Engineering flow devices Not operating at steady state

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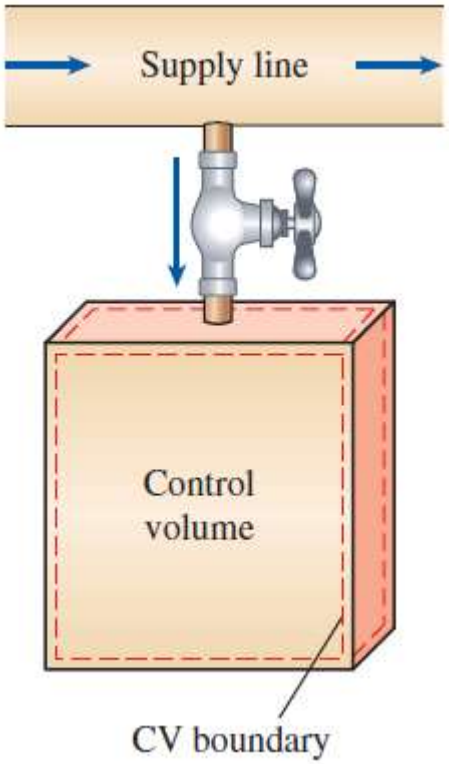
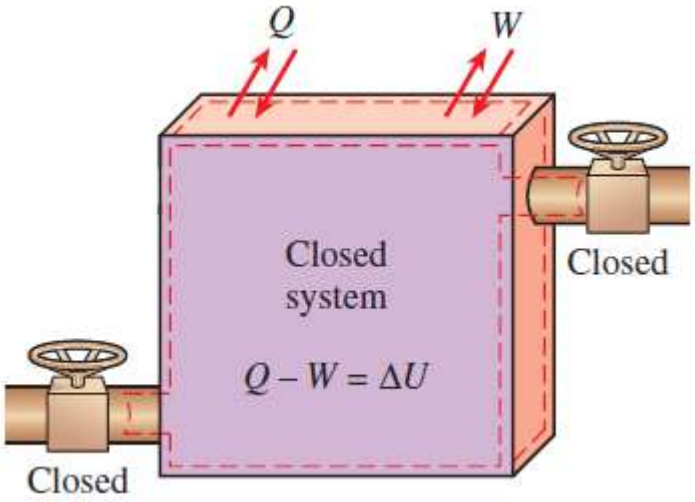
1st Law of TD for flow systems

- Engineering flow applications operating at Steady State: Turbines, Nozzles, Diffusers, Valves, Heat Exchangers…

