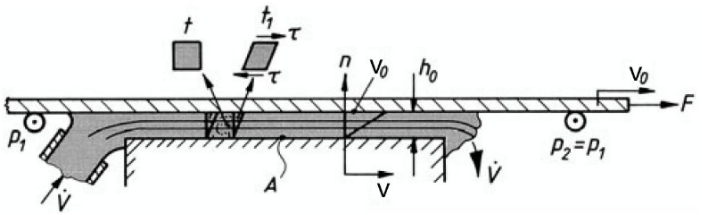
I. Viscous flow

1. Flows with friction



$$F = \eta \frac{v_0 \cdot A}{h_0}$$

$$\tau = \frac{F}{A} = \eta \frac{v_0}{h_0} = \eta \frac{\mathrm{d}v}{\mathrm{d}n}$$

where:
- η = dynamic viscosity [Pa·s]
- τ = shear stress [Pa]
- $\mathrm{d}n$ = normal distance [m]

2. Viscosity

2.1 Newtonian fluids

- Rate of deformation $\mathrm{d}u/\mathrm{d}y$ (velocity gradient) is linearly proportional to the shear stress τ
- The constant of proportionality is the viscosity (slope)
- $\mu = \dfrac{\tau}{\mathrm{d}u/\mathrm{d}y}$

2.2 Non-Newtonian fluids

Non-linear relation between shear stress and deformation rate.

2.2.1 Dilatant (shear thickening) fluids

Viscosity increases with increasing strain rate.

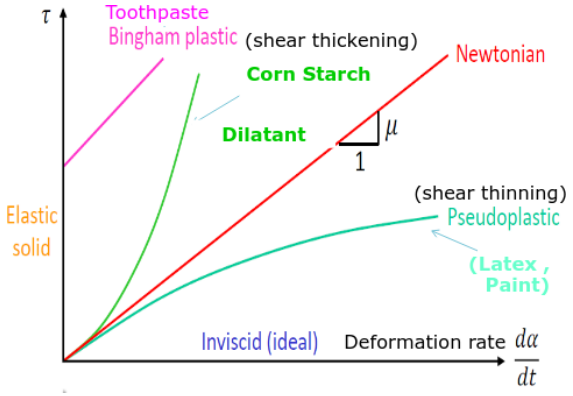
2.2.2 Plastic or pseudo-plastic (shear thinning) fluids

Viscosity decreases with increasing strain rate.

2.2.3 Bingham medium

Flow occurs only after a yield stress τ_0 is reached.

2.3 Graphical representation



2.4 Reynolds Number

$$\mathrm{Re} = \frac{\rho v L}{\eta} = \frac{vL}{\nu}$$

$$\nu = \frac{\eta}{\rho}$$