# Unit - 02



## Fluid flow phenomenon

### * Potential flow :-

The flow of incompresible fluids without the presense of sheare is refared to as potential flow. In potential flows, eddies and cross and current -ts- cannot form within the stream and friction cannot develop.

### One dimentional flow :-

In thir type of flow all parameters (velocity) are fuctione of time one space cardinate only.

or

In this distanse is measured along the centre line not neccerity straight in which flued is flowing.

जिस flow में सभी Parameter (velocity) सिर्फ time और space के fuction होते है उसे one dimentinal flow कहते है।

ex :- flow in a pipe.

• Laminar flow :

streamlines remin ~~streameter~~ distuct The flow in with the separated from one another over their entire length of flow is termed as laminar flow It's also called as stream line flow or viscous flow.

ex :- The flow in which the fluid flow in paralled, straigt lines is called laminar flow this occurs at low fluid viscosity.

" वह flow जिसमें fluid समांतर तथा सीधी रेखा में flow होता है उसे laminar flow कहते है। यह low fluid viscosity पर प्राप्त होता है।

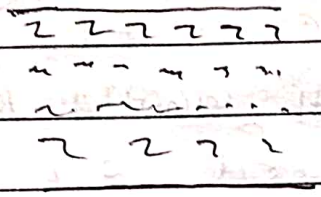
Laminar flow

★ Turbulent flow :-

The fluid in which the fluid insted of following in an orderly

manner. moves exactically in the from called cross currents and eddies is called turbulent flow.

This occurs at high flow of velocity and there is a lateral mixing in the type of flow



turbulent flow

- Velocity Gradient :-

Velocity gradient can be defined as "The different in vilocity between adjaccent layers of the fluid is knocon as 'vilocity gradient".

" किसी liquid के adjacent (सटा हुआ) layers के वीच के अंतर को "vilocity gradient कहते है।

S.I. unit of vilocity gradient is per. sec. dimentinal formula is $M^0L^0T^{-1}$

## Shear rate :-

shear rate is the rate of change of velocity which layer of fluid pases over an adjacent layer.

" किसी liquid के एक layer के उपर से adjacent layer के pass होने पर उसके velocity में बदलाव कि दर को shear rate कहते है।

It can be represent by S.I. unit of shear persecond.

The shear rate for a fluid falloewing between two parallel plates one moving at a constant speed and the other statinary is difined as :-

$$\gamma = \frac{v}{h}$$

where:-

$\gamma$ is the shear rate (per sec)

$v$ is the velocity of the moving plates (m/s)

$h$ is the distance between the tree parallel plates (m)

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- Shear stress :-

-friction between fluid particles due to viscocity caused shear stress. its define by 'I'

" fluid particles के मध्य viscocity के कारण होने वाले stress को shear stress कहते है।
इसका S.I. unit paccal है।

$$\tau = \frac{F}{A}$$

$\tau$ = shear stress
F = the force applied.
A = The cross-sectinal area of meterial with area perpendicular to the applied force vector.

Coefficient vilocity dynamic viscosity

- Newton's law of viscosity :-

The shear stress required to produce unit rate of shear deformation (or shear rate).

$$\eta = \frac{\tau}{du/dy}$$

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Newton's law of viscosity = $\tau$

viscosity = $u$

Inverse Proportinal distance = $y$.

- **Newtonian Fluid :-**

Fluids that obey newton's law of viscosity i.e. the fluids for which the ratio of the shear stress to the rate of sheare or shear rate constant are called "Newtonian fluid.

This is true for all gases and for most pure liquid.

eg. All gases, air, liquid.

- **Non-Newtonian Fluid :-**

Fluids for which the ratio of the shear stress to the shear to the shear rate is not follow Newton's law of viscosity are called as 'non-newtonian fluid.

eg. Tooth paste, paits, gels etc.

Realationship between shearrate and shear stress.

$$\tau = \eta \frac{du}{dy}$$

where-

$\tau$ - is the shear Stress

$\eta$ - is the viscosity

$\frac{du}{dy}$ - is the shear rate.

- Viscosity :- The resistance of a fluid (liquid or gas) to a change in shape or movement of neighbouring portion relative to one another.

its define as '$\eta$' and S.I. unit is ($Ns/m^2$) or pascal.sec.

① Dynamic viscosity
② Kinetic Viscosity

- Dynamic viscosity :-

Dynemic viscosity of a liquid is the preportion of shear presure.

$$\eta = \frac{\tau}{dy/dy}.$$

where

$\tau$ - is the shear stress

$\mu$ - is the viscosity

$\frac{du}{dy}$ - is the shear rate

## Kinetic viscosity :-

kinetic viscosity of a liquid is ratio of the dynamic viscosity ($\mu$) over the density of the fluid ($\rho$). its denoted by $\nu$.

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

SI unit $N\text{-}m\text{-}s/kg$ or $J\text{-}s/kg$.

## Turbulence :-

In fluid dynamics, turbulence or turbulent flow is fluid motion characterized by chaotic changes in pressure and flow velocity.

- Clear-air turbulence experienced during airplane flight, as well

as poor astronomical seeing.

