JECRC Foundation

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

# JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTER

Class – B.Tech Civil ( III SEM)
Subject –Fluid Mechanics
Unit – 1
Presented by – Ashish Boraida (Assistant Professor)

# VISION AND MISSION OF INSTITUTE

## VISION OF INSTITUTE

To became a renowned centre of outcome based learning and work towards academic professional ,cultural and social enrichment of the lives of indivisuals and communities

## MISSION OF INSTITUTE

Focus on evaluation of learining ,outcomes and motivate students to research apptitude by project based learning.

- Identify based on informed perception of indian ,regional and global needs ,the area of focus and provide plateform to gain knowledge and solutions.
- 
- Offer oppurtunites for interaction between academic and industry .
- Develop human potential to its fullest extent so that intellectually capable and imaginatively gifted leaders may emerge.

# VISION AND MISSION OF DEPARTMENT

## Vision

To become a role model in the field of Civil Engineering for the sustainable development of the society.

## Mission

1)To provide outcome base education.

2)To create a learning environment conducive for achieving academic excellence.

3)To prepare civil engineers for the society with high ethical values.

# Introduction, Objective and Outcome of Fluid Mechanics

**Objective:**

,

The primary purpose of the study of Fluid mechanics is to develop the capacity to understand important basic terms used in fluid mechanics, understand hydrostatics and buoyancy with practice of solving problems. Student could be able to understand Kinematics of flow and fluid dynamics, Bernoulli's equation and laminar flow with practice of solving problems in practical life for the benefit of society and mankind.

**Outcomes**

- Student will be able to understand basics of fluid mechanics, types of fluids.
- Student will be able to understand fluid statics and buoyancy.
- Student will be to understand Kinematics of flow and fluid dynamics and solving relevant problems.
- Student will be to understand Bernoulli's equation and laminar flow with practice of solving problems.

# CONTENTS

- Introduction, Definition of Fluid Mechanics
- Fluids
- Types of Fluids
- Properties of Fluids
- Surface Tension
- Capillarity

# Fluid Mechanics

The branch of physical science that deals  the study of fluids at rest or in motion.

- It has traditionally been applied in such areas as the design of canal, and dam systems.

- The aerodynamics of automobiles and sub- and supersonic airplanes;
and the development of many different flow measurement devices such as gas pump meters

