UIT-RGPV (Autonomous) Bhopal
Department of Petrochemical Engineering

Subject In-charge: Prof. M.S. Chouhan
Semester: III
Subject code – PC 702 **Subject: Transport Phenomena**
Unit: -I

Lecture no. 1 (date:25.08.2021)

Introduction to transport Phenomena

1. What are the transport phenomena?

- Momentum, heat and mass transfer are called transport phenomena

The subject of transport phenomena includes three closely related topics:

(a) Fluid dynamics: Involves the transport of momentum**.**

(b) Heat transfer: H.T. deals with the transport of energy.

(c) Mass transfer: M.T. is concerned with the transport of mass of various chemical species.

2. What is difference between Laminar and turbulent flow?

- **Laminar flow:**

This type of flow exists at low velocities and assumes that the fluid adjacent layers slide past one another like playing cards. This type of flow is characterized by:

a. There is no lateral mixing.

b. There is no cross current or eddies.

c. The velocity gradient is high.

- **Turbulent flow :**

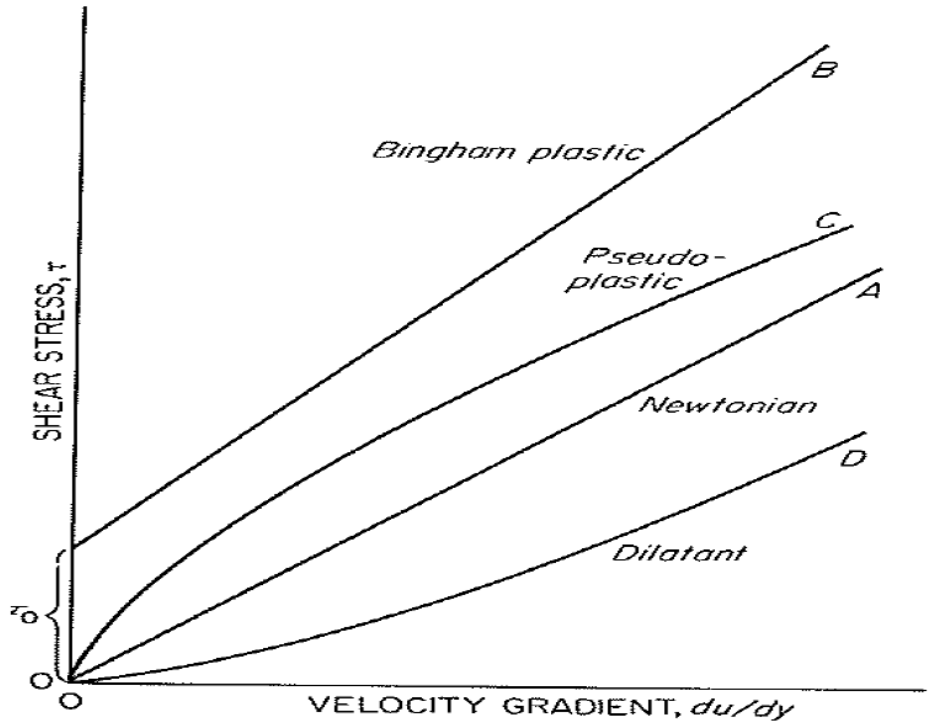
Exists at high velocities and is characterized by:

a. There is mixing and cross currents

b. The velocity gradient is lower than that of turbulent flow

3. Newtonian and non-Newtonian fluids

- According to Newton's law of viscosity fluids are classified based on their rheological behaviour into two categories: (a) Newtonian fluids (b) Non-Newtonian fluids
- By plotting shear stress versus shear rate for different types of fluids the following curve was obtained:



Shear stress versus velocity gradient for Newtonian and non-Newtonian fluids

1. Curve (A)

- All fluids that follow Newton's law (i.e. there is a linear relationship between shear stress and velocity gradient) are called Newtonian fluids. It includes gases and most liquids.

2. Curve (B)

- These materials behave as a rigid body at low stresses and don't flow at all until a minimum shear stress is attained and is denoted by ( ) after which it flows linearly as a viscous fluid at high stress greater than . Materials acting this way are called Bingham plastic fluids.

Examples: Paints, Tooth paste, Drilling mud

3. Curve (C)

- The curve passes through the origin is concave downward at low shears and becomes linear at high shears. These types of fluids are called pseudoplastic fluids.

- In this type of fluids the viscosity decreases with increasing the shear stress that is why it is call shear rate thinning.

Examples: Paper pulp, Blood, Syrup, Molasses

4. Curve (D)

- The curve passes through the origin is concave upward at low shears and becomes linear at high shears. These types of fluids are called dilatant fluids.
- In this type of fluids the viscosity increases with increasing the shear stress that is why it is call shear rate thickening.

Examples: sand in water (sand filled emulsion), Suspension of corn starch.

4. What is viscosity?

Viscosity is a measure of a fluid's resistance to flow. It describes the internal friction of a moving fluid. A fluid with large viscosity resists motion because its molecular makeup gives it a lot of internal friction. A fluid with low viscosity flows easily because its molecular makeup results in very little friction when it is in motion.

5. Newtons law of viscosity

That is, the force should be proportional to the area to the velocity, and inversely proportional to the distance between the plats. The constant of proportionality 'μ' is a property of the fluid, define to the viscosity.

We replace F/A by the symbol τ_{yx} replace v/y by – dv_x/dy

$$\tau_{xy} = -\mu \frac{dv_x}{dy}$$

Which states that the shearing force per unit area is proportional the negative of the velocity gradient is often call newtons law of viscosity.