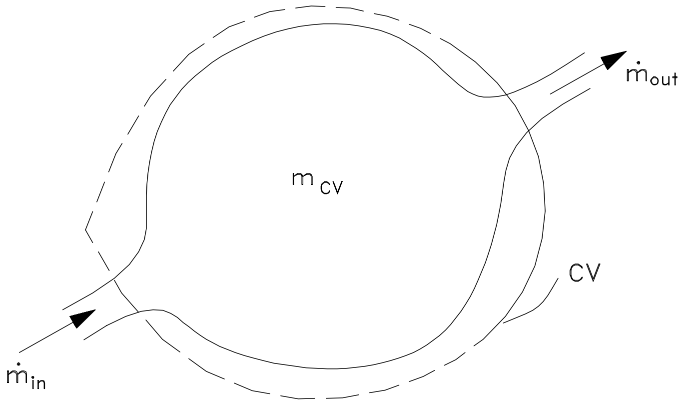
Week 1: Lecture 2

Conservation of Mass

Control Volume Analysis



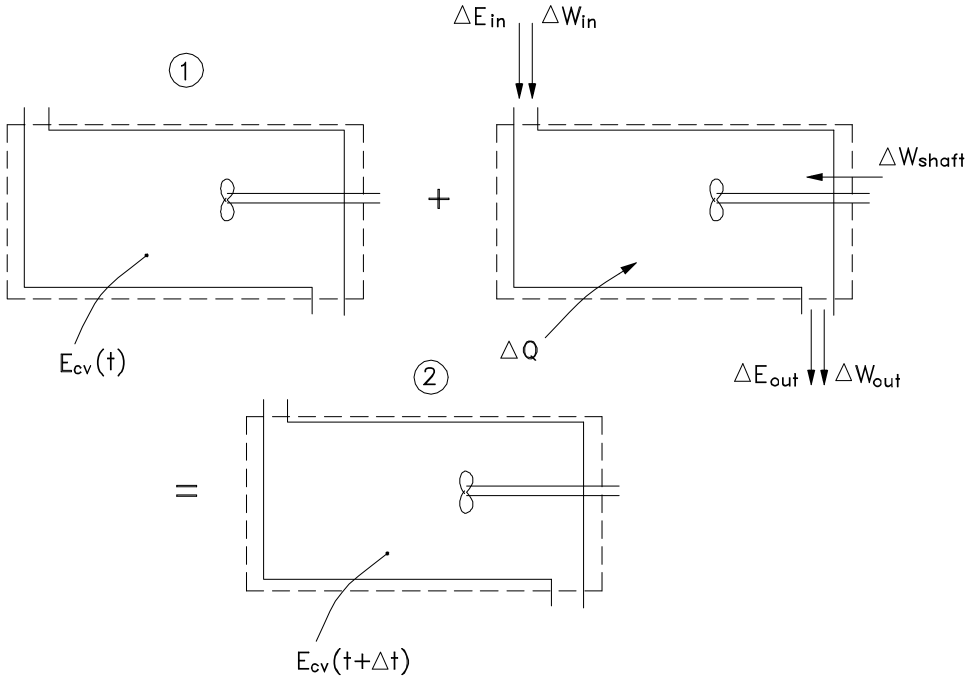
$$\left\{ \begin{array}{c} \text{Rate of Increase} \\ \text{of mass within} \\ \text{the CV} \end{array} \right\} = \left\{ \begin{array}{l} \text{Net rate of} \\ \text{mass flow} \\ \text{IN} \end{array} \right\} - \left\{ \begin{array}{c} \text{Net rate of} \\ \text{mass flow} \\ \text{OUT} \end{array} \right\}$$

$$\frac{d}{dt}(m_{CV}) = \dot{m}_{in} - \dot{m}_{out}$$

Week 1: Lecture 2

First Law of Thermodynamics

Control Volume Analysis



$$E_{CV}(t+\Delta t) - E_{CV}(t) = \Delta Q + \Delta W_{shaft} + \Delta m_{in}(e+Pv)_{in} - \Delta m_{out}(e+Pv)_{out}$$

The 1st law for a control volume can also be written as a rate equation by dividing the above equation by Δt and taking the limit as $\Delta t \rightarrow 0$

$$\frac{dE_{CV}}{dt} = \dot{Q} + \dot{W}_{shaft} + [\dot{m}(e+Pv)]_{in} - [\dot{m}(e+Pv)]_{out}$$

where $\dot{m} = \rho v^* A$

Note that

$$\begin{aligned} e + Pv &= \underbrace{u + Pv} + \frac{(v^*)^2}{2} + gz \\ &= h(enthalpy) + KE + PE \end{aligned}$$