# Fluids

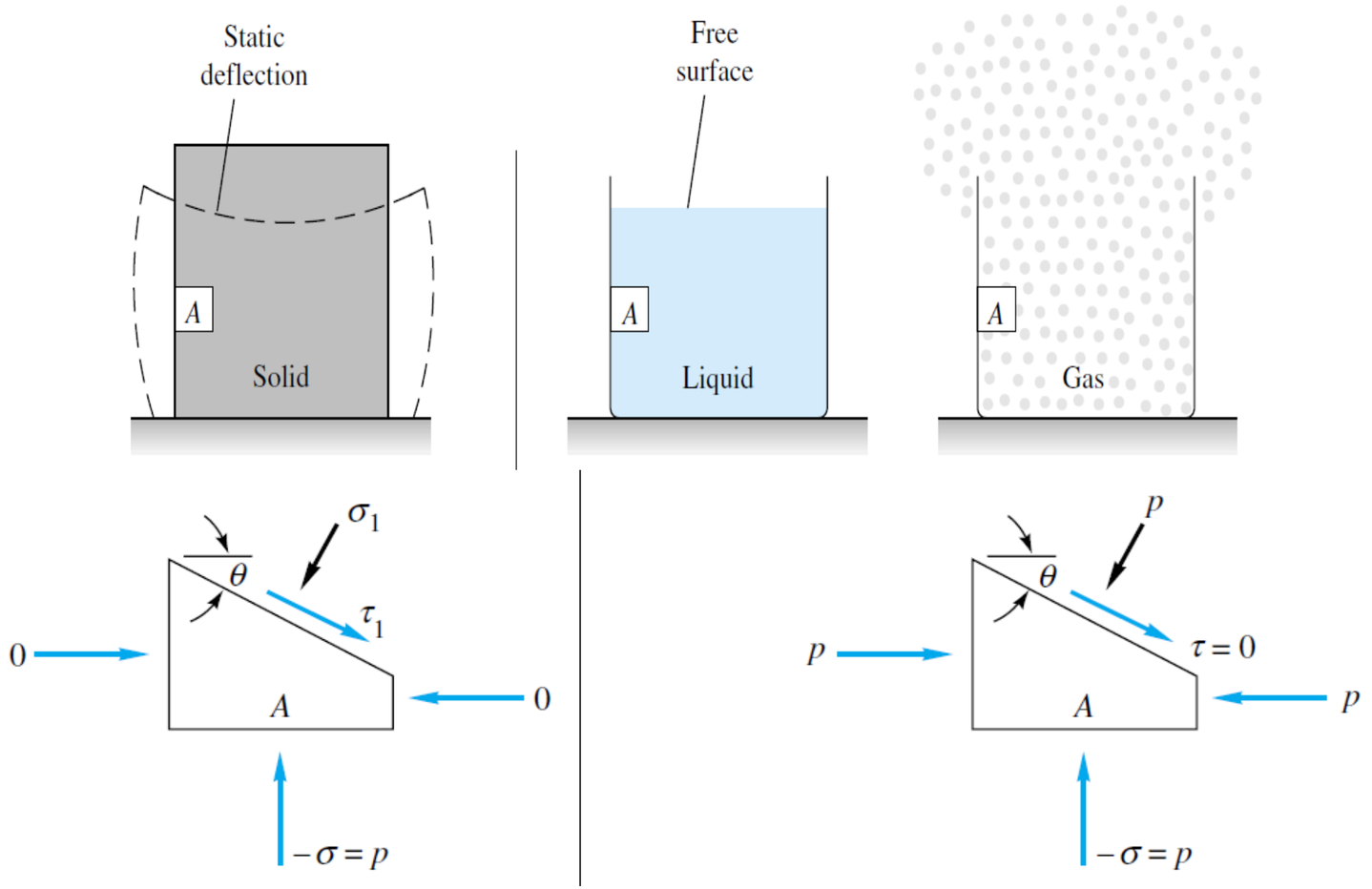
A fluid is a substance that deforms continuously under the application of a shear (tangential) stress no matter how small the shear stress may be.

Because the fluid motion continues under the application of a shear stress, we can also define a fluid as any substance that cannot sustain a shear stress when at rest

Fluid is a substance that is capable of flowing. It  has no definite shape of its own. It assumes the  shape of its container.

Both liquids and gases are fluids.
Examples of fluids are : water, Milkm, kerosene, petrol, emulsions etc.

# Solid Liquids and gases



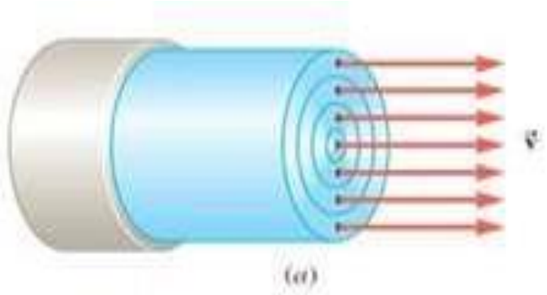
# TYPES OF FLUIDS

Fluids can be classified into five basic types. They are:

- Ideal Fluid
- Real Fluid
- Pseudo-plastic Fluid
- Newtonian Fluid
- Non-Newtonian Fluid

# IDEAL FLUID

- An Ideal Fluid is a fluid that has no viscosity.
- It is incompressible in nature.
- Practically, no ideal fluid exists.

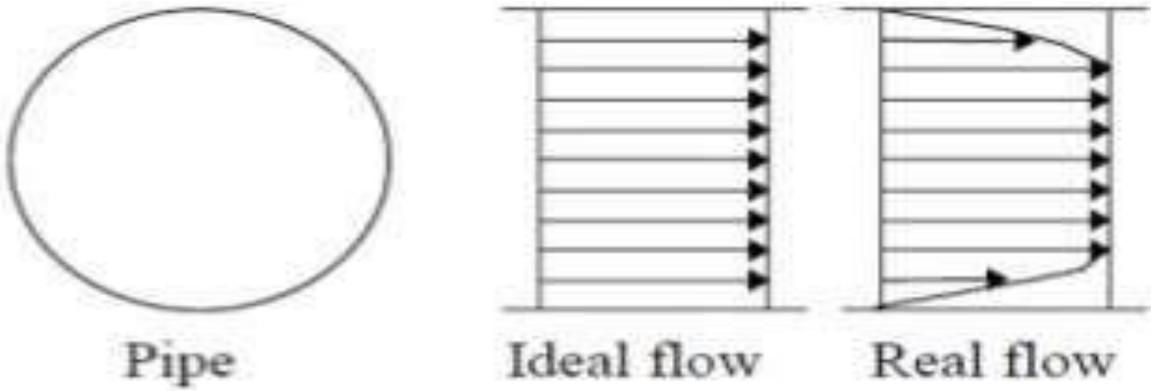



Flow of an ideal fluid.

