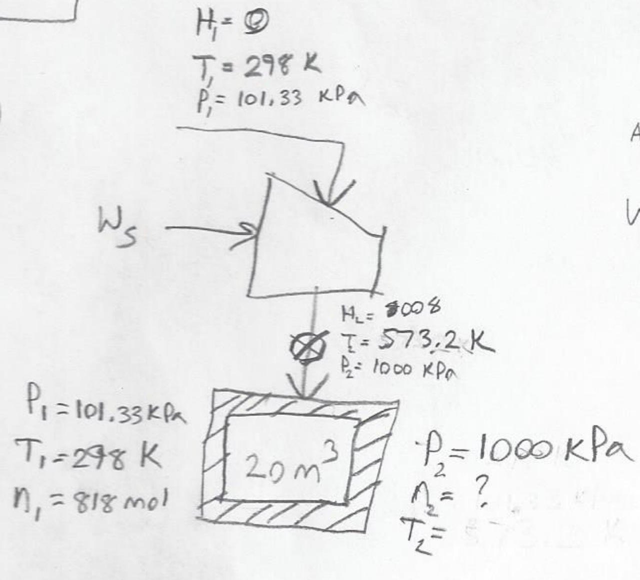
HW 5

(1)



$C_p = 7/2\, R$

Adiabatic, ideal gas, isentropic

$W_s = ?$

$\dot{W}_s = \dot{n}_{in} \Delta \tilde{H}$

$\hat{W}_s = n_{in} \Delta \tilde{H}$

Reference state air @ 25°C, 101.33 kPa

$P_1 V_1 = n_1 R T_1$

$(101.33 \times 10^3)(20) = n_1 (8.314)(298)$

$n_1 = 818$ mole

$P_2 V_1 = n_2 R T_2$

$P_1 V_1 = n_1 R T_1$

$\Delta \tilde{H} = \tilde{C}_p \Delta T$

$\Delta \tilde{H} = \frac{7}{2}(8.314)(275.2\text{ K})$

$\Delta \tilde{H} = 8008$ J/mol $= \tilde{H}_2 - \tilde{H}_1 = \tilde{H}_{in}$

$$\Delta S = R \int_{T_1}^{T_2} \frac{\frac{7}{2}R}{R} \frac{dT}{T} - R \ln \frac{P_2}{P_1}$$

$$\Delta S = 0 = \frac{7}{2} R \ln \frac{T_2}{298} - R \ln \left(\frac{1000}{101.33}\right)$$

$$\ln\left(\frac{1000}{101.33}\right) = \frac{7}{2} \ln \frac{T_2}{298} \qquad T = 573.2 \text{ K}$$

$$\frac{d(n\tilde{U})}{dt} = \sum \dot{n}_{in} \tilde{H}_{in} - \sum \dot{n}_{out} \tilde{H}_{out} + \dot{Q} + \dot{W}_s$$

$$\frac{d(n\tilde{U})}{dt} = \dot{n}_{in} \tilde{H}_{in} \qquad \frac{dn}{dt} = \dot{n}_{in} - \dot{n}_{out} \qquad \frac{P_2}{n_2 T_2} = \frac{P_1}{n_1 T_1}$$

$$\frac{d(n\tilde{U})}{dt} = \frac{dn}{dt} \tilde{H}_{in} \qquad \int_{n_1 \tilde{U}_1}^{(n_1 + n_{in})\tilde{U}_2} d(n\tilde{U}) = \int_0^{n_{in}} \tilde{H}_{in}\, dn \qquad n_2 = \frac{n_1 T_1}{P_1} \cdot \frac{P_2}{T_2}$$

$$(\tilde{U}_2 - \tilde{U}_1) = \frac{5}{2}(8.314)(T_2 - 298)$$

$$(n_1 + n_{in}) \tilde{U}_2 - n_1 \tilde{U}_1 = n_{in} \tilde{H}_{in}$$

$$\left(\frac{n_1 T_1}{P_1} \cdot \frac{P_2}{T_2}\right)\left(\frac{5}{2} R \left[T_2 - 298\right]\right) = \left(\frac{n_1 T_1}{P_1} \cdot \frac{P_2}{T_2} - n_1\right)\left(\tilde{H}_{in}\right)$$

$$\left(\frac{818(298)}{101.33} \cdot \frac{1000}{T_2}\right)\left(2.5(8.314)(T_2 - 298)\right) = \frac{818(298)}{101.33} \cdot \frac{1000}{T_2} - 818(8008)$$

$$\left(\frac{2.406 \times 10^6}{T_2}\right)\left[20.785(T_2 - 298)\right] = \frac{1.926 \times 10^{10}}{T_2} - 6.55 \times 10^6$$

$T_2 = 1746.4$ K