جامعة التقنية والعلوم التطبيقية
University of Technology and Applied Sciences - Ibra

Department Of Mechanical Engineering

Fluids Mechanics-1 (MIME 2240)

Chapter-1
Introduction to Fluids Mechanics and Fluid Properties

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Ref: http://agrimoon.com/fluid-mechanics-pdf-book-free-download/

Contents:

- Cohesion
- Adhesion
- Surface Tension
- Capilarity
- Vapoure Pressure

Cohesion

- Cohesion means intermolecular attraction between *molecules of the same liquid.*
- It enables a liquid to resist small amount of tensile stresses.
- Cohesion is a tendency of the liquid to remain as one *assemblage of particles.*
- "*Surface tension*" *is due to cohesion between particles at the free surface.*

Adhesion

Adhesion means *attraction between the molecules of a liquid and the molecules of a solid boundary surface in contact with the liquid.*

This property enables a liquid to stick to *another body.*

Capillary action is due to both *cohesion* and *adhesion.*

Surface tension: $\sigma = N/M$

is caused by the *force of cohesion at the free surface.*

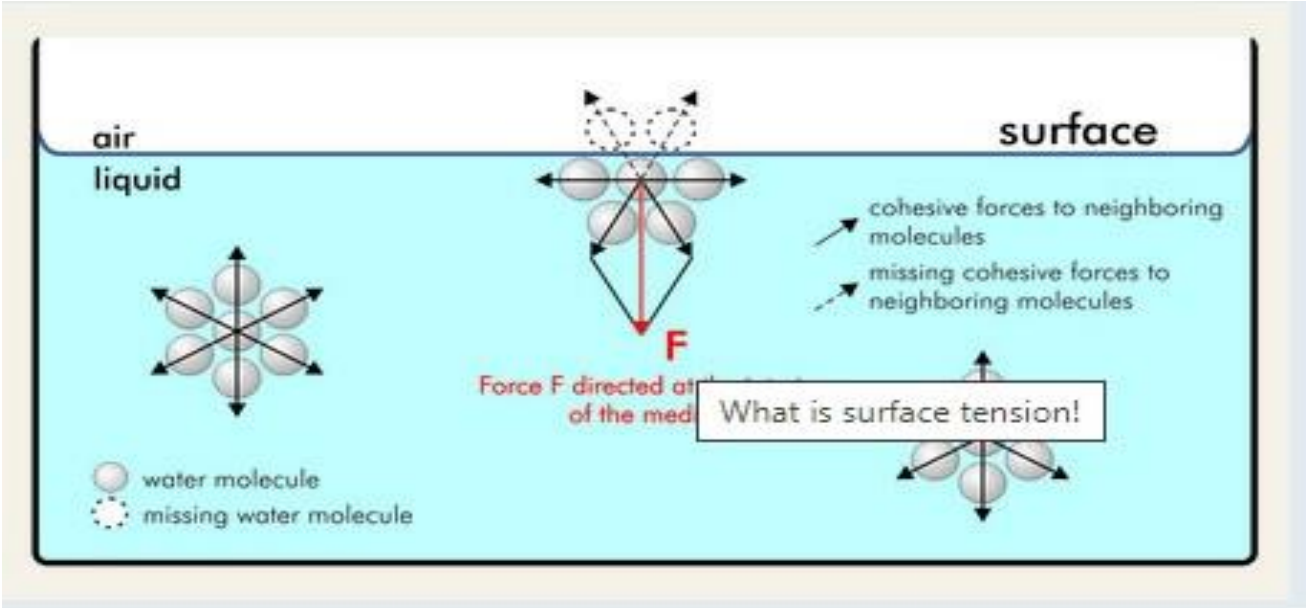
A liquid molecule in the interior of the liquid mass

is surrounded by other molecules all around and is in equilibrium.

