Rheological properties of dental materials

Rheology: **Rheo= flow, logy= study**

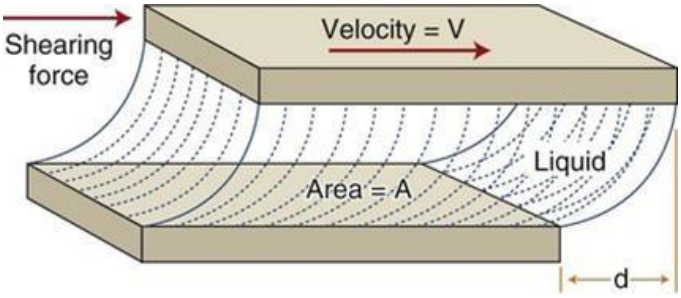
The study of flow of matter. In dentistry, study of Rheology is necessary because many dental materials are liquids at some stage of their use.

e.g. molten alloy and freshly mixed impression materials and cements. Other materials appear to be solids but fl**ow** over a period of time.

Viscosity

It is the resistance offered by a liquid when placed in motion, e.g. honey has greater viscosity than water.

It is measured in poise (p) or centipoise (cp) (1 cp = 100p).



Classification of fluids based on Rheology:

1. Newtonian:

The viscosity of a Newtonian fluid is constant and independent of shear rate.

e.g., some dental cements

2. Pseudoplastic:

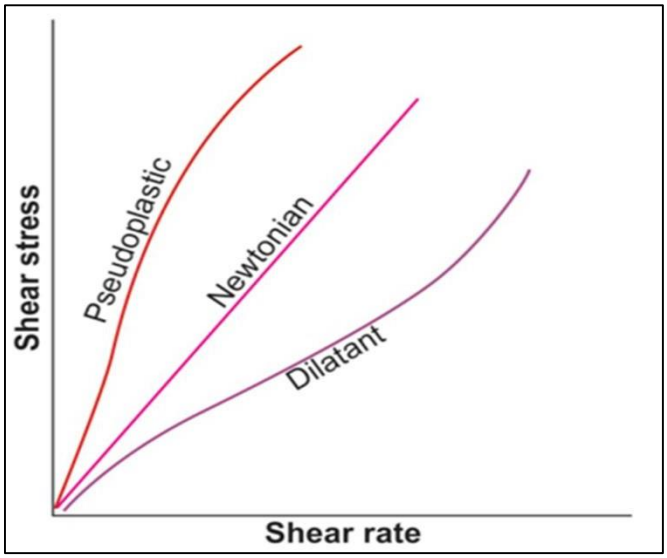
The viscosity of a pseudoplastic fluid decreases with increasing shear rate.

e.g., elastomeric impression materials.

3. Dilatant:

The viscosity of a dilatant fluid increases with increasing shear rate**.**

e.g. fluid denture base.



Shear diagrams of pseudoplastic, newtonian and dilatant liquids.

Thixotropic:

It is a property of some materials which change their viscosity and become more fluid when subject to constant shear force and reset after being allowed to stand.

Plaster of Paris, resin cements, and some impression materials are thixotropic**.**

Zinc oxide eugenol cements show reduced viscosity after vigorous mixing. Dental prophy paste is another example

Structural relaxation

It is a rheological phenomenon of solids that occurs so slowly that it is not noticed until the process completes. The two categories of interest in dentistry are:

- **Stress relaxation**
- **Creep and flow.**

Stress Relaxation:

When substances are deformed, internal stresses get trapped because of the displacement of the atoms. The condition is unstable and the atoms try to return to their original positions. This results in a change in shape or contour in the solid as atoms or molecules rearrange themselves. This change in shape due to release of stresses is known as relaxation. The material is said to warp or distort. e.g., wax

Creep: is defined as the increase in strain in a material under constant stress. It is time dependent plastic deformation or change of shape that occurs when a metal is subjected to a constant load near its melting point. This may be **static** or **dynamic** in nature

I. **Static creep** is a time dependent deformation produced in a completely set solid subjected to a constant stress.

II. **Dynamic creep** produced when the applied stress is fluctuating.

Dental amalgam has components with melting points that are slightly above room temperature and the creep produced can be very destructive to the restoration.

Flow: is similar to creep. In dentistry, the term flow is used instead of creep to describe rheology of amorphous substances, e.g. waxes.

Creep or flow may be measured under compressive load for a specified time and temperature.