9. VORTEX MOTION

A ***whirling*** mass of fluid is called vortex flow.

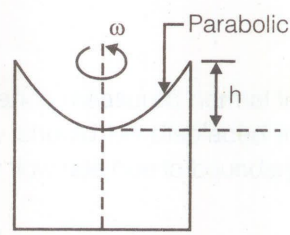
FREE VORTEX FLOW

- In this flow fluid mass rotates due to conservation of angular momentum. $mvr = C$
  The velocity profile is inversely proportional with the radius.
  $\Rightarrow$ $v\,r$ = constant $v \propto \frac{1}{r}$
  The point at the centre of rotation is called singular point, where velocity approaches to infinite.
  Example of free vortex motion are whirling mass of liquid in wash basin, whirlpool in rivers etc.

No ***external*** torque or energy is required.
In free vortex flow ***Bernoulli's equation*** can be applied.

FORCED VORTEX FLOW

When a fluid is rotated about a vertical axis at constant speed, such that every particle has the same angular velocity, motion is known as the forced vortex.



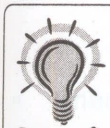
$V = r\omega$

$$h = \frac{\omega^2 r^2}{2g}$$

where h is height of paraboloid, and r is radius of cylinder.

$$\text{Volume of paraboloid} = \frac{1}{2}\pi r^2 h$$

= ½ of volume of circumscribing cylinder



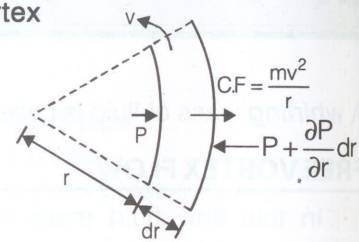
- The surface profile of forced vortex flow is ***parabolic***.
- Forced vortex requires constant supply of ***external*** energy/ torque.
  Example of forced vortex flow are rotating cylinder & flow inside centrifugal pump.

VARIATION OF PRESSURE

- Valid for Free as Well as Forced Vortex

$$dp = \frac{\rho v^2}{r} \cdot dr - \rho g . dz$$

(z in upward direction)



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