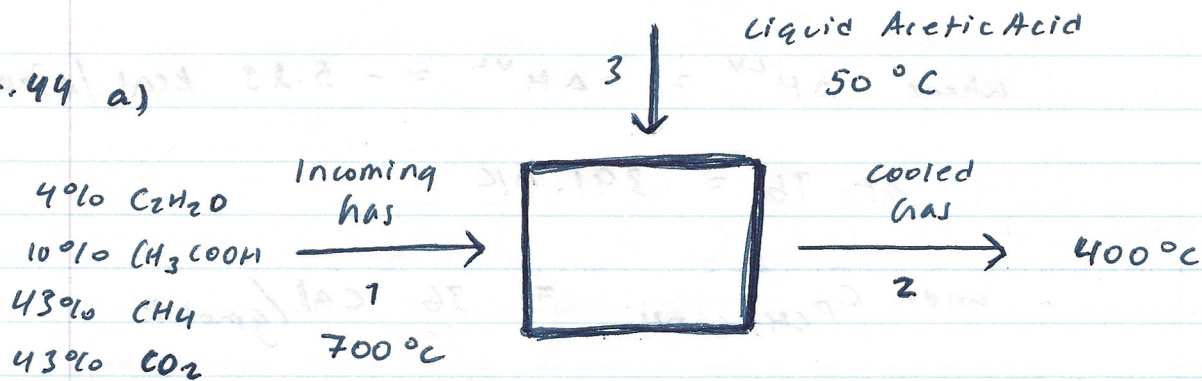


7.44 a)



$$\dot{N}' = 100 \text{ mol/h}$$

$$0 = \sum \dot{N}_i \bar{h}_i - \dot{W}_s + \dot{Q}$$

$$\dot{W}_s = 0$$

$$\dot{Q} = 0$$

$$\begin{aligned} 0 = & 4 \bar{h}_{\text{C}_2\text{H}_2\text{O}}^v + 10 \bar{h}_{\text{CH}_3\text{COOH}}^v + 43 \bar{h}_{\text{CH}_4}^v \\ & + 43 \bar{h}_{\text{CO}_2}^v + \dot{N}^3 \bar{h}_{\text{CH}_3\text{COOH}}^L \\ & - 4 \bar{h}_{\text{C}_2\text{H}_2\text{O}}^v - 10 \bar{h}_{\text{CH}_3\text{COOH}}^v - 43 \bar{h}_{\text{CH}_4}^v \\ & - 43 \bar{h}_{\text{CO}_2}^v - \dot{N}^3 \bar{h}_{\text{CH}_3\text{COOH}}^L \end{aligned}$$

• let reference be vapour at 700 °C

* T in °C

$$\begin{aligned} 0 = & 4 \int_{700}^{700} C_{P,\text{C}_2\text{H}_2\text{O}}^v dT + 10 \int_{700}^{700} C_{P,\text{CH}_3\text{COOH}}^v dT \\ & + 43 \int_{700}^{700} C_{P,\text{CO}_2}^v dT + 43 \int_{700}^{700} C_{P,\text{CH}_4}^v dT + \dot{N}^3 \left[\int_{700}^{T_b} C_{P,\text{CH}_3\text{COOH}}^v dT \right. \\ & \left. + \Delta h^{LV} + \int_{T_b}^{30} C_{P,\text{CH}_3\text{COOH}}^L dT \right] - 4 \int_{700}^{400} C_{P,\text{C}_2\text{H}_2\text{O}}^v dT \\ & - 10 \int_{700}^{400} C_{P,\text{CH}_3\text{COOH}}^v dT - 43 \int_{700}^{400} C_{P,\text{CH}_4}^v dT \\ & - \dot{N}^3 \int_{700}^{400} C_{P,\text{CH}_3\text{COOH}}^v dT - 43 \int_{700}^{400} C_{P,\text{CO}_2}^v dT \end{aligned}$$

where $\Delta H^{LV} = -\Delta H^{VL} = -5.83 \text{ kcal/gmol}$

at $T_b = 391.4 \text{ K}$

and $\bar{C}_{P, \text{CH}_3\text{COOH}}^L = 36 \text{ cal/gmol}\cdot\text{K}$

→ MATLAB

$N^3 = 30.16 \text{ mol/h}$

b) Suppose $N^3 = 40 \text{ mol/h}$

→ using same energy balance

$$0 = 40 \left[\int_{700}^{T_b} \bar{C}_{P, \text{CH}_3\text{COOH}}^V dT + \Delta H^{LV} + \int_{T_b}^{50} \bar{C}_{P, \text{CH}_3\text{COOH}}^L dT \right] \\ - 4 \int_{700}^{T_2} \bar{C}_{P, \text{C}_2\text{H}_2\text{O}}^V dT - 10 \int_{700}^{T_2} \bar{C}_{P, \text{CH}_3\text{COOH}}^V dT \\ - 43 \int_{700}^{T_2} \bar{C}_{P, \text{CH}_4}^V dT - 43 \int_{700}^{T_2} \bar{C}_{P, \text{CO}_2}^V dT \\ - 40 \int_{700}^{T_2} \bar{C}_{P, \text{CH}_3\text{COOH}}^V dT$$

→ MATLAB

$T_2 = 612.76 \text{ K}$