UNIT – 2

Rheology:

1. Newtonian Systems:

- **Law of Flow:** In Newtonian systems, the rate of shear is directly proportional to the applied shear stress.
- **Kinematic Viscosity:** It is the ratio of dynamic viscosity. It represents the resistance of a fluid to flow under the influence of gravity.
- **Effect of Temperature:** Generally, the viscosity of Newtonian fluids decreases with an increase in temperature.

2. Non-Newtonian Systems:

- **Pseudoplastic (Shear-Thinning):** The viscosity decreases with increasing shear rate. Common in many polymer solutions and colloidal dispersions.
- **Dilatant (Shear-Thickening):** The viscosity increases with increasing shear rate. Uncommon but can be observed in some concentrated suspensions.
- **Plastic Flow:** A minimum shear stress (yield stress) must be applied before flow begins. Once the yield stress is exceeded, the material flows like a Newtonian fluid. Common in certain colloidal systems and some gels.
- **Thixotropy:** The property of a material to become less viscous over time under constant shear stress. The recovery of viscosity occurs when the shear stress is removed. Many paints and some gels exhibit thixotropic behaviour.
- **Thixotropy in Formulation:** Thixotropic behaviour is desirable in formulations such as paints, where the material needs to be easily applied during shear but maintain a stable consistency at rest.

3. Determination of Viscosity:

- **Capillary Viscometers:** Measure the flow of a liquid through a capillary tube under the influence of gravity.
- **Falling Sphere Viscometers:** Measure the rate of descent of a sphere through a liquid.
- **Rotational Viscometers:** Utilize the rotation of a spindle in a sample to measure the torque required to overcome the viscous resistance.

Deformation of Solids:

- **Plastic Deformation:** Irreversible deformation that occurs when stress exceeds a certain value.
- **Elastic Deformation:** Reversible deformation that occurs when stress is applied but is removed once the stress is removed.

- **Heckel Equation:** Describes the compression behaviour of powders during tableting in pharmaceutical manufacturing.
- **Stress-Strain Relationship:** Describes the relationship between applied stress and resulting strain in a material.
- **Elastic Modulus:** Represents the stiffness or rigidity of a material. It includes Young's modulus (for tension and compression) and shear modulus (for shear).

Understanding rheological properties and deformation behaviour is crucial in various fields, including material science, pharmaceuticals, and food science, as it influences processing, stability, and application properties of substances.