Newton's Law of viscosity $\boxed{\tau = \eta \cdot \frac{dv}{dx}}$ → viscosity = cons. when Temp = cons.

Dimentions

$\boxed{\Delta p = ML^{-1}T^{-2},\ \eta = ML^{-1}T^{-1},\ \rho = ML^{-3},\ v = LT^{-1}}$

* For gases viscosity increases with temp. increase, but for liquids vise versa.

Pascal's law: $\boxed{\frac{dp}{dz} = -\rho g}$, Continouity eq.: $\dot{m}_{in} = \dot{m}_{out} \Longleftrightarrow \boxed{\rho_1 V_1 A_1 = \rho_2 V_2 A_2}$ ⟹ incompressable fluid → ρ = Cons.

Momentum eq.: $\boxed{F = \dot{M}_2 - \dot{M}_1 = \dot{m}_2 V_2 - \dot{m}_1 V_1 = \rho_2 A_2 V_2^2 - \rho_1 A_1 V_1^2}$ Solving using integral form.

Bernoulli equation assumption: * Steady-state. * Along streamline. * No viscous forces. * ρ = Cons.

$\Longrightarrow \boxed{P_1 + \frac{\rho}{2} V_1 + \rho g Z_1 = P_2 + \frac{\rho}{2} V_2 + \rho g Z_2}$

Simitude: $Eu_M = Eu_R = \frac{\Delta P}{\rho V^2}$ $\quad Re_M = Re_R = \frac{\rho V d}{\eta}$ $\quad Fr_M = Fr_R = \frac{V^2}{d g}$

Extended Bernoulli: $\dot{V}_1 \left(P_1 + \frac{\rho}{2} V_1^2 + \rho g h_1\right) + P_P = V_2 \cdot A_2 \left(P_2 + \frac{\rho}{2} V_2^2 + \rho g h_2 + \Delta P_{losses}\right) + P_T$

$\Delta P_{losses} = \Delta P_\lambda + \Delta P_\zeta$, $\Delta P_\lambda = \lambda \cdot \frac{L}{d} \frac{\rho}{2} V^2$ $\quad \Delta P_\zeta = \zeta \cdot \rho \frac{V^2}{2}$ → Tables

$Re \ll 2300$ (Laminar flow) → $\lambda = \frac{64}{Re}$

$Re \gg 2300$ (Turbulent) → Moody diagram

Internal flow

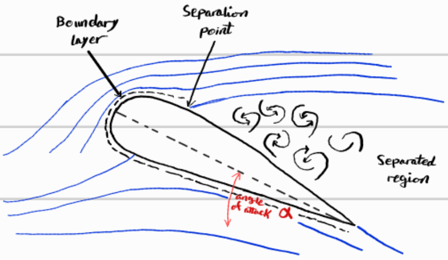
$\boxed{\text{reference Error } \Delta\mathcal{E} = \frac{|V_{i+1} - V_i|}{V_i} < 5\% - 10\%}$

* External Flow: Drag Force is acting in the direction of the flow: ($\vec{F}_D = \vec{F}_{th}$ Thrust) , $\vec{F}_{Lift}$: is normal to drag force $\vec{F}_D$.

$C_D = \frac{2F_D}{\rho_f \cdot V^2 \cdot A} = \underset{\text{(Form)}}{\vec{C}_P} + \underset{\text{(Skin)}}{\vec{C}_F} + \underset{\text{(Induced)}}{\vec{C}_{Ind}} = \frac{F_P + F_F}{\frac{1}{2}\rho V^2 A}$, $C_L = \frac{F_L}{\frac{\rho}{2} \cdot V^2 A} = \frac{P - P_\infty}{\frac{1}{2}\rho_\infty V^2}$, $\vec{F}_P = \oint p\, dA$, $\vec{F}_F = \oint \tau\, dA$

$Re < 1$ → $C_D = \frac{24}{Re_d}$

$Re \geq 1$ → The graph



$\boxed{\text{Stall is highly undesireable on aircraft at cruise conditions and leads to inefficiencies, when it occurs on turbine blades. However, it's used to provide the high drag needed when landing an aircraft.}}$

Velocity low → pressure high → Aircraft will be "pushed down"

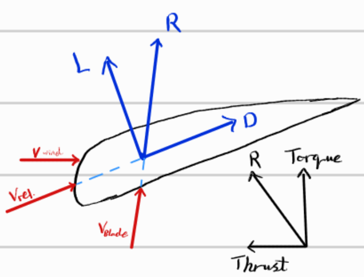
$F_B = \rho_f V g$ (B: Bouncy, f: fluid, V → volume of the particle.)

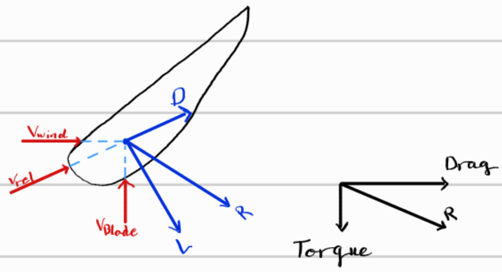
Sedmentation: With $A = \frac{\pi}{4} d^2$ & $V = \frac{\pi}{6} d^3 \Longrightarrow \boxed{V_\infty = \sqrt{\frac{2g(\rho_S - \rho_L) \cdot 4d}{6 C_D \rho_L}}}$

If Creeping flow ($Re<1$) ⟶ $C_D = \frac{24}{Re} \Longrightarrow V_\infty = \sqrt{\frac{4g(\rho_S - \rho_L)d}{3\rho_L} \cdot \frac{Re}{24}} \Longrightarrow V_\infty = \frac{g(\rho_S - \rho_L)d^2}{18\eta_L}$, If $1000 < Re < 2\times10^5 \Longrightarrow C_D \approx 0.44 \Rightarrow \boxed{V_\infty = \sqrt{\frac{2g(\rho_S - \rho_L) \cdot 4d}{6(0.44)\rho_L}}}$

Separting condition $\Longrightarrow V_\infty \geq V_L = \frac{4\dot{V}}{\pi D^2} \Longrightarrow \boxed{D \geq \sqrt{\frac{4\dot{V}}{\pi V_\infty}}}$ → D is basin's diameter.

$\boxed{\text{Propeller blade}}$ $\qquad$ $\boxed{\text{Rotor blade}}$





$\frac{P_{turb}}{A} = C_P \cdot \frac{\rho}{2} \bar{V}_1^3$, $C_P = \frac{P_{Turb}/A}{P_{wind}/A_1} = \frac{1+X}{2} \cdot (1-X^2)$, $X = \frac{\bar{V}_2}{\bar{V}_1}$, $\bar{V}_3 = \frac{1}{2}(\bar{V}_2 + \bar{V}_1)$