Forms of Energy

- **(1). Kinetic Energy:** Energy due to motion of body. A body of mass, *m*, when moving with velocity, *V*, posses kinetic energy,

$$KE = \frac{1}{2} m V^2$$

m and *V* are mass and velocity of body

- **(2). Potential Energy:** Energy due to elevation of body above an arbitrary datum

$$PE = mgZ$$

Z is elevation of body from arbitrary datum
m is the mass of body

- **(3). Pressure Energy:** Energy due to pressure above datum, most usually its pressure above atmospheric

$$\mathrm{PrE} = \gamma h \qquad !!!$$

Forms of Energy

- (4). Internal Energy: It is the energy that is associated with the molecular, or internal state of matter; it may be stored in many forms, including thermal, nuclear, chemical and electrostatic.

HEAD

- Head: Energy per unit weight is called head

- Kinetic head: Kinetic energy per unit weight

$$\text{Kinetic head} = \frac{KE}{Weight} = \left(\frac{1}{2}mV^2\right)/mg = \frac{V^2}{2g} \qquad \because Weight = mg$$

- Potential head: Potential energy per unit weigh

$$\text{Potential head} = \frac{PE}{Weight} = (mgZ)/mg = Z$$

- Pressure head: Pressure energy per unit weight

$$\text{Pressure head} = \frac{\text{PrE}}{Weight} = \frac{P}{\gamma}$$

TOTAL HEAD

- **TOTAL HEAD**

= Kinetic Head + Potential Head + Pressure Head

$$\frac{V^2}{2g} \qquad Z \qquad \frac{P}{\gamma}$$

$$\text{Total Head} = \text{H} = Z + \frac{P}{\gamma} + \frac{V^2}{2g}$$

Power

- Rate of work done is termed as power

$$Power = Energy/time$$

$$Power = (Energy/weight)(weight/time)$$

- If H is total head=total energy/weight and γQ is the weight flow rate then above equation can be written as

$$Power = (H)(\gamma Q) = \gamma QH$$

In BG: 1 horsepower=550ft.lb/s

$$\text{Power in (horsepower)} = (H)(\gamma Q)/550$$

In SI:

$$\text{Power in (Kilowatts)} = (H)(\gamma Q)/1000$$

Momentum and Forces in Fluid Flow

- We have all seen moving fluids exerting forces. The lift force on an aircraft is exerted by the air moving over the wing. A jet of water from a hose exerts a force on whatever it hits.

- In fluid mechanics the analysis of motion is performed in the same way as in solid mechanics - by use of Newton's laws of motion.

- i.e., *F = ma which is used in the analysis of solid mechanics to relate applied force to acceleration.*

- *In* fluid mechanics it is not clear what mass of moving fluid we should use so we use a different form of the equation.

$$\sum \mathrm{F} = ma = \frac{d(m\mathrm{V})_s}{dt}$$

Momentum and Forces in Fluid Flow

- Newton's 2nd Law can be written:
- *The Rate of change of momentum of a body is equal to the resultant force acting on the body, and takes place in the direction of the force.*

$$\sum \mathrm{F} = \frac{d(m\mathrm{V})_s}{dt}$$

$\sum F =$ Sum of all external forces on a body of fluid or system s

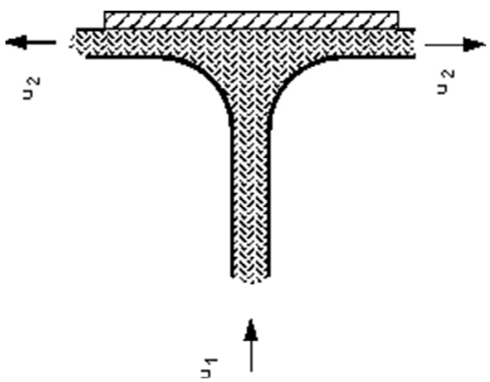
$mV =$ Momentum of fluid body in direction s

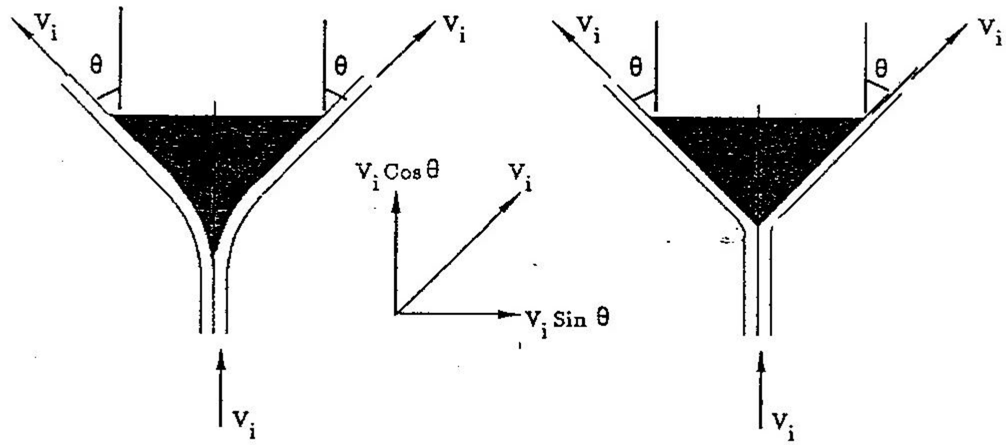
- *The symbols F and V represent vectors and so the change in momentum must be in the same direction as force.*

$$\sum \mathrm{F}dt = d(m\mathrm{V})_s$$

It is also termed as impulse momentum principle

Impact of a Jet on a Plane





$$\frac{F_{th}}{\rho\, Q\, Vi} = 1 - \text{Cos}\ \theta$$

Impact of a Jet on a Plane