solve for T_{cf} with $P_{cf} = P_f$

$$\frac{P_f}{T_{cf}}\frac{V_c}{V} = \frac{P_i}{T_i} - \frac{P_f}{T_f} = \frac{P_i}{T_i}\left[1 - \frac{P_f}{T_f}\frac{T_i}{P_i}\right]$$

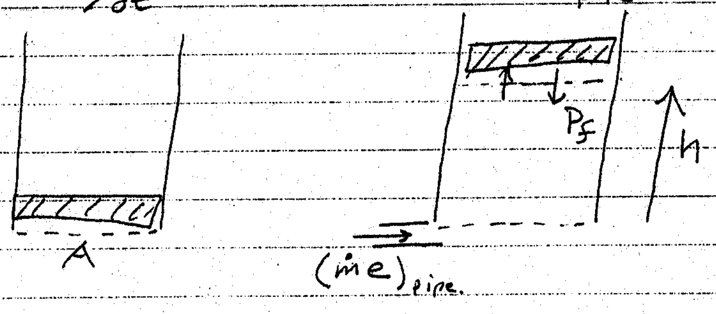
again $P = \rho R T \Rightarrow P/T = \rho R$

$$\frac{P_f}{T_{cf}}\frac{V_c}{V} = \frac{P_i}{T_i}\left[1 - \frac{\rho_f}{\rho_i}\right] = \frac{P_i}{T_i}\left[1 - \left(\frac{P_f}{P_i}\right)^{1/\gamma}\right]$$

$$T_{cf} = \frac{\frac{P_f T_i}{P_i}\frac{V_c}{V}}{1 - \left(\frac{P_f}{P_i}\right)^{1/\gamma}}$$

need to find V_c/V, look at energy balance

$$\underbrace{\frac{\partial}{\partial t}\iiint_V \rho\left(e + \cancelto{0}{\frac{V^2}{2}}\right)dV}_{\partial E/\partial t} + \underbrace{\iint_S \rho \bar{V}\cdot\hat{n}\left(e + \frac{V^2}{c}\right)dS}_{\text{flux across connecting pipe}} = -\iint_S p\bar{V}\cdot\hat{n}\,dS + \cancelto{0}{\delta Q}$$



$$\delta W = -P_f h A$$
$$= -P_f V_c$$

$$dE + (\dot{m}e)_{pipe} = +\delta W \leftarrow \text{work done } \underline{\text{on fluid}}$$

increase in E

i.e. final − initial state

temporally integrated energy flux through pipe