**Flow of a viscous fluid.**

# REAL FLUID

- Real fluids are compressible in nature. They have  some viscosity.
- Real fluids implies friction effects.
- Examples: Kerosene, Petrol, Castor oil




Velocity distribution of pipe flow

# PSEUDO-PLASTIC FLUID

- A fluid whose apparent viscosity or consistency decreases instantaneously with an increase in shear rate.
- Examples are:
  - quick sand
  - ketch-up etc.

ketch-up

Quick sand

# NEWTONIAN FLUID

- Fluids that obey Newton's law of viscosity are known as Newtonian Fluids. For a Newtonian fluid, viscosity is entirely dependent upon
- the temperature and pressure of the fluid.
- Examples: water, air, emulsions

Different types of Emulsions

# NON-NEWTONIAN FLUIDS

- Fluids that do not obey Newton's law of viscosity are non-Newtonian fluids.
- Examples: Flubber, Oobleck (suspension of starch in water), Pastes, Gels & Polymer solutions.

Flubber

# NON-NEWTONIAN FLUIDS

Starch in Water

Gel

Tooth Paste

## Density & Specific Weight

Density is the amount of mass per unit volume of a substance

$$\rho = \frac{m}{V}$$

kg/m$^3$

slugs/ft$^3$

Specific Weight is the amount of weight per unit volume of a substance

$$\gamma = \frac{w}{V}$$

N/m$^3$

lb/ft$^3$

$$\boxed{\gamma = \rho g}$$

$g = 32.2 \frac{ft}{s^2}$ (SI)

$g = 9.81\ m/s^2$ (IMP)

# Note: *Specific Volume*

The specific volume of a substance is the ratio of the substance's volume to its mass. It is the reciprocal of density and is an intrinsic property of matter.

$$\nu = \frac{V}{m} = \rho^{-1}$$

$$\nu - Specific\ Volume\ {}^{m^3}/_{Kg}$$

| Substance Name | Density | Specific Volume |
|---|---|---|
| | $Kg/m^3$ | $m^3/Kg$ |
| Air | 1.2 | 0.83 |
| Ice | 916.7 | 0.00109 |
| Water (liquid) | 1000 | 0.00100 |
| Salt Water | 1030 | 0.00097 |
| Mercury | 13546 | 0.00007 |

# Specific Gravity

Simply the ratio of the density of a substance to the density of water. It is one of the few unitless quantities in chemistry.

$$\text{sp gr} = \frac{d_{\text{sample}}}{d_{\text{water}}}$$

# SPECIFIC WEIGHT

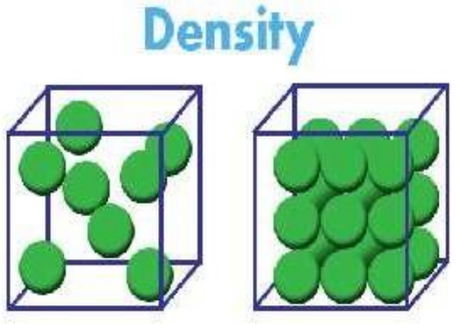
- Specific weight is the weight possessed by unit volume of a fluid. It is denoted by ‘w’. Its unit is $N/m^3$.
- Specific weight varies from place to place due to the change of acceleration due to gravity (g).

$$\text{Specific weight, } w = \frac{\text{Weight}}{\text{Volume}} \quad \frac{N}{m^3}$$

# DENSITY

- Density is the mass per unit volume of a fluid. In other words, it is the ratio between mass (m) and volume (V) of a fluid.
- Density is denoted by the symbol ‘ρ’. Its unit is $kg/m^3$.