- Most of the terrestrial atmospheric circulation.
- The oceanic and atmospheric mixed layer and intense oceanic currents.
- The flow condition in many industrial equipment gas and machines.
- The motions of matter in stellar atmoshpheres.

Reynolds number — in fluid mechanics, a criterion of whether fluid or on the average steady with small unsteady fluctuations.

Roynolds number

$$Re = \frac{uL}{\nu} = \frac{\rho u L}{\mu}$$

where.

$\rho$ - density of the fluid ($kg/m^3$)

$u$ = flow speed (m/s)

L - characteristic linear dimension. (m)
$\mu$ - dynamic viscosity (Pa s or N·s/m²)
$\nu$ - kinematic viscosity of the fluid ($m^2/s$.)

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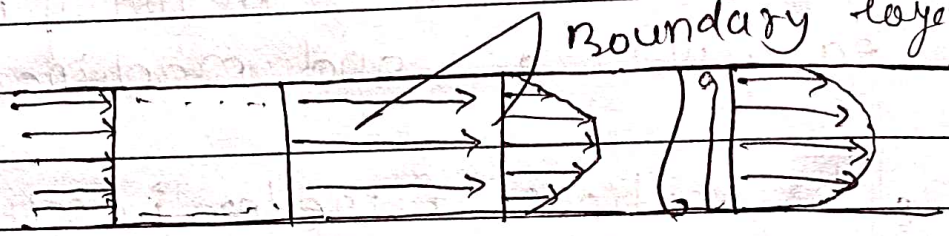
## * Boundary layer formation in straight tube




considering straight thin-walled tube with fluid entering it at a uniform velocity As shown in above fig. A boundary layer begins to form as the fluid move to the from at the enterance to the tube and as the fluid move to the first part of the channel.

At the point the velocity distribution in the tube reaches its final point & remains unchanged for the remaining part fluid.

Such flow with an unchanging velocity distribution is called fully developed flow.

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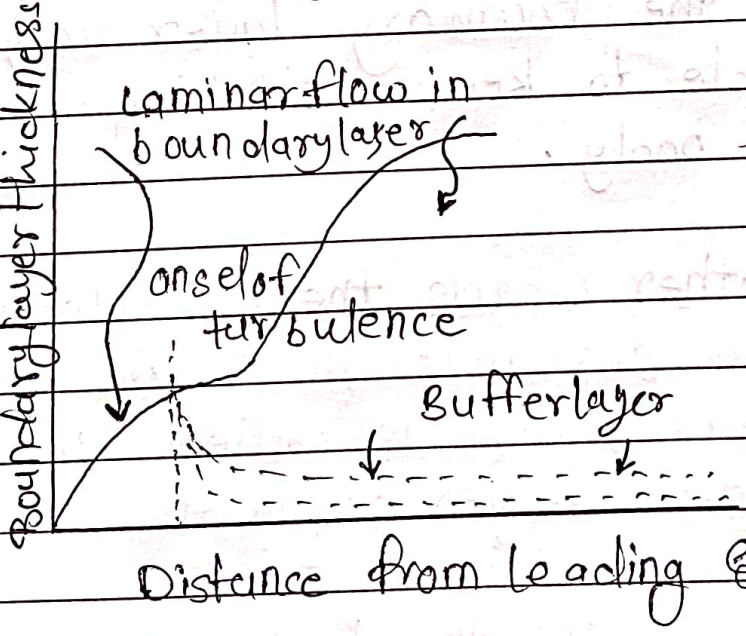
## * Laminar Turbulent flow in Boundary Layer :

flow near the boundary layer is laminar flow. Since velocity is very low as we move further from the solid boundary the velocity is fairly large and velocity is fairly long and hance the floe become turblars.

- There are Three layer :

1) Viscaus 2) Buffen layer
3) Turbulent layer.




## * Separation of boundary layer

- As the flow proceed over a soil surface the boundary layer thickness increase

- The velocity profit change from parabolic to logarithmic.
- The fluid layer adjecent to the solid surface has to do work against sarface friction by consuming some kinetic energy.
- Thus the velocity of the layer goes an decreasing.
- Along the length of solid body at a certain point a stage may come when the boundary layer may not be able to keep sticking to the solid body.
- In other wards the boundary layer will be separated from the surface this phenomenon is called the boundary layer separation.
- The point on the body at which the boundary layer the boandary layer may not be able to verge of separatation from the ser-face is called point of separation.

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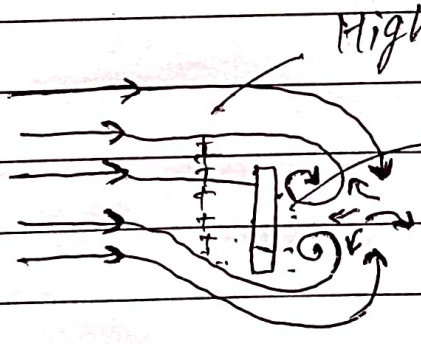
## * Flow separation & formation of wake :

when a blunt body abstructs the path of a fluid flow the flow layer unable to remain in contact in surface gets separated, resulting in formation of wacks. ~~resulting~~ region the fluid re-circable in low pressure wake regin. the phenomena known as vertexing.

The whole phenomena results in formation of high & low pressure regions thus increasing the pressure drag acting on body.

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