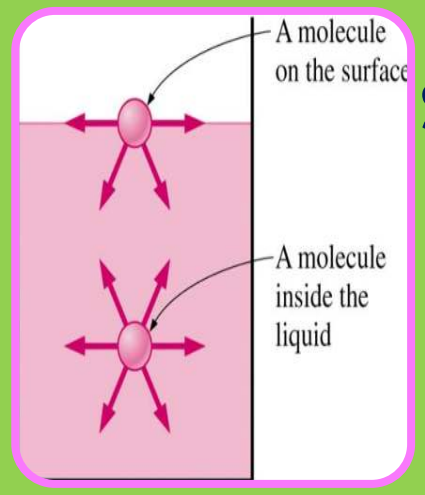
At the free surface of the liquid, there are no liquid molecules above the surface to balance the force of the molecules below it.

Consequently, as shown in Fig. there is a net inward force on the molecule. The force is normal to the liquid surface.

At the free surface a thin layer of molecules is formed. This is because of this *film that a thin small needle can float on the free surface* (the layer acts as a *membrane*).



Reff: https://www.sita-process.com/information-service/process-parameter-surface-tension/overview/



Surface tension

- defined as *the force acting a unit length of a line drawn in the liquid surface*

Surface tension

- Surface tension tend to reduce the surface area of a body of liquid
- The internal pressure within the droplet, p and the surface tension forces,σ must be in equilibrium.

$$2\pi r\sigma = p\pi r^2$$

Surface tension on a liquid Droplet

$$2\pi r\sigma = p\pi r^2$$

$$p = \frac{2\sigma}{r} \Longrightarrow \sigma = \frac{pr}{2}$$

Surface tension on a Hollow bubble or Soap bubble

$$p = \frac{4\sigma}{r}$$

CAPILLARITY

When a liquid comes into contact with a solid surface:

- Adhesion forces: forces between solid and liquid
- Cohesion forces: forces within liquid

If cohesive forces > adhesive forces, the meniscus in a glass tube will take a shape as in figure (a) and (b).

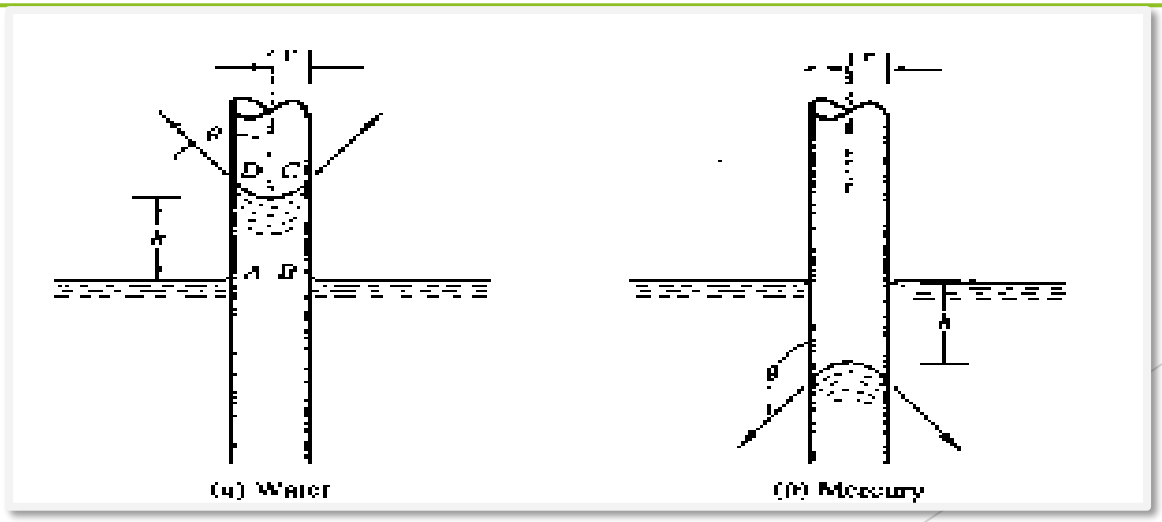
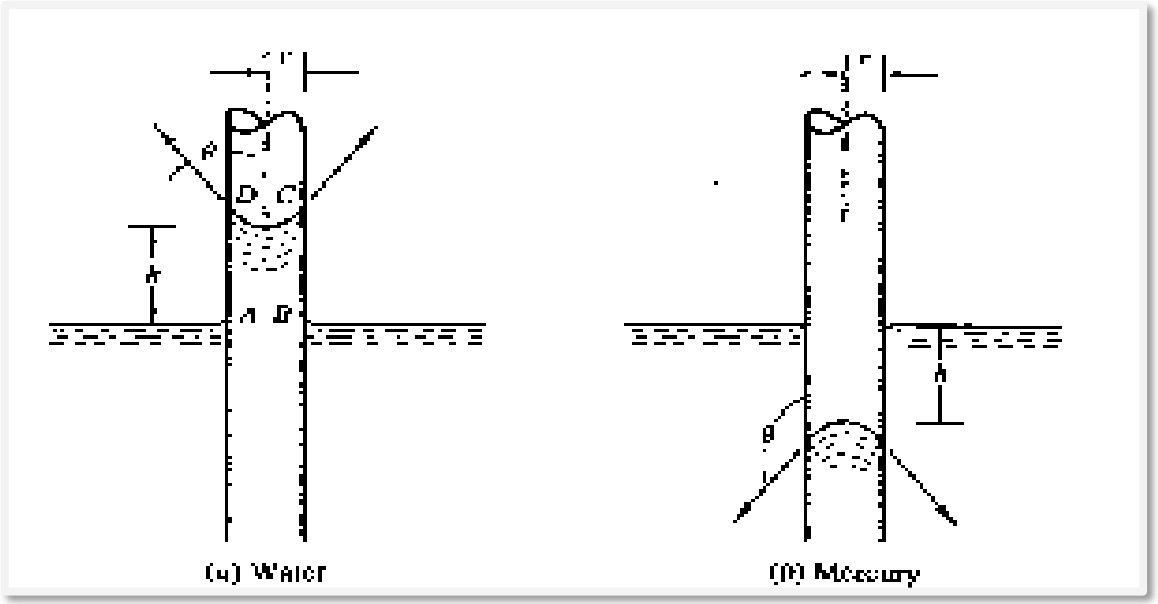