$$\text{Density}, \rho = \frac{\text{Mass}}{\text{Volume}} \quad \frac{kg}{m^3}$$

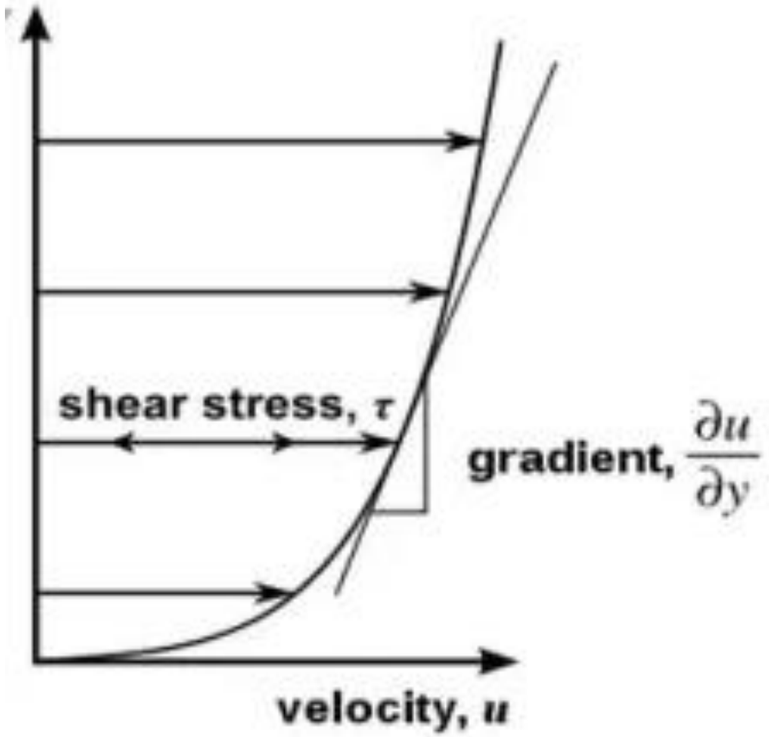


# VISCOSITY

- Viscosity is the fluid property that determines the amount of resistance of the fluid to shear stress.
- It is the property of the fluid due to which the fluid offers resistance to flow of one layer of the fluid over another adjacent layer.

