

Thixotropy:-

Thixotropy is defined as an isothermal and compositionally slow recovery on standing of a material of consistency lost through shearing.

→ The phenomenon of thixotropy can be observed by constructing consistency curve.

→ The rate of shear is progressively increased when the readings are plotted and get up curve a to b .

→ After the desired maximum b , the rate of shear is reduced and the down curve bc will be towards the left the up curve.

→ In case of Newtonian system the down curve is deeper impose with the up curve.

Mechanism:-

The phenomenon of thixotropy can be explained in terms of particle-particle interaction.

→ At rest the particles in the dispersion impart rigidity on the system through multi point contact and the system behaves like a gel.

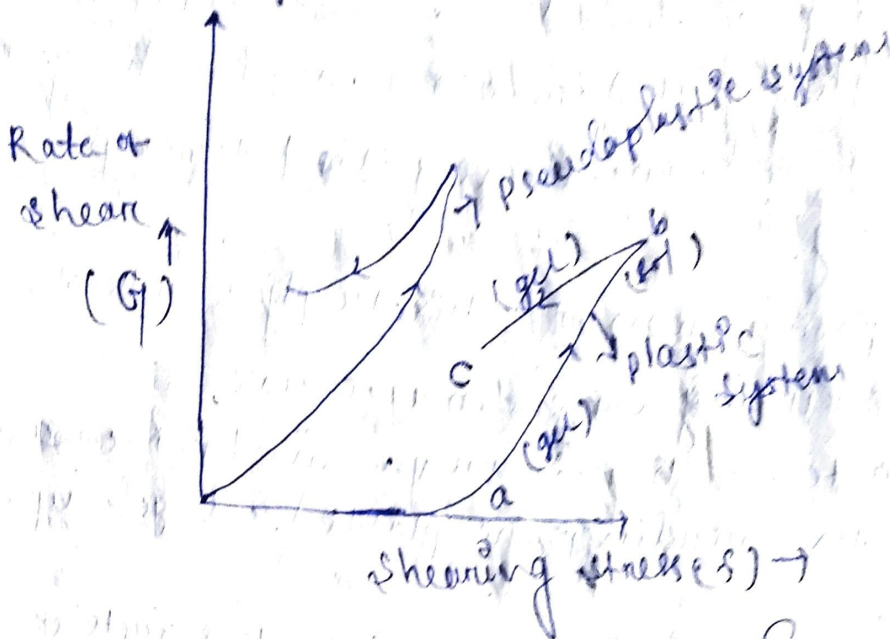
→ When shear is applied the contact begins to break, the particles are aligned and the flow is starts.

→ It exhibits ~~soft~~ state on equilibrium.

→ When the stress will be removed the system regains its original state.

→ That means the gel sol-gel transformation.

will occur this phenomenon of thixotropy.



(Thixotropy behavior exhibited by plastic and pseudoplastic system)

Multi-point contacts
(High consistency or
high viscosity)

→ Gel state

At rest
(on storage)

↓ Rapid process

Contact breakdown
(Low consistency
low viscosity)

→ Sol state

on shear
(at equilibrium)

↓
particle contacts are
established due to
brownian motion
(High consistency
High viscosity)

→ Gel state

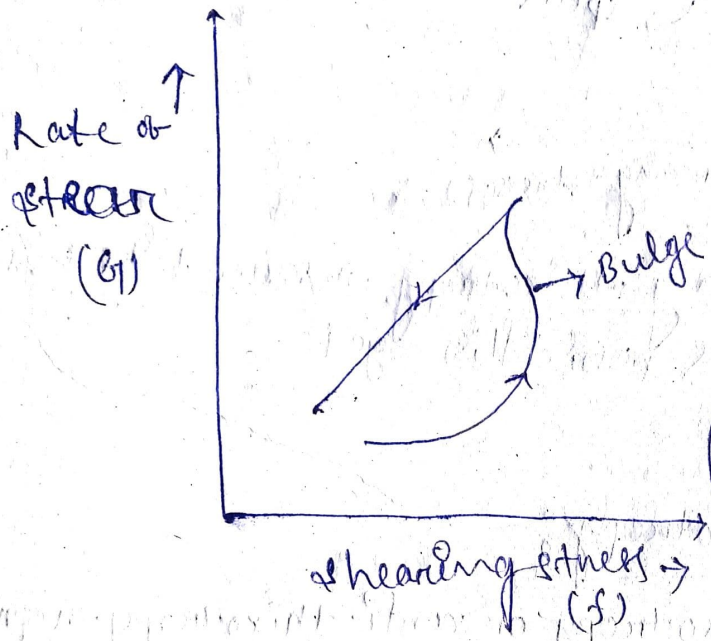
~~SET~~
~~ASIDE~~
(Removal of stress)

(particle-particle interaction in a thixotropy material gel-sol-gel transformation)

bulges

The concentrated aqueous magma or bentonite (10-15% by weight) produces hysteresis loops with a characteristic bulge at each cycle.