Figure (a) and (b)



Capillary effect is the rise or fall of a liquid in a small-diameter tube

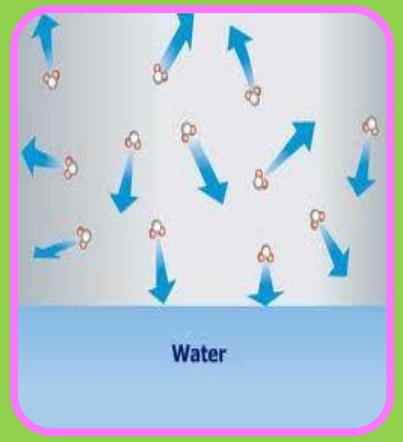
$$h = \frac{4\sigma\cos\theta}{\rho g d} \quad @ \quad h = \frac{4\sigma\cos\theta}{\gamma d} \quad @ \quad h = \frac{2\sigma\cos\theta}{\rho g r}$$

Units= m @ mm

where h = height of capillary rise (or depression)
σ = surface tension
θ = wetting (contact) angle
γ = specific weight of liquid
r = radius of tube

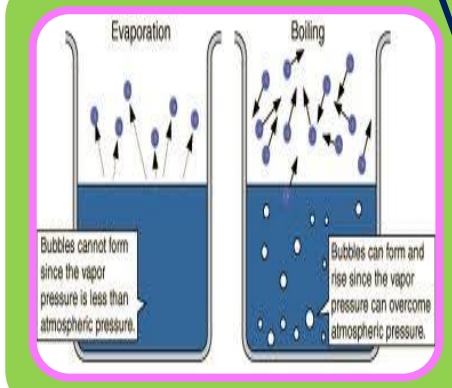
VAPOR PRESSURE, P_v

Vapor pressure



- defined as the pressure at which a liquid turns to vapour
- the pressure exerted by its vapor in phase equilibrium with its liquid at a given temperature
- The molecules which moves above the surface of the liquid exert pressure in the confined surface

Vapor pressure



$$P_{vapour} = P_{saturation}$$

Units: N/m^2 or Pascal

Units Of Viscosity

1 poise= (1/10) Ns/m2

I Stoke= cm2/sec

= 10-4 m2/sec

CentiStokes=(1/100)Stokes

THANK YOU!

for your attention