$ORIGIN := 1$

$a := 1$ This represents methane to steam mole ratio

$$n_{CH4}(\varepsilon_1, \varepsilon_2) := 1 - \varepsilon_1 - \varepsilon_2$$

$$n_{H2O}(\varepsilon_1, \varepsilon_2) := a - \varepsilon_1 - 2\varepsilon_2$$

$$n_{CO}(\varepsilon_1, \varepsilon_2) := \varepsilon_1$$

$$n_{CO2}(\varepsilon_1, \varepsilon_2) := \varepsilon_2$$

$$n_{H2}(\varepsilon_1, \varepsilon_2) := 3\varepsilon_1 + 4\varepsilon_2$$

$$n(\varepsilon_1, \varepsilon_2) := n_{CH4}(\varepsilon_1, \varepsilon_2) + n_{H2O}(\varepsilon_1, \varepsilon_2) + n_{CO}(\varepsilon_1, \varepsilon_2) + n_{CO2}(\varepsilon_1, \varepsilon_2) + n_{H2}(\varepsilon_1, \varepsilon_2)$$

$\varepsilon_1 := 0.1$ $\varepsilon_2 := 0.1$

Given

$$0.031 = 4 \cdot \left(\frac{n_{CO}(\varepsilon_1, \varepsilon_2) \cdot n_{H2}(\varepsilon_1, \varepsilon_2)^3}{n_{CH4}(\varepsilon_1, \varepsilon_2) \cdot n_{H2O}(\varepsilon_1, \varepsilon_2) \cdot n(\varepsilon_1, \varepsilon_2)^2} \right)$$

$$0.096 = 4 \cdot \left(\frac{n_{CO2}(\varepsilon_1, \varepsilon_2) \cdot n_{H2}(\varepsilon_1, \varepsilon_2)^4}{n_{CH4}(\varepsilon_1, \varepsilon_2) \cdot n_{H2O}(\varepsilon_1, \varepsilon_2)^2 \cdot n(\varepsilon_1, \varepsilon_2)^2} \right)$$

$$\begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \end{pmatrix} := Find(\varepsilon_1, \varepsilon_2) = \begin{pmatrix} 0.055 \\ 0.147 \end{pmatrix}$$

$$y_{CH4} := \frac{n_{CH4}(\varepsilon_1, \varepsilon_2)}{n(\varepsilon_1, \varepsilon_2)} = 0.332 \qquad y_{H2O} := \frac{n_{H2O}(\varepsilon_1, \varepsilon_2)}{n(\varepsilon_1, \varepsilon_2)} = 0.271$$

$$y_{CO} := \frac{n_{CO}(\varepsilon_1, \varepsilon_2)}{n(\varepsilon_1, \varepsilon_2)} = 0.023 \qquad y_{CO2} := \frac{n_{CO2}(\varepsilon_1, \varepsilon_2)}{n(\varepsilon_1, \varepsilon_2)} = 0.061$$

$$y_{H2} := \frac{n_{H2}(\varepsilon_1, \varepsilon_2)}{n(\varepsilon_1, \varepsilon_2)} = 0.313$$

$$\alpha := \begin{pmatrix} -1 & -1 & 1 & 3 & 0 & 0 \\ -1 & -2 & 0 & 4 & 1 & 0 \\ 0 & 0 & -2 & 0 & 1 & 1 \\ 0 & 1 & -1 & -1 & 0 & 1 \\ -1 & 0 & 0 & 2 & 0 & 1 \end{pmatrix}$$

$$\text{rank}(\alpha) = 3$$

$y_{CO} := 0.01$ $\quad y_{H2} := 0.3$ $\quad y_{CH4} := 0.1$ $\quad y_{H2O} := 0.3$ $\quad y_{CO2} := 0.1$ $\quad n := 5$

Given

$$0.031 = \frac{y_{CO} \cdot y_{H2}^{3} \cdot 2^{2}}{y_{CH4} \cdot y_{H2O}}$$

$$0.096 = \frac{y_{CO2} \cdot y_{H2}^{4} \cdot 2^{2}}{y_{CH4} \cdot y_{H2O}^{2}}$$

$$108 = \frac{y_{CO2}}{y_{CO}^{2}} \cdot \frac{1}{2}$$

$$y_{CH4} + y_{H2O} + y_{CO} + y_{H2} + y_{CO2} = 1$$

$$4y_{CH4} + 2y_{H2O} + 2y_{H2} = \frac{6}{n}$$

$$y_{H2O} + y_{CO} + 2y_{CO2} = \frac{1}{n}$$

$$\text{Find}\left(y_{CH4}, y_{H2O}, y_{CO}, y_{H2}, y_{CO2}, n\right) = \begin{pmatrix} 0.257 \\ 0.324 \\ 0.012 \\ 0.373 \\ 0.034 \\ 2.477 \end{pmatrix}$$