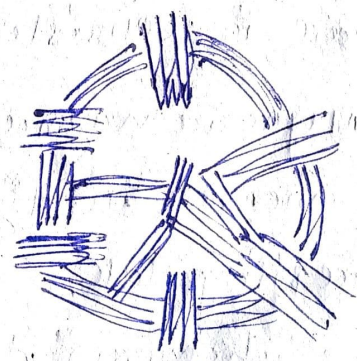
The mechanism behind such a bulge is due to the crystalline plates of bentonite form a house of cards like structure that ~~possess~~ causes pulling of magma which causes a bulged loop.



(Aqueous magma 10-15% bentonite weight forming hysteresis)



(a) At rest crystalline plates are irregularly arranged

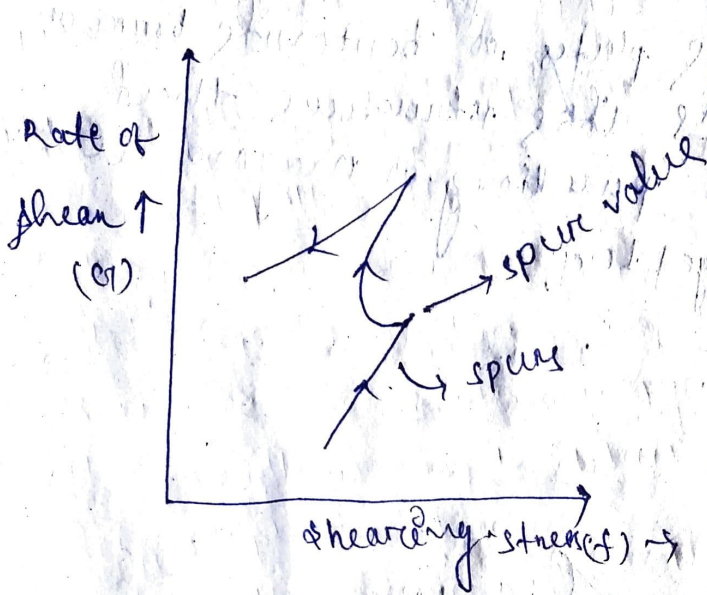


(b) on shear crystalline plates are arranged to form house of cards

(Mechanism for the behavior of bulges in the thixotropic curve)

Spurs

In case of procaine penicillin gel, this up curve produces a spur-like protrusion.
→ The spur value is represented as γ , which represents the sharp point of structural break down at low shear rate on up curve.



The graph showing thixotropy or spur-like hysteresis loop in procaine penicillin gel.

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Negative thixotropy:

→ Negative thixotropy or anti-thixotropy represents increase in consistency on the down curve.

ex- magnesium magma exhibit enhance to flow with increase in time or shear compare to the resting state.

→ In the rheogram down curve shifts to right at up curve.

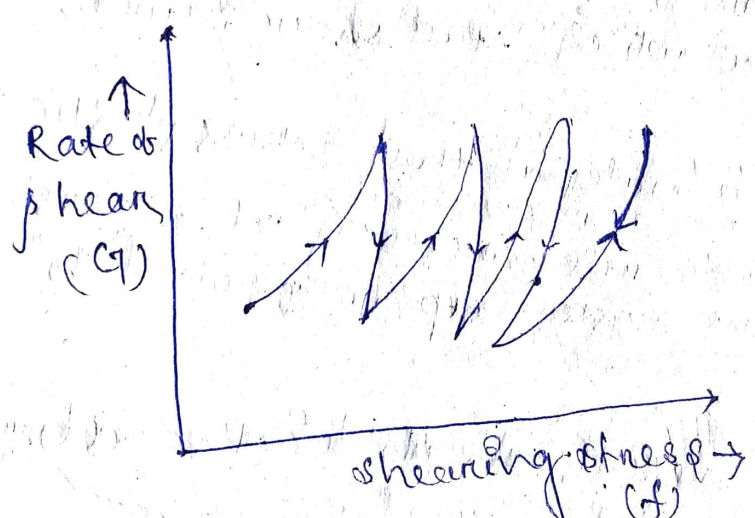
→ when the magnesium magma sheared with decrease in increase in state of shear the magma thickens.

As this cycle continues - the extent ^{increases} or ^{thickness} reduces gradually and finally reaches the equilibrium state.

There will be no change in consistency ^{change} on further cycle of shear rate.

mechanism:

- At resting state, the system consist of large no of individual particle and small floccules
- when the product is sheared the polymer molecule collides with each other as a result inter-particle bonding increases.
- At equilibrium large floccules exhibit in small number and hence sol form is bonding.



Examples of anisotropic behaviour
magnesia magma

- At rest (no storage) → large in number small floccules (low viscosity)
- on shear (at equilibrium) → particles collisions particles contacts are more large floccules in small number (high viscosity)
- set aside → Floccules contact break individual particle consistency

Rheopexy :-

Rheopexy is a phenomenon in which the sol transitions to gel state but it doesn't return to the sol state at rest. That means it exhibits ~~thixotropic~~ neither nor anti-thixotropic property.

Measurement of thixotropy :-

→ In a thixotropic system the hysteresis loop is formed by the up and down curve of the rheogram.

→ The area of hysteresis loop has been proposed as a measure of thixotropy breakdown. It is readily obtained readily with the help of planimeter.

