

Non-Newtonian flow:

Some liquid doesn't obey the newton's law of flow these are called non-newtonian flow.

~~and the so.~~

→ There are certain flow of non newtonian fluid

such as 1. plastic flow.

2. pseudo plastic flow

3. Dilatant flow:-

↳ plastic flow:-

It is a non-newtonian flow in which the curve does not pass through the origin.
→ This substance initially behaves like a solid & tends to flow when less amount of flow is applied.

→ Further increase in shear stress leads to non-newtonian increase in shear rate and the if gets linearize.

→ The linear portion when extra plotted intercepts the x-axis at a point called yield value that means the plastic flow resembles the newtonian flow above the yield value.

ex- p. flows are concentrated suspension, butter, certain ointment, pastes, gels.

Mechanism of flow:-

They are present ~~pro~~ ~~flow~~ flocs which are the aggregation of particles which interact with particle contact.

→ At the resting condition this state is maintained, but whenever the shearing stress will be applied and the interparticle contact will be broken.

→ At the yield value, the particles behave individually & the force applied to reach yield value is called forces of flocs.

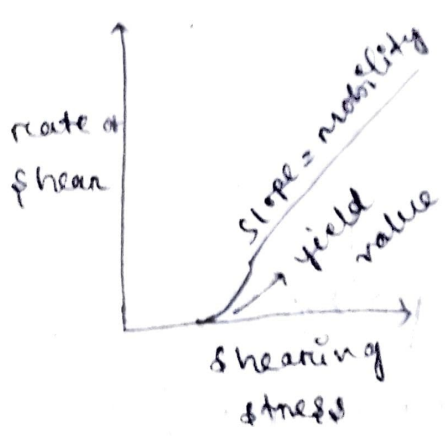
once the yield value is obtained the increase in shearing stress leads to linear increase in rate of shear.

The materials which exhibit this plastic flow are called as Bingham body in honor of scientist Bingham.

The slope of the Bingham line is termed as mobility and its reciprocal is called plastic viscosity (μ)

$$\text{Plastic viscosity } (\mu) = \frac{F - F_0}{G}$$

where: F = shearing stress
 F_0 = yield value
 G = rate of shear



mobility = reciprocal of plastic viscosity (μ)

$$\mu = \frac{F - F_0}{G}$$

(plastic flow)

2. Pseudoplastic flow:

The consistency curve for a pseudoplastic flow begins at the origin but it is not linear that means the viscosity of a pseudoplastic flow can't be expressed by a single value.

Example of pseudoplastic flow includes emulsion suspension, polymer dispersion, tragacanth in H_2O , Na alginate in water, methyl cellulose in H_2O , and Na carboxymethyl cellulose in H_2O .

under normal conditions the long chain molecules & polymers are randomly arranged in the dispersion

→ on applying the shear stress the molecule begins to change in their long axis in the direction of force applied.

→ The stress reduces the internal resistance water molecules are released from the polymer so the concentration & size of the molecule lower.

→ Hence the material allows greater shear rate on progressive increasing in shearing stress.

→ This Pseudoplastic flow rheogram can be described by the following equation i.e.

$$F^N = \eta' G \quad \text{--- (1)}$$

N = Number

η' = viscosity

G = Rate of shear

F = shearing stress

→ When $N = 1$ then the equation (1) becomes

$F = \eta' G$ that means it follows Newtonian flow.

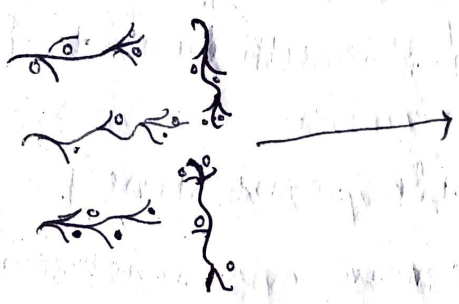
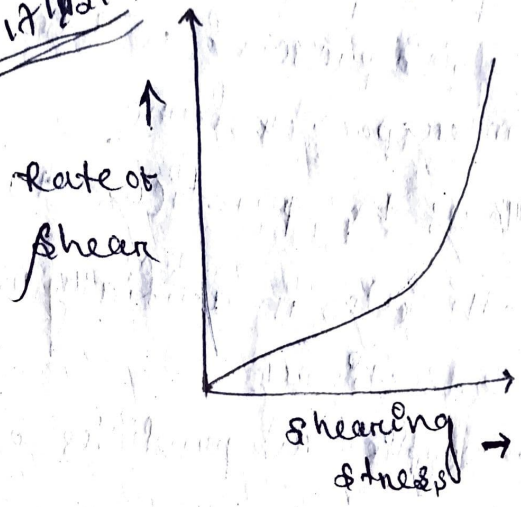
→ when $N < 1$ it represents Pseudoplastic flow.

→ Taking logarithm on both sides of equatⁿ (1) can be written as $N \log F = \log \eta' + \log G$

$$\log G = N \log F - \log \eta' \quad \text{--- (3)}$$

the equation (3) represents the straight line equation that means some liquid don't obey equation (3) but the exhibit Pseudoplastic flow.

dt = 17/12/19



polymers at rest random arrangement water is bound



polymers under flow alignment on log axis water is released

(mechanistic explanation for the pseudoplastic behavior)

3) Dilatant flow:

The system exhibits increase resistance with increased rate of shear.

At shearing condition the volume is increased hence it is called dilatant flow. ex- suspension containing high content of solid (more than 50%).

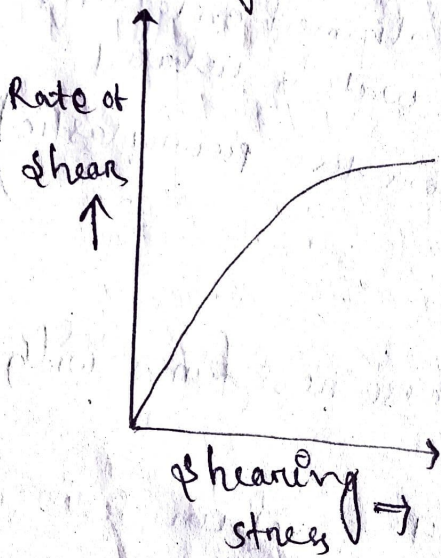
→ suspension of starch in H₂O

→ suspension of kaolin (12%) in H₂O

→ suspension of zinc oxide (30%) in H_2O .

Mechanism:-

- At rest the molecules are closely packed having optimum space present in betⁿ the
- This amount of vehicle present will be sufficient to fill the interspace volume.
- This situation allows the particles to move relating to each other so in initially stage the exhibit low consistency.
- when shear stress is applied the particles expand and interparticular space increases.
- The amount of vehicle is insufficient to fill the interparticle space.
- so they behaves paste like consistency.
- so rate of shear will decrease on increase in shearing stress.



At rest,

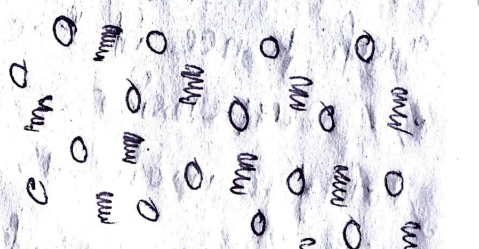
packed.

minimum void

volume

vehicle relating

low consistency



open-packed high void

volume insufficient vehicle relating high consistency