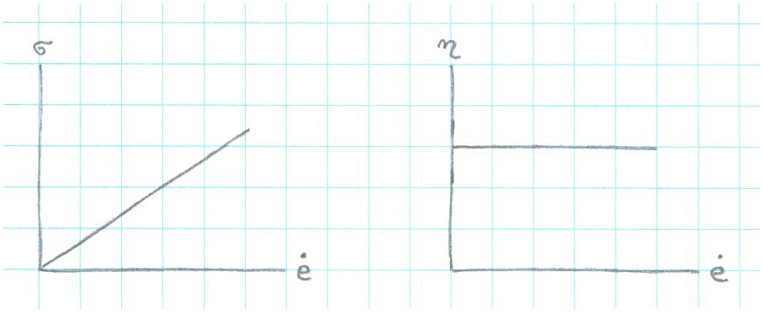
Nonlinear Viscous Behavior [pln22]

Nonlinear effects of all types as observed in dispersions can be interpreted as a consequence of particle rearrangements in response to flow (see section on colloids).

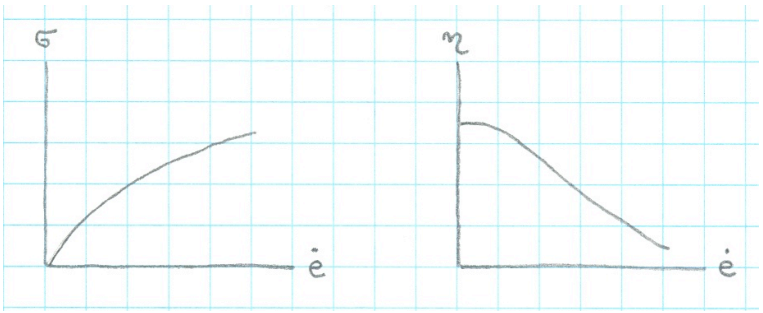
Shear stress versus strain rate: $\sigma(\dot{e}) = \eta(\dot{e})\dot{e}$.

(i) Newtonian liquid: reference system with $\eta = \text{const}$.

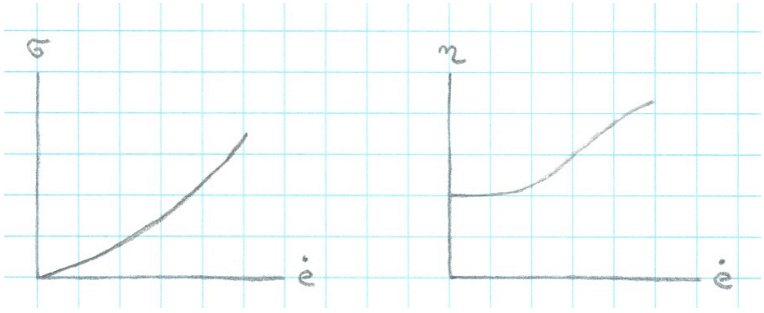


(ii) Shear thinning: paints, yoghurt.

- ▷ Model for polymeric fluids: $\eta(\dot{e}) = \dfrac{\eta_0}{1 + (\dot{e}/\dot{e}_c)^n}$,
- ▷ material parameters: $\eta_0, \dot{e}_c, n$,
- ▷ stress relaxation time: $\tau = 1/\dot{e}_c$,
- ▷ fast strain rates, $\dot{e} \simeq \dot{e}_c$, prevent polymers from relaxing to equilibrium.



(iii) Shear thickening: pastes, whipped cream.



(iv) Bingham fluid: concentrated colloid suspensions.

▷ Onset of flow requires threshold shear stress.