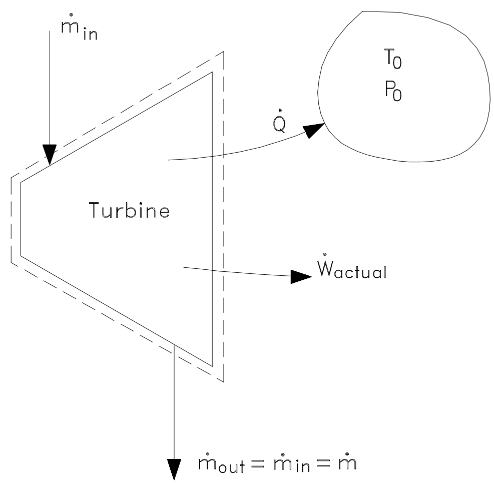
Week 3: Lecture 2

Control Volume Analysis



From the 1st law

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

From the 2nd law

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

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

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

The specific flow availability is given as

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

For a steady state, steady flow process

$$\dot{W}_{rev} = (\dot{m}\psi)_{in} - (\dot{m}\psi)_{out}$$

$$\dot{I} = \dot{W}_{rev} - \dot{W}_a = T_0\dot{\mathcal{P}}_s$$