Properties of Matter

Fluid Mechanics: Viscosity

Energy of Flowing Fluid

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Energy of a Fluid

Since, a fluid has inertia therefore it possess three types of energies.

✓<u>Kinetic energy</u>:

If any fluid of mass 'm' is flowing with velocity 'v' then,

$$\text{K.E} = \frac{1}{2}mv^2$$

$$\text{K.E. per unit volume} = \frac{\text{K. E.}}{\text{volume}} = \frac{1}{2}\frac{mv^2}{\text{Vol.}}$$

$$\text{K.E. per unit volume} = \frac{1}{2}\rho v^2$$

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✓Potential energy:

The potential energy of a fluid of mass 'm' at a height 'h' above the surface of earth will be

$$P.E. = mgh$$

But P.E. per unit vol. will be

$$\frac{P.E.}{volume} = \frac{mgh}{Vol.} = \rho gh$$

Where

ρ = density of fluid

✓Pressure energy:

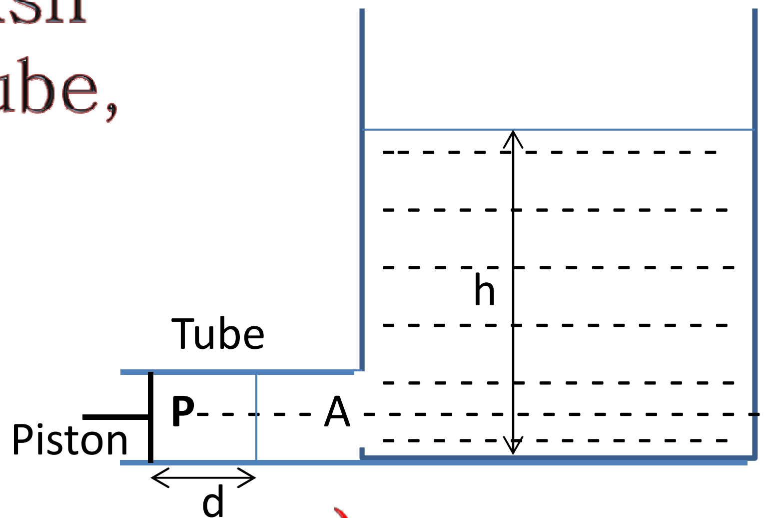
The force on the piston = pressure x area

$F = P \times A$

Work performed to push the liquid inside the tube,

W= F x displacement

$W = (P \times A) \times d$



$$W = P \times \Delta V$$

(This work is called pressure energy)

$$W/\Delta V = P$$

Pressure energy per unit volume is equal to "**Pressure**"

Total energy:

Total energy of flowing fluid

E = K.E.+ P.E. + Pressure energy

$$E = \frac{1}{2}mv^2 + mgh + P \times \Delta V$$

Total energy per unit volume = $\frac{E}{\Delta V}$

$$\frac{E}{\Delta V} = P + \frac{1}{2}\rho v^2 + \rho g h$$

Note: These tree types of energy are interconvertible

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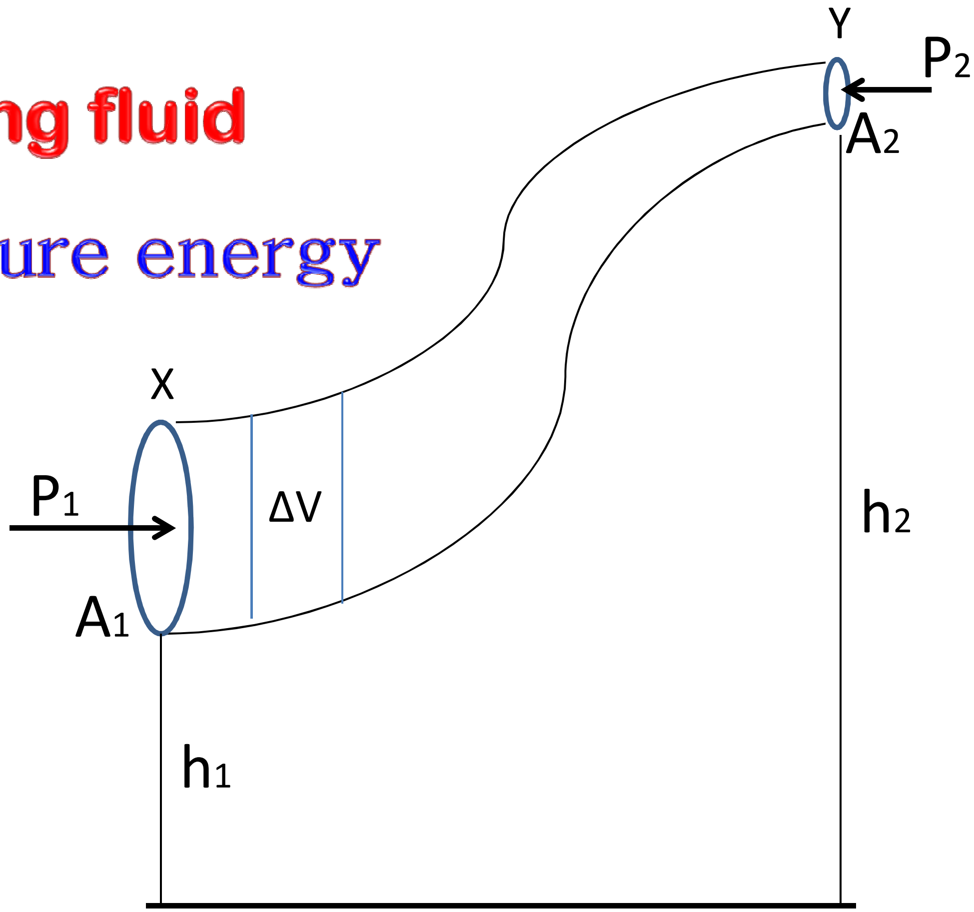
Total energy of flowing fluid

E = K.E.+ P.E.+ Pressure energy

$$E = \frac{1}{2}mv^2 + mgh + P \times \Delta V$$



Total energy per unit volume

$$\frac{E}{\Delta V} = P + \frac{1}{2}\rho v^2 + \rho g h$$

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Bernoulli's Theorem

In case of streamline flow of ideal fluid through a tube of non-uniform cross section, the **total energy per unit volume remains constant** at every point in the tube.

$$P + \frac{1}{2}\rho v^2 + \rho g h = \text{constant}$$

Note: It is another form of law of conservation of energy.