→ In the thixotropic system largely depends on the rate at which the shear is increased/decreased.

→ Consider a material that shows plastic flow. Suppose shear rate is increased at a "constant" rate on the system up to a point "a" then decreased.

→ When the results are plotted the rheogram is obtained.

→ If the shear is maintained at "a" for a time t_1 second then decreased 'abc' rheogram is obtained.

→ Similarly at point b if the shear rate is maintained for time t_2 second then decrease 'abde' curve is obtained.

→ The structural breakdown with respect to time at constant rate of shear gives the

rheogram.

→ Based on such rheogram the thixotropy coefficient B calculated by the following equation

$$B = \frac{u_1 - u_2}{\ln(t_2/t_1)}$$

where, u_1 & u_2 are the plastic viscosity at the 2 down curv

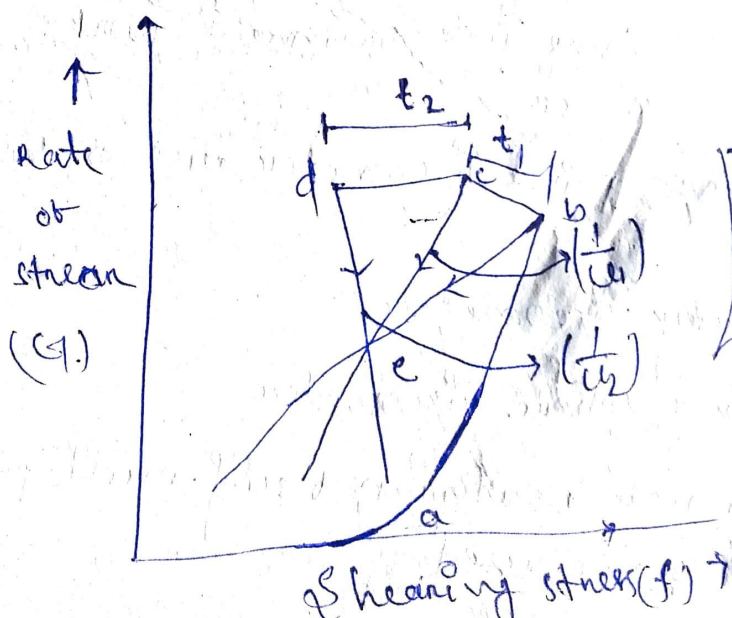
→ The thixotropy coefficient B represents the rate of breakdown with time at constant shear rate.

→ In this method the system is subjected to different rate of shear i.e. v_1 & v_2 the rheogram is obtained which shows the hysteresis loops.

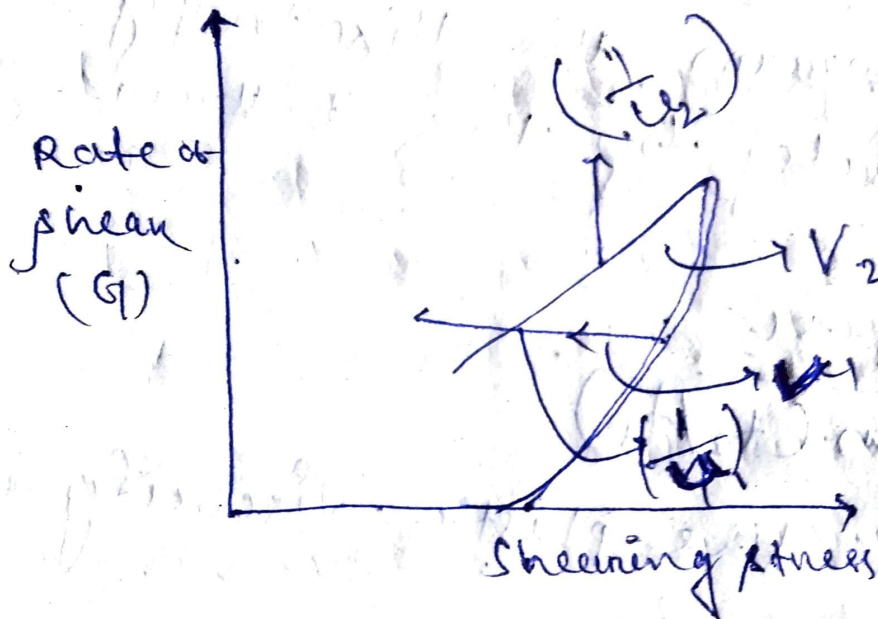
→ The thixotropy coefficient M is calculated by the following equation.

$$M = \frac{2(u_1 - u_2)}{\ln\left(\frac{v_1}{v_2}\right)}$$

where, u_1 & u_2 are the plastic viscosity and v_1 & v_2 are rate of shears respectively.



$$B = \frac{u_1 - u_2}{\ln(t_2/t_1)}$$



$$n = \frac{2(u_1 - u_2)}{\ln(V_2/V_1)}$$

Application of thixotropy:

1. Greater the thixotropy higher is the physical stability of suspension.
2. Greater the thixotropy which is ^{related} specific surface of penicilline use. (Thixotropy is breakdown of particle so that the product pass through the needle).