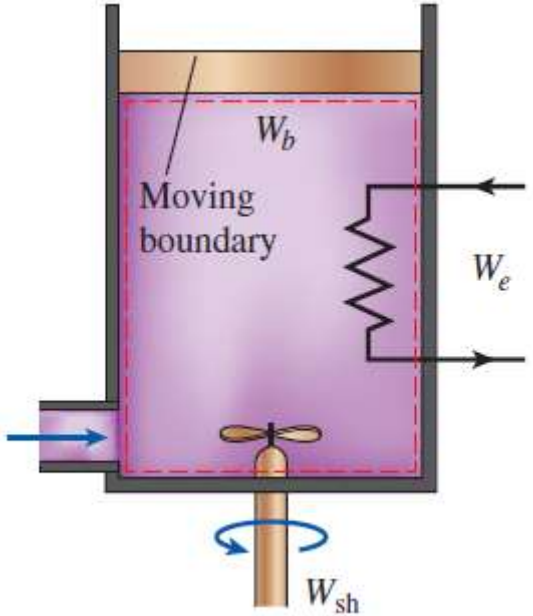
Flow devices: Unsteady & uniform flow





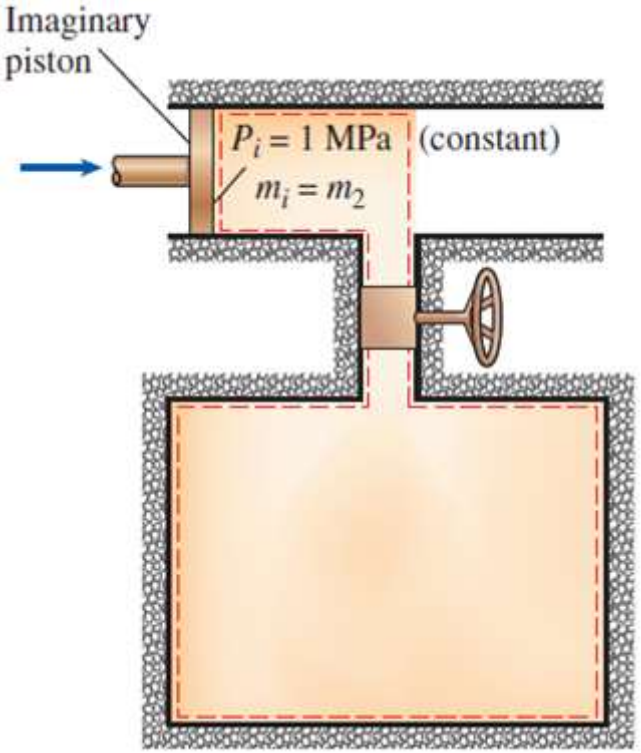
$$m_i - m_e = (m_2 - m_1)_{CV}$$

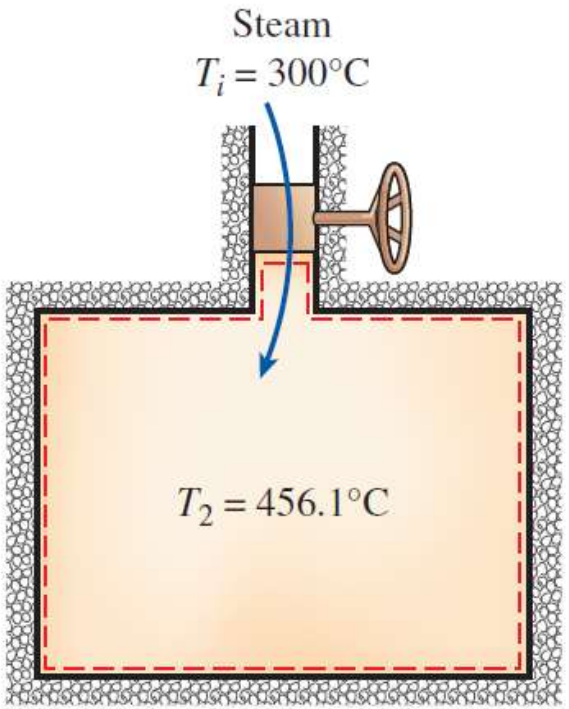
$$Q - W = \sum_{out} mh - \sum_{in} mh + (m_2u_2 - m_1u_1)_{system}$$



Figs: Cengel & Boles: TD

Charging a rigid tank: Two viewpoints





Mass balance: $m_{in} - m_{out} = \Delta m_{system} \rightarrow m_i = m_2 - \overset{0}{m_1} = m_2$

Energy balance:

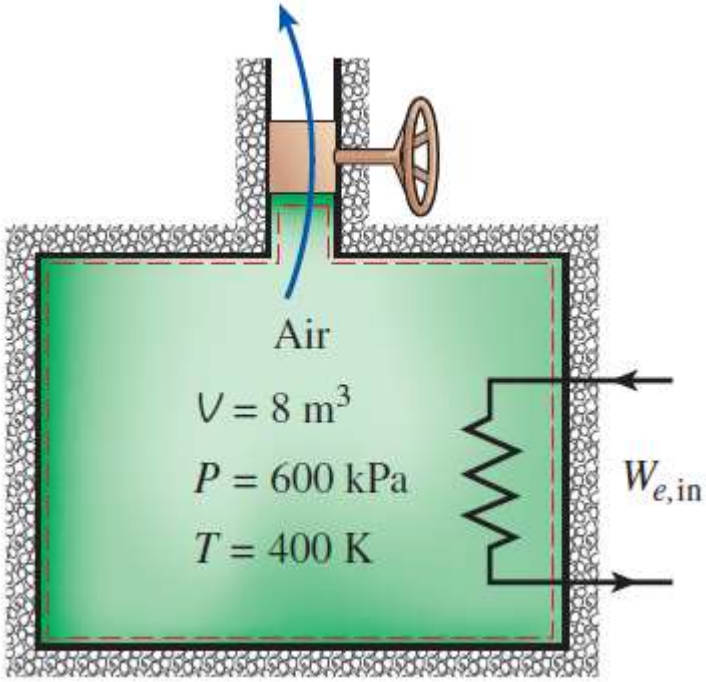
$$\underbrace{E_{in} - E_{out}}_{\text{Net energy transfer by heat, work, and mass}} = \underbrace{\Delta E_{system}}_{\text{Change in internal, kinetic, potential, etc., energies}}$$

$$m_i h_i = m_2 u_2 \quad (\text{since } W = Q = 0, \text{ke} \cong \text{pe} \cong 0, m_1 = 0)$$

$$u_2 = h_i$$

Figs: Cengel & Boles: TD

Discharging heated air: Energy balance



Mass balance: $m_{in} - m_{out} = \Delta m_{system} \rightarrow m_e = m_1 - m_2$

Energy balance: $\underbrace{E_{in} - E_{out}}_{\text{Net energy transfer by heat, work, and mass}} = \underbrace{\Delta E_{system}}_{\text{Change in internal, kinetic, potential, etc., energies}}$

$$W_{e,in} - m_e h_e = m_2 u_2 - m_1 u_1 \quad (\text{since } Q \cong \text{ke} \cong \text{pe} \cong 0)$$

Figs: Cengel & Boles: TD

What's next?

- Closing statements on 1st TD & 2nd Law!