

Heywood - Homework Problem 4.1(a)

(a) Calculate the low temperature burned gas composition resulting from the combustion of 7 g/s air with 0.48 g/s ethane.

$$m_{\text{air}} = 0.007$$

$$m_{\text{fuel}} = 0.00048$$

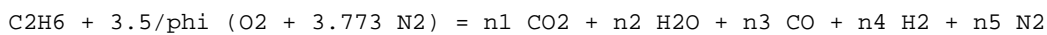
$$AF1 = \frac{m_{\text{air}}}{m_{\text{fuel}}}$$

$$y1 = 3$$

$$AFs1 = \left[1 + \frac{y1}{4} \right] \left[\frac{32 + 3.773 \cdot 28.16}{12.01 + 1.008 \cdot y1} \right]$$

$$\frac{1}{\text{phil}} = \frac{AF1}{AFs1}$$

Rich mixture. Here is the stoichiometric equation.



Balance

$$2 = n_1 + n_3$$

$$6 = 2 \cdot n_2 + 2 \cdot n_4$$

$$3.5 \frac{2}{\text{phil}} = 2 \cdot n_1 + n_2 + n_3$$

$$3.773 \cdot 3.5 \frac{2}{\text{phil}} = 2 \cdot n_5$$

Equilibrium equation

$$\frac{n_2 \cdot n_3}{n_1 \cdot n_4} = 3.5$$

Mole fractions

$$Nm1 = n_1 + n_2 + n_3 + n_4 + n_5$$

$$y1_{CO_2} = \frac{n_1}{Nm1}$$

$$y1_{H_2O} = \frac{n_2}{Nm1}$$

$$y1_{CO} = \frac{n_3}{Nm1}$$

$$y1_{H_2} = \frac{n_4}{Nm1}$$

$$y_{1N_2} = \frac{n_5}{Nm_1}$$

(b) Calculate the low temperature burned gas composition resulting from the combustion of 7 g/s air with 0.48 g/s ethanol.

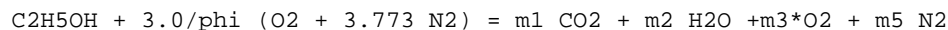
$$AF_2 = \frac{m_{air}}{m_{fuel}}$$

$$AFs_2 = 8.94$$

$$\frac{1}{\phi_2} = \frac{AF_2}{AFs_2}$$

$$as = 3$$

Lean mixture. Here is the stoichiometric equation.



Balance

$$2 = m_1$$

$$6 = 2 \cdot m_2$$

$$1 + as \cdot \frac{2}{\phi_2} = 2 \cdot m_1 + m_2 + 2 \cdot m_3$$

$$3.773 \cdot as \cdot \frac{2}{\phi_2} = 2 \cdot m_5$$

Mole fractions

$$Nm_2 = m_1 + m_2 + m_3 + m_5$$

$$y_{2CO_2} = \frac{m_1}{Nm_2}$$

$$y_{2H_2O} = \frac{m_2}{Nm_2}$$

$$y_{2O_2} = \frac{m_3}{Nm_2}$$

$$y_{2N_2} = \frac{m_5}{Nm_2}$$

Unit Settings: [kJ]/[K]/[kPa]/[kg]/[radians]

AF1 = 14.58	AF2 = 14.58	AFs1 = 16.09	AFs2 = 8.94	as = 3	m1 = 2
m2 = 3	m3 = 1.894	m5 = 18.46	m _{air} = 0.007	m _{fuel} = 0.00048	n1 = 1.565
n2 = 2.779	n3 = 0.4352	n4 = 0.2208	n5 = 11.97	Nm1 = 16.97	Nm2 = 25.36
phi1 = 1.103	phi2 = 0.613	y1 = 3	y1 _{CO} = 0.02565	y1 _{CO2} = 0.09222	y1 _{H2} = 0.01301
y1 _{H2O} = 0.1638	y1 _{N2} = 0.7053	y2 _{CO2} = 0.07887	y2 _{H2O} = 0.1183	y2 _{N2} = 0.7281	y2 _{O2} = 0.07468