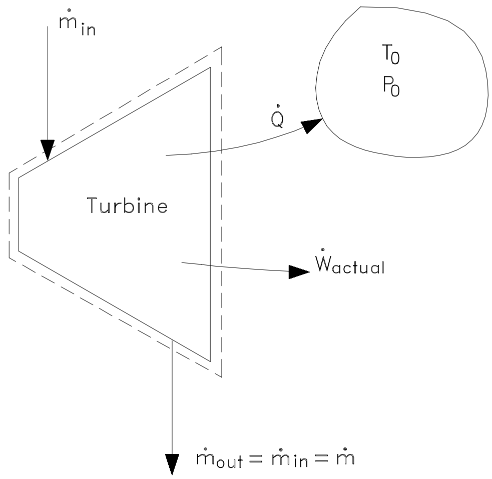
Week 3: Lecture 2

Control Volume Analysis



From the 1st law

$$\cancelto{0}{\frac{dE_{cv}}{dt}} = -\dot{W}_a - \dot{Q} + [\dot{m}(h + \frac{(v^*)^2}{2} + gz)]_{in} - [\dot{m}(h + \frac{(v^*)^2}{2} + gz)]_{out}$$

From the 2nd law

$$\cancelto{0}{\frac{dS_{cv}}{dt}} = \left(\dot{m}s + \frac{\cancelto{0}{\dot{Q}}}{T_{TER}}\right)_{in} - \left(\dot{m}s + \frac{\dot{Q}}{T_0}\right)_{out} + \dot{\mathcal{P}}_s$$

Which leads to the actual work output of the turbine, given as

$$\dot{W}_a = \dot{m}\left[-T_0\Delta s + \Delta h + \Delta KE + \Delta PE\right] - (T_0\dot{\mathcal{P}}_s)$$

The specific flow availability is given as

$$\psi = -T_0(s - s_0) + (h - h_0) + \left(\frac{(v^*)^2}{2} - \frac{(\cancelto{0}{v_0^*})^2}{2}\right) + g(z - \cancelto{0}{z_0})$$

For a steady state, steady flow process

$$\begin{aligned} \dot{W}_{rev} &= (\dot{m}\psi)_{in} - (\dot{m}\psi)_{out} \\ \dot{I} &= \dot{W}_{rev} - \dot{W}_a = T_0\dot{\mathcal{P}}_s \end{aligned}$$