

Energy Balance

Heat

Work

Heat

- Conduction
- Convection
- Radiation

work

Types

1. Shaft work

Energy produced due to the movement of internal system parts

2. Flow work

Energy provided externally to run a system

Types of Energy

1. Kinetic Energy

Energy due to the motion of particles

2. Potential energy

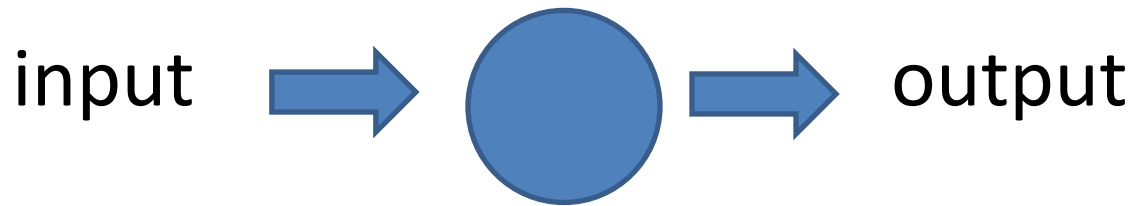
Energy due to the position of particles

3. Internal energy of the system

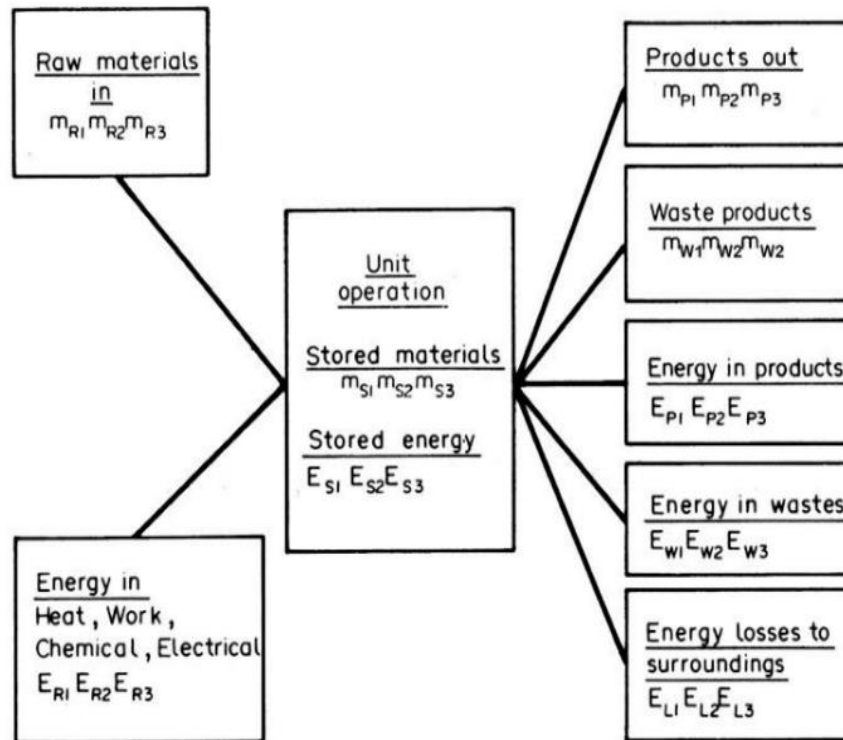
Sum of the molecular, atomic, subatomic energies of the system

1st law of Thermodynamic

- Energy can neither be created nor be destroyed but can be changed from one form to another form



Mass and Energy Balance Box Diagram



Mass Balance

$$\text{Mass In} = \text{Mass Out} + \text{Mass Stored}$$

$$\text{Raw Materials} = \text{Products} + \text{Wastes} + \text{Stored Materials.}$$

$$\Sigma m_R = \Sigma m_P + \Sigma m_W + \Sigma m_S$$

(where Σ (sigma) denotes the sum of all terms).

$$\Sigma m_R = m_{R1} + m_{R2} + m_{R3} = \text{Total Raw Materials.}$$

$$\Sigma m_P = m_{P1} + m_{P2} + m_{P3} = \text{Total Products.}$$

$$\Sigma m_W = m_{W1} + m_{W2} + m_{W3} = \text{Total Waste Products.}$$

$$\Sigma m_S = m_{S1} + m_{S2} + m_{S3} = \text{Total Stored Products.}$$

- A single effect evaporator is fed with **10,000kg** per hour of **weak liquor** containing **15% sugar** by weight and is concentrated to **thick liquor 40% sugar** by weight. **Calculate kg/h of water evaporated** and **kg/h of thick liquor obtained**.



Let the flow rate of thick liquor= S

Let the flow rate of water evaporated= T

Overall material balance equation

$$S+T= 10,000$$

$$T= 10,000-S\text{.....(1)}$$

By carrying out sugar balance

$$0.4 S = 0.15 \times 10,000$$

$$S = 1500/0.4$$

$$S= 3750 \text{ Kg/h}$$

Substituting value of S in equation (1)

$$T= 10,000 - S$$

$$T= 10,000- 3750$$

$$T= 6250 \text{ Kg/h}$$