incompressible, gases may be compressed much more readily. Where conditions are such that an amount of gas undergoes a negligible change of volume, its behavior is similar to that of a liquid and it may then be regarded as incompressible. If, however, the change in volume is not negligible, the compressibility of the gas must be taken into account in examining its behavior.

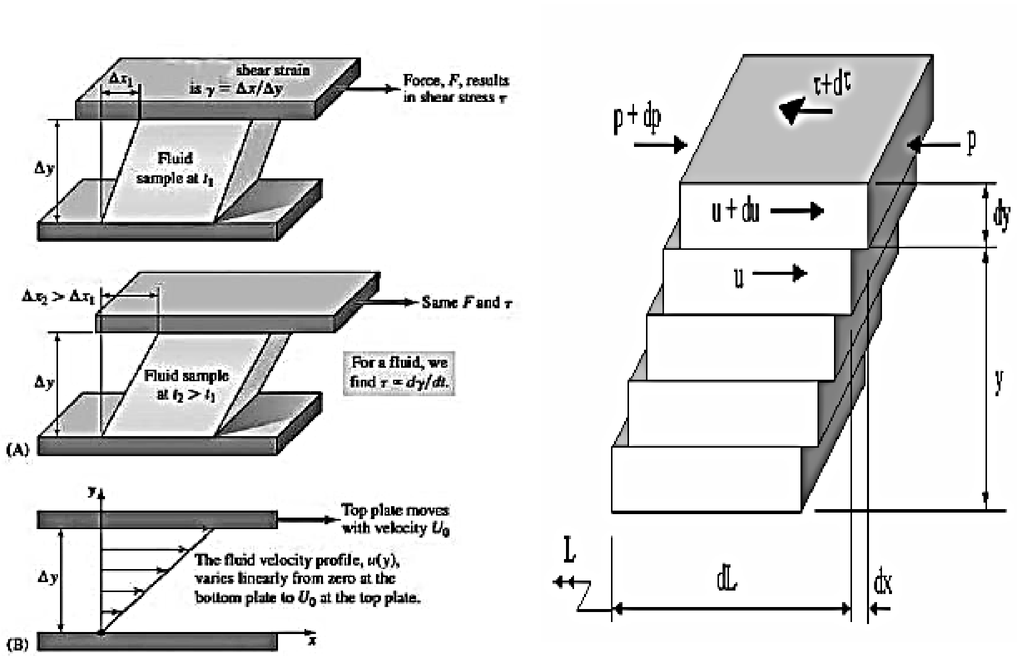


Figure 1: (A) The displacement and the corresponding shear strain increase linearly with time. For a fluid, the relationship between shear stress and shear strain is proportional. (B) The fluid velocity in the x direction, u, is a function of the y coordinate. The velocity u(y) varies linearly from 0 at the bottom plate to U0 at the top plate.

Liquids have much greater densities than gases. As a consequence, when considering forces and pressures that occur in fluid mechanics, the weight of a liquid has an important role to play. Conversely, effects due to weight can usually be ignored when gases are considered. The different characteristics of solids, liquids and gases result from differences in their molecular structure.

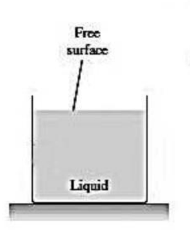


Figure 2: The liquid occupies only part of the container, and it forms an interface separating it from its own vapor.

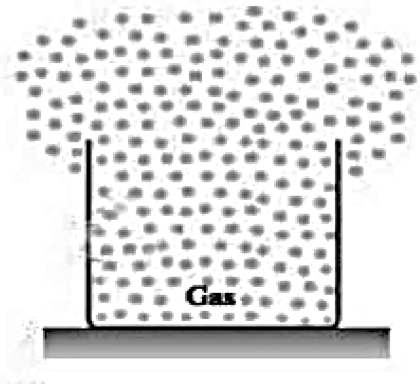


Figure 3: A fixed amount of a gas, by itself in a closed container, will always expand until its volume equals that of the container.

All substances consist of vast numbers of molecules separated by empty space. The molecules have an attraction for one another, but when the distance between them becomes very small (of the order of the diameter of a molecule) there is a force of repulsion between them which prevents them all gathering together as a solid lump.

2-Fluid properties

Definition 2 ***The density of a fluid (or any other form of matter) is the amount of mass per unit volume.***

$$\rho^{-} = \frac{\Delta M}{\Delta V}$$

or the density at a point in fluid as

$$\rho = \lim_{\Delta \to 0} \frac{\Delta M}{\Delta V}$$

The unit of density is kg/m^3.

The ***density*** r (rho) or more strictly, ***mass density,*** of a fluid is its *mass* per unit volume, while the ***specific weight*** γ (gamma) is its *weight* per unit volume. In the British Gravitational (BG) system density ρ will be in slugs per cubic foot (kg/m^3 in SI units), which can also be expressed as units of lb_sec^2/ft^4 (N_s^2/m^4 in SI units)

Specific weight γ represents the force exerted by gravity on a unit volume of fluid, and therefore must have the units of force per unit volume, such as pounds per cubic foot (N/m^3 in SI units). Density and specific weight of a fluid are related as:

$$\rho = \frac{\gamma}{g} \quad \text{or} \quad \gamma = \rho g$$

Since the physical equations are dimensionally homogeneous, the dimensions of density are

$$\text{Dimensions of } \rho = \frac{\text{dimensions of } \gamma}{\text{dimensions of } g} = \frac{\text{lb/ft}^3}{\text{ft/sec}^2} = \frac{\text{lb}\cdot\text{sec}^2}{\text{ft}^4} = \frac{\text{mass}}{\text{volume}} = \frac{\text{slugs}}{\text{ft}^3}$$

In SI units

$$\text{Dimensions of } \rho = \frac{\text{dimensions of } \gamma}{\text{dimensions of } g} = \frac{\text{N/m}^3}{\text{m/s}^2} = \frac{\text{N}\cdot\text{s}^2}{\text{m}^4} = \frac{\text{mass}}{\text{volume}} = \frac{\text{kg}}{\text{m}^3}$$

Note that density ρ is absolute, since it depends on mass, which is independent of location. Specific weight γ, on the other hand, is not absolute, since it depends on the value of the gravitational acceleration g, which varies with location, primarily latitude and elevation above mean sea level.

Specific volume v is the volume occupied by a unit mass of fluid. We commonly apply it to gases, and usually express it in cubic feet per slug (m^3/kg in SI units).

Specific volume is the reciprocal of density. Thus

$$v = \frac{1}{\rho}$$

Specific gravity *s* of a liquid is the dimensionless ratio

$$s_{\text{liquid}} = \frac{\rho_{\text{liquid}}}{\rho_{\text{water at standard temperature}}}$$

Physicists use 4°C (39.2°F) as the standard, but engineers often use 60°F (15.56°C). In the metric system the density of water at 4°C is 1.00 g/cm^3 (or 1.00 g/mL), equivalent to (1000 kg/m^3, 62.4 lb/ft^3, 8.34 lb/gal) and hence the specific gravity (which is dimensionless) of a liquid has the same numerical value as its density expressed in g/mL or Mg/m^3.

The specific gravity of a gas is the ratio of its density to that of either hydrogen or air at some specified temperature and pressure, but there is no general agreement on these standards, and so we must explicitly state them in any given case. Since the density of a fluid varies with temperature, we must determine and specify specific gravities at particular temperatures.