

(Newton's law)

mathematical expression of viscosity:

Shear stress is defined as the force per unit area which is applied to bring about flow

i.e. Shear stress $(F) = \frac{F}{A}$

where $f = \text{force}$

$$F = \text{shear stress}$$

$$= \text{N/m}^2$$

$$A = \text{Area} = \text{m}^2$$

→ when stress is applied then the substance
move to flow by changing its shape which
can be regarded as rate of shear.

→ Rate of shear is otherwise termed as velocity
gradient which is change in velocity of
change in distance.

$$\text{Rate of shear } (G) = \frac{dv}{dr}$$

$$v = \text{velocity} = \text{m/sec}$$

$$r = \text{distance} = \text{m}$$

$$G = \text{Rate of shear} = \text{sec}^{-1}$$

The shearing stress is directly \propto to the
rate of shear. i.e. more is the force per unit
area more is the velocity gradient.

→ so the expression can be written as

shear stress \propto Rate of shear

$$\frac{F}{A} \propto \frac{dv}{dr}$$

$$\text{or } \frac{F}{A} = \eta \frac{dv}{dr}$$

$$\text{or } \frac{F}{A} = \eta G$$

$$\text{or } \boxed{F = \eta G} \quad \text{--- (1)}$$

where $\frac{F}{A} = \text{shearing stress}$

$\frac{dv}{dr} = \text{rate of shear } (G)$

(c) η = viscosity

(5)

the unit of η = N s m^{-2}

$\Rightarrow \eta$ is calculated by $\frac{F}{G}$ --- (2)

\rightarrow Co-efficient of viscosity or viscosity is defined as the force per unit area required to maintain unit difference velocity betⁿ 2 parallel layers in the liquid one metre apart

\rightarrow In CGS unit the viscosity expressed as

~~poise~~ poise or $\frac{\text{dyne}}{\text{cm}^2}$

\rightarrow In S.I unit it is expressed as pascal sec.

Rheogram :-

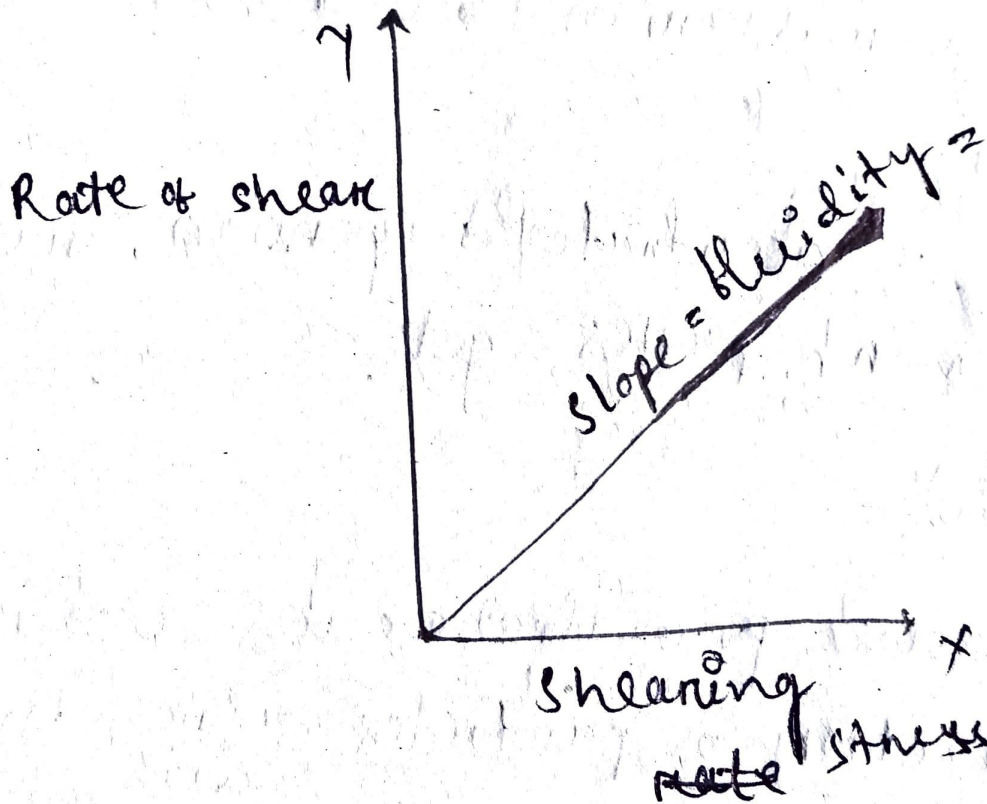
it is otherwise known as consistency curve

→ when shear stress and shear rate relationship is represented in the form of curve on plot

is called rheogram.

→ Here shearing stress will be taken in τ -axis & rate of shear will be taken in $\dot{\gamma}$ -axis

→ In case of Newtonian fluid the rheogram passes through the origin and the slope of represents coefficient of viscosity.



Ex: Newtonian fluids are water, glycerol, dilute syrup, very dilute colloidal sol.