Fluid statics

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Specific gravity: ratio of the density of a fluid to the density of water at 4°C
Specific weight: weight per unit volume of a fluid

$$\gamma = \frac{mg}{V}$$

Normal force. perpendicular F_{σ}.

Shear force. In line with surface F_{τ}.

Stress is the internal force per unit area exerted by one material on another

No-slip boundary: the assumption that for a viscous fluid at a solid boundary the fluid relative to the solid boundary is 0

Velocity gradient of a fluid is proportional to the applied shear stress.
Fluids of different viscosities will resist the action of the shear force differently. Viscosity is dependent on the molecular structure

Dynamic viscosity: measure of fluid's resistance to gradual deformation by shear stress.
SI unit is kg/m s

$$\tau = \mu \frac{dv}{dy}$$

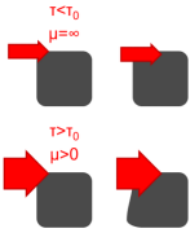
Kinematic viscosity: ratio of dynamic viscosity to density
Si unit is m^2 /s

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

Cohesion: intermolecular forces that causes like molecules to be attracted to each other
Adhesion: intermolecular forces that causes different molecules to be attract to each other

At the interface of a liquid with another thingo, there may be an imbalance of cohesive and adhesive forces which causes surface tension.
Si unit for surface tension is kg/s^2

Capillary action: ability of a liquid to flow in narrow spaces due to surface tension



Rheology is the study of the flow of matter in response to an applied force. Usually for stuff in liquid state or soft solid
Show yield stress refers to the fact that the matter does not deform until a finite yield stress is applied.

- If the viscosity is constant then it is a Bingham Plastic material.
- If the viscosity decreases with applied shear stress then it is called a herschel -Bulkley material

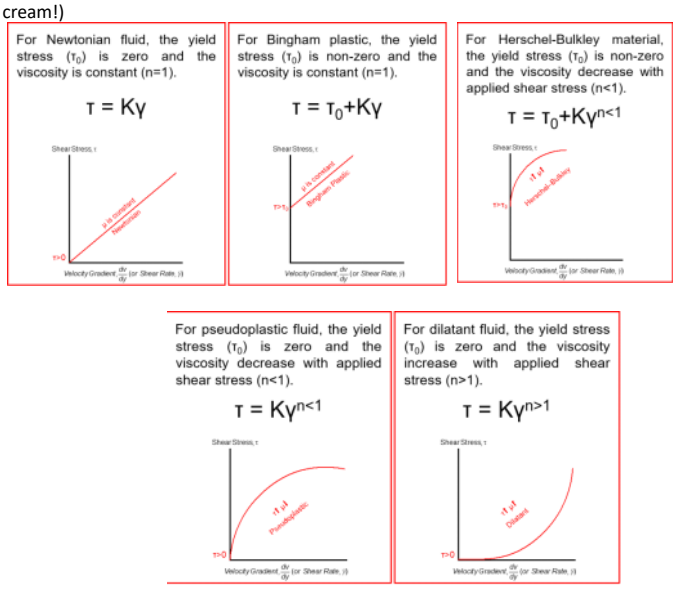
No yield stress refers to the fact that the matter will deform at any applied stress.

- If viscosity is constant then it is a Newtonian Fluid e.g water and most other shit
- If the viscosity decreases with applied shear stress then it is a pseudoplastic (shear -thinning) e.g nail polish, syrups, paint
- If the viscosity increases with applied shear stress then it is a dilatant (shear -thickening)

Viscosity can change with duration of the applied shear stress

- If viscosity decreases it is a thixotropic fluid e.g ketchup, cream cheese, synovial fluid
- If viscosity increases it is a rheopectic fluid e.g printer ink, cream(whipped cream!)

$$\tau = \tau_0 + K\gamma^n$$



T = shear stress
T_0 = yield stress
K = consistency coefficient
N = flow rate (degree to which the fluid is shear thinning or thickening)
Y = shear rate (or velocity gradient)

Dynamic viscosity
Given by the slope of the applied shear stress versus the shear rate curve

$$\mu = \frac{\partial \tau}{\partial \gamma} = \frac{\partial}{\partial \gamma}(\tau_0 + K\gamma^n) = nK\gamma^{n-1}$$

Apparent viscosity
Instantaneous viscosity measured by a viscometer at a particular shear rate

$$\mu_{app} = \frac{\tau - \tau_0}{\gamma} = \frac{\tau_0 + K\gamma^n - \tau_0}{\gamma} = K\gamma^{n-1}$$

Pressure is the force per unit area exerted by the fluid in the direction perpedicular to the surface over which the force is distributed
In kg/m s^2 or N/m^2 or Pa

At any point, static pressure has the same magnitude and acts equally in all directions

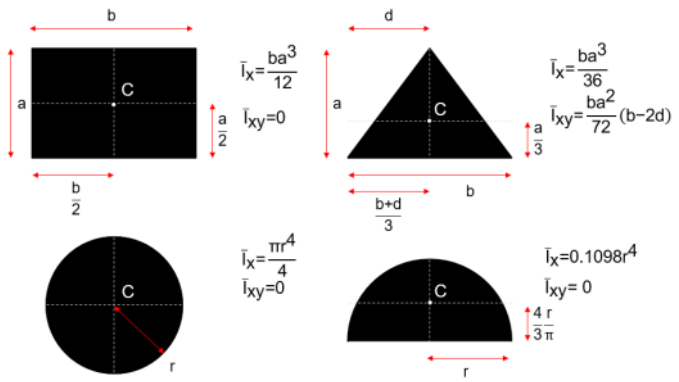
Static pressure can be called pressure head, static head, static pressure head. Pressure head is the equivalent height of a liquid which exerts the same pressure

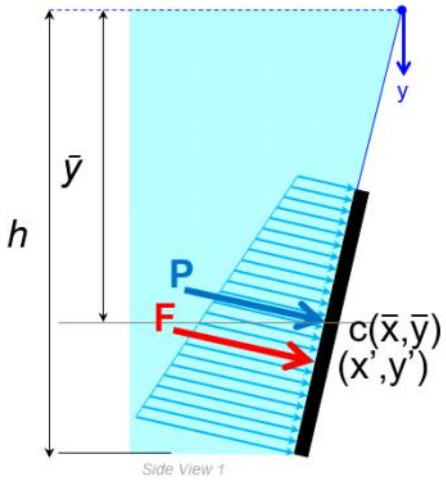
$$h = \frac{P}{\rho g}$$

Absolute pressure: pressure where 0 is taken as the reference
Gauge pressure: pressure where atmospheric pressure is taken as the reference

$$P_{abs} = P_{gauge} + P_{atm}$$

On a submerged surface, the static pressure acts on the centroid
and the hydrostatic force acts at the centre of pressure of the plane.





$$y' = \bar{y} + \frac{\bar{I}_x}{A\bar{y}} \quad \text{and} \quad x' = \bar{x} + \frac{\bar{I}_{xy}}{A\bar{y}}$$

Law of Buoyancy
Any object, displaces its own volume of the liquid in which it is submerged
Any object immersed in a fluid experiences an up-thrust force called the buoyant force. The magnitude of the force is equal to the weight of the fluid displaced

So long as the density of the fluid is constant, the buoyant force is constant
Buoyant force acts through the centre of buoyancy which is located at the centroid of the volume of liquid displaced by the plane
Gravitational force acts through the centre of gravity which is located at the centroid of the plane