INTRODUCTION

Anything which can flow like liquid & gases Known as Fluids.

Pressure

Force acting per unit Area. $P = \frac{F_{\perp}}{A}$

Gauge Pressure

Excess pressure over the atmospheric pressure ($P_o - P_{atm}$) measured with instrument. $P_{gauge} = P - P_o = \rho gh$

Atmospheric Pressure

Force exerted by atmospheric column on unit area at mean sea level.

$[P_o = 1.013 \times 10^5 \text{ N/m}^2]$

Hydraulic Paradax

Water is filled to a height H behind a dam of width w. The resultant Pressure on dam will be – $P_{net} = \rho gH$

9. MECHANICAL PROPERTIES OF FLUIDS

Characteristics of Ideal Fluids

- Incompressible
- Non – Viscous
- Irrotational
- Steady (Laminar) flow

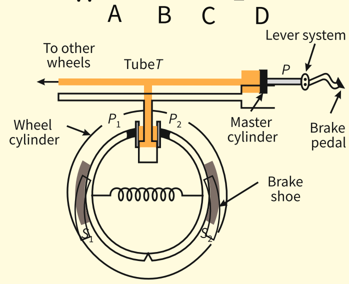
Pascal Law

Whenever external Pressure is applied on any part of fluid contained in a Vessel, it is transmitted undiminished and equally in all direction is known as Pascal Law.

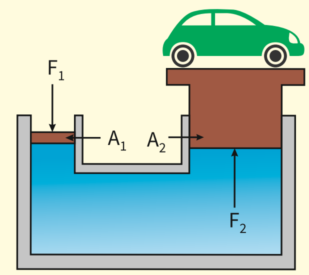
Hydraulic Machine

Hydraulic Brakes

$$\therefore \frac{F_A}{A} = \frac{F_B}{B} = \frac{F_C}{C} = \frac{F_D}{D}$$



Hydraulic lift



Hydrodynamics

Equation of Continuity

$$A_1V_1 = A_2V_2$$

Bernoulli's Theorem

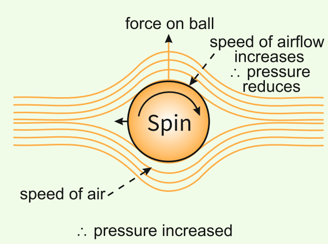
$$P + \rho gh + \frac{1}{2}\rho v^2 = \text{Constant}$$

P = Pressure; v = Velocity

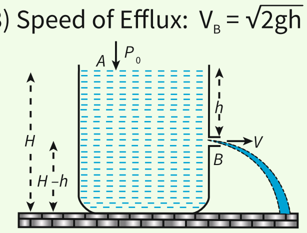
ρ = density ; h = height ; g = gravity

Applications

(1) Magnus Effect:

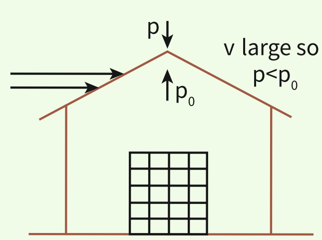


(3) Speed of Efflux: $V_B = \sqrt{2gh}$



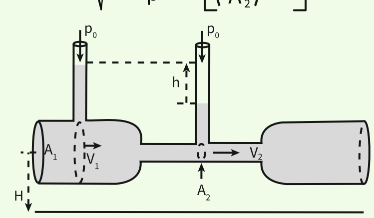
H = Height from the Top

(2) Blowing off of thin Roof in storm:



(4) Venturi meter : The entering Velocity of fluids is given by

$$V_1 = \sqrt{\frac{2\rho mgh}{\rho}}\left[\left(\frac{A_1}{A_2}\right)^2 - 1\right]^{-\frac{1}{2}}$$



VISCOSITY

Newton's Law of Viscosity

Viscous Force, $f = -\eta A \dfrac{dV}{dx}$

A = Area

velocity Gradient = $\dfrac{dV}{dx}$

Stoke's Law

When a small sphere of radius r is moving with velocity v through a homogeneous Fluid, then viscous force acting on sphere – $\mathbf{F_v = 6\,\pi\eta r\upsilon}$;

Where η = Coefficient of viscosity; Unit of η = Poise.

Terminal Velocity

Constant Velocity achieved Before net force on a body becomes Zero.

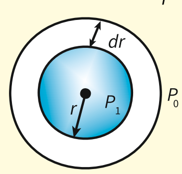
Surface energy

Additional potential energy exhibited by liquid molecules present at the surface of the molecules.

Excess Pressure Inside a Curved Liquid Surface

Excess pressure inside the drop

$$P_{ex} = (P_i - P_0) = \frac{2S}{r}$$

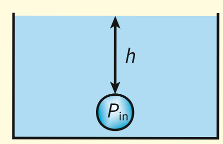


Excess pressure inside a cavity or air bubble in liquid

$$P_{ex} = \frac{2S}{r} + \rho gh$$

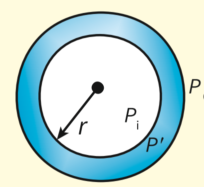
$$P_{inside} = P_{atm} + \frac{2S}{r} + \rho gh$$

$$P_{out} = P_{atm}$$



Excess pressure inside a soap bubble

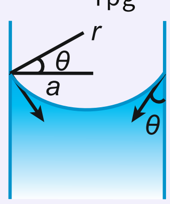
$$P_{ex} = P_i - P_0 = \frac{4S}{r}$$



Capillarity

It is Property due to which liquid elevates & depressed in a capillary Tube. The Rise in height of liquid in capillary tube is given by

$$-h = \frac{2S\cos\theta}{r\rho g}$$



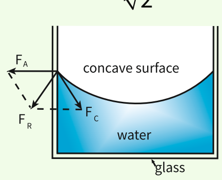
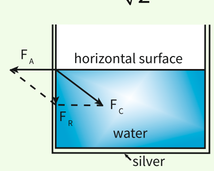
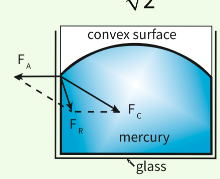
Cohesive Force and Adhesive Force

Cohesive Force:- Attractive Force between the molecules of same materials.
Adhesive Force:- Attractive Force between the molecules of different Materials.

Angle of Contact

Angle between tangent Plane at the liquid surface and tangent plane at point of contact of solid.

Shape of Meniscus

Relation between cohesive and adhesive force	$F_A > \dfrac{F_C}{\sqrt{2}}$ 	$F_A = \dfrac{F_C}{\sqrt{2}}$ 	$F_A < \dfrac{F_C}{\sqrt{2}}$ 
Angle of contact	q < 90° (Acute angle)	q = 90° (Right angle)	q > 90° (Obtuse angle)
Shape of meniscus	Concave	Plane	Convex
Wetting property	Liquid wets the solid surface	Liquid does not wet the solid surface	Liquid does not wet the solid surface
Level in capillary tube	Liquid rises up	Liquid neither rises nor falls	Liquid falls (or) depressed
Example	Glass-Water	Silver-Water	Glass-Mercury