Viscosity

# VISCOSITY




Viscosity, $\tau = \mu \frac{du}{dy}$

Where,

$\mu$ = Dynamic viscosity

$\tau$ = Shear stress= F/A

$\frac{du}{dy}$ = Rate of shear deformation

# VISCOSITY

Newton's Law of viscosity, $\tau \alpha \frac{du}{dy}$

$$\tau = \mu \frac{du}{dy}$$

Where,

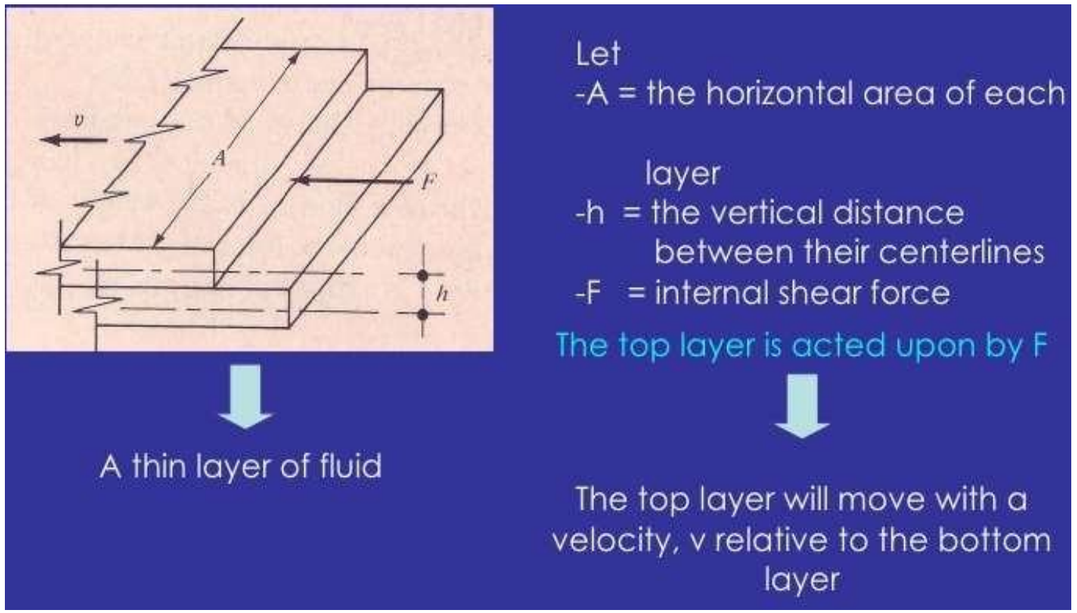
$\mu$ = Viscosity

$\tau$ = Shear stress= F/A

$\frac{du}{dy}$ = Rate of shear deformation

# COEFFICIENT OF DYNAMIC VISCOSITY

- The Dynamic (shear) viscosity of a fluid expresses its resistance to shearing flows, where adjacent layers move parallel to each other with different speeds.




$$F = \mu A \frac{u}{y}.$$

μ = Dynamic Viscosity

# KINEMATIC VISCOSITY

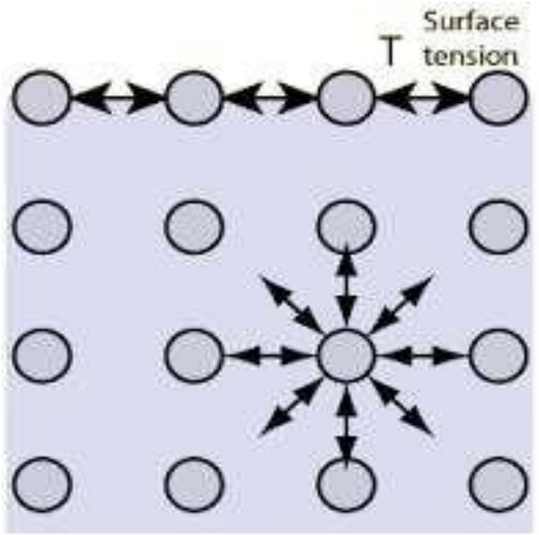
- The kinematic viscosity (also called "momentum diffusivity") is the ratio of the dynamic viscosity $\mu$ to the density of the fluid $\rho$.

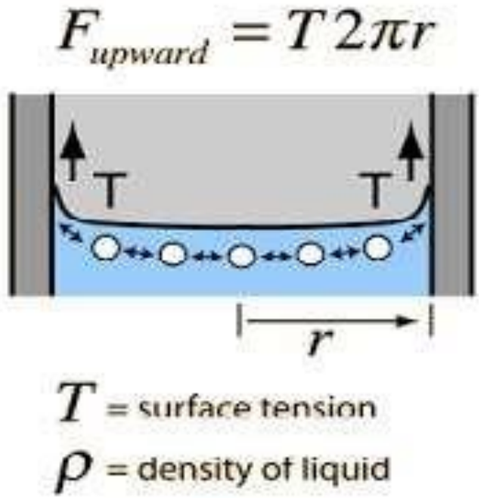
$$\nu = \frac{\mu}{\rho}$$

$\nu$ = kinematic viscosity, $m^2/s$
$\mu$ = Dynamic viscosity, $N.s/m^2$ or $Pa.s$
$\rho$ = Density of fluid, $kg/m^3$

# SURFACE TENSION

- The property of fluids to resist tensile stresses on their surface is called as Surface Tension.

