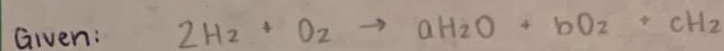


Name: Veronica Woomis

SP B



- Find:
- a) Adiabatic flame temp, T_c
 - b) Coefficient of products, a
 - c) Molecular weight of products, M
 - d) Gamma of the products
 - e) Characteristic velocity of the products, c^*
 - f) Plot of specific heat of water, O_2 , and H_2 as function of temp
 - g) Bonus: Plot of total enthalpy as function of temp

Schematic: \emptyset

Assumptions:

- Adiabatic combustion
- No dissociation
- Heat of formation from table 5.1
- Specific heats from table 5.3
- $P = 1 \text{ atm}$
- Reactant temp = 298 K
- One dissociation reaction
- equilibrium constants from Purdue

Equations:

$$h_{A,i} = \int_{T^0}^T C_{P,A,i} dT + h_{A,i}^0$$

$$\gamma_{\text{mix}} = \frac{C_{p,\text{mix}}}{C_{p,\text{mix}} - R_u}$$

$$C^* = \sqrt{\frac{R_u T_c}{8M}} \left[\frac{2}{(\gamma+1)} \right]^{-(\gamma+1)/2(\gamma-1)}$$

$$K_p = \frac{a(b-a)^{1/2}}{(2-a)^{3/2}}$$

Analysis:

a)

$$\begin{aligned} & a \left[-57800 \frac{\text{cal}}{\text{mol}} + 4.184 \frac{\text{J}}{\text{cal}} + \left[29.182 T + \frac{14.503}{2} T(T/1000) - \frac{2.0235}{3} T(T/1000)^2 \right]_{298}^{T_c} \right. \\ & + (2-a) \left[24.896 T + \frac{4.35011}{2} T(T/1000) - \frac{0.32674}{3} T(T/1000)^2 \right]_{298}^{T_c} \\ & \left. + \frac{2-a}{2} \left[28.186 T + \frac{6.3011}{2} T(T/1000) - \frac{0.74986}{3} T(T/1000)^2 \right]_{298}^{T_c} \right] = 0 \end{aligned}$$

Solve in MATLAB

$$T_c = 3500 \text{ K}$$

$$b) K_p = 10^{B T^3 + C T^2 + D T + E}$$

$$K_p = 4.3874$$

$$B = -1.8559 \text{e-}10$$

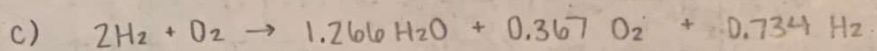
$$C = 2.3375 \text{e-}6$$

$$D = -1.05 \text{e-}2$$

$$E = 1.6715 \text{e}1$$

$$K_p = \frac{a(b-a)^{1/2}}{(2-a)^{3/2}}$$

$$a = 1.26666$$



$$M = 1.266(2.02 + 16) + 0.367(32) + 0.734(2.02) \text{ g/gmol}$$

$$M = 22.813 + 11.744 + 1.48268 \text{ g/gmol}$$

$$M = 36.04 \text{ g/gmol}$$

d) $C_p = \text{on boy}$

$$C_{p\text{H}_2\text{O}} @ 3500\text{K} = 29.182 + 14.503(3500/1000) - 2.0235(3500/1000)^2 =$$

$$C_{p\text{H}_2} @ 3500\text{K} = 26.896 + 4.3501(3500/1000) - 0.32674(3500/1000)^2 =$$

$$C_{p\text{O}_2} @ 3500\text{K} = 28.186 + 6.3011(3500/1000) - 0.74986(3500/1000)^2 =$$

$$C_p = 134.3271 \text{ J/gmolK}$$

$$\gamma = \frac{C_p}{C_p - R_u}$$

$$\gamma = \frac{134.3271}{134.3271 - 8.317}$$

$$\gamma = 1.066$$

$$e) C^* = \sqrt{\frac{8.317 \frac{\text{Nm}}{\text{gmolK}} \times 3500\text{K} \times 1000 \text{ g/kg}}{1.066 \times 36.04 \text{ g/gmol}}} \left[\frac{2}{2.066} \right]^{-2.066/2(0.666)}$$

$$C^* = 1446.6 \text{ m/s}$$