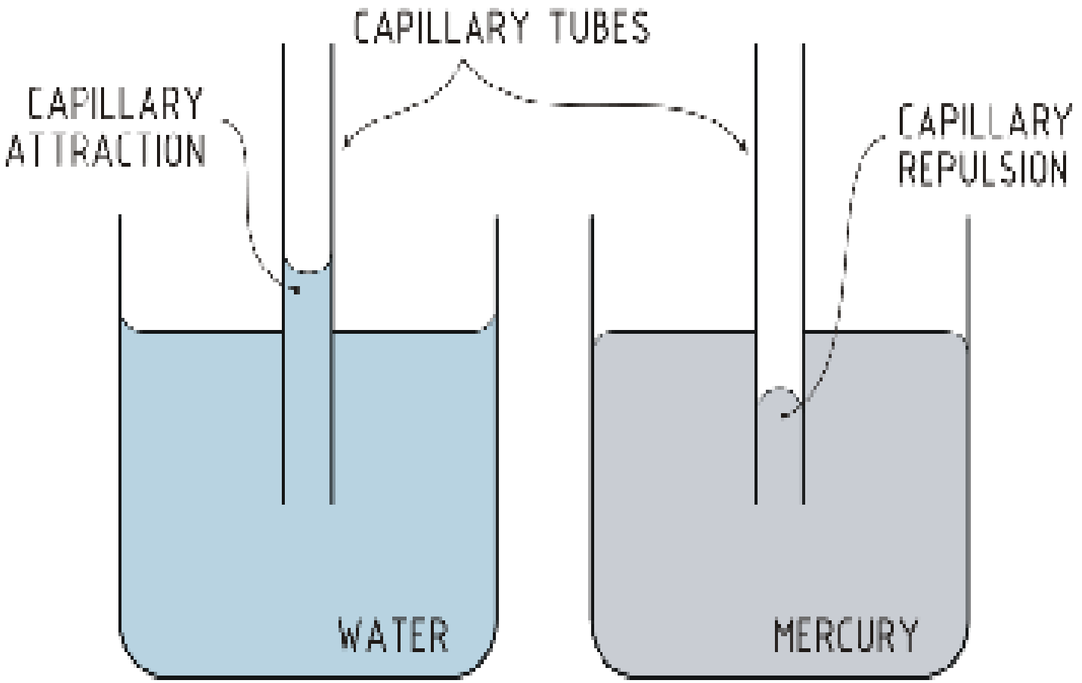


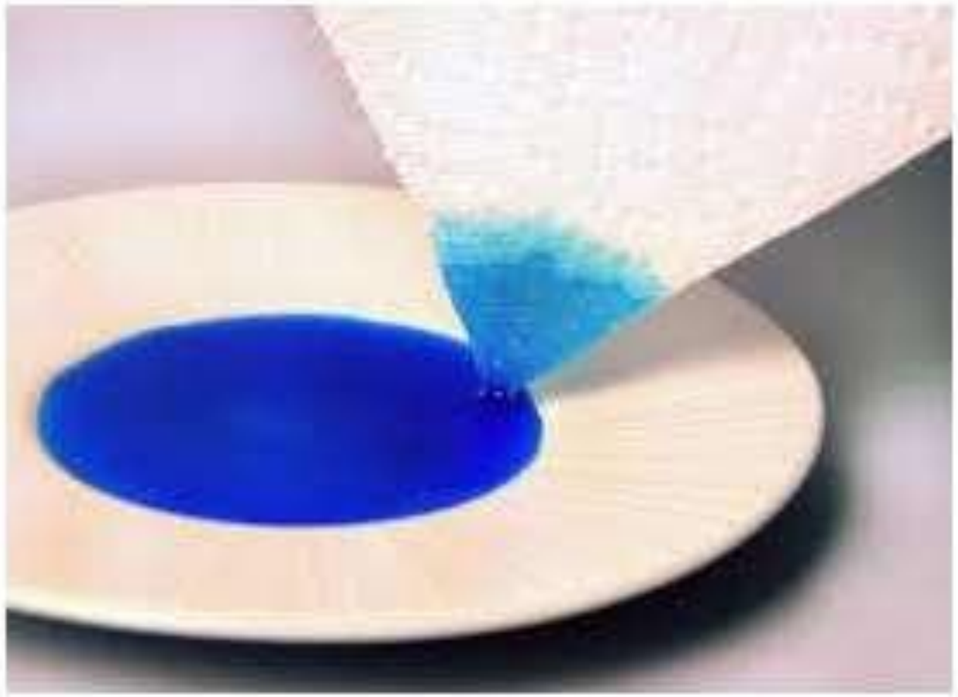
# CAPILLARY ACTION

- Capillary action is the property of fluid to flow in a narrow spaces without assistance of and in opposition to external forces like gravity.
- The effect can be seen in the drawing up of liquids between the hairs of a paint-brush, in a thin tube, in porous materials such as paper and plaster, in some non-porous materials such as sand or in a cell.
- It occurs because of intermolecular forces between the liquid and surrounding solid surfaces.

# CAPILLARY ACTION




Capillary action between water and mercury.



Tissue paper absorbing ink due to capillary action

JECRC Foundation

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

# Thank you!

STAY HOME, STAY SAFE