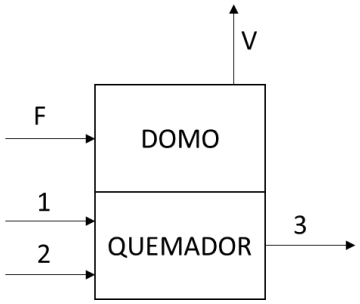
13.



Datos:

Corriente 1: CH_4 70%, C_3H_8 30%; 25°C; 5,5 m^3/h

Corriente 2: aire; 90°C; exceso 20%

Corriente 3: humos; 300°C

Corriente F: agua de reposición; 35°C

Corriente V: vapor; 150°C

$$PV = nRT$$

$$1\ (atm) * 5500\ \left(\frac{L}{h}\right) = n_1 \left(\frac{mol}{h}\right) * 0{,}08206\ \left(\frac{atm\ L}{mol\ K}\right) * 273\ (K)$$

$$n_1 = 245\ mol/h$$

Balance de materia en el quemador, O_2 estequiométrico (α_q)

$$a\ CH_4, \quad b\ C_3H_8, \quad \alpha_q O_2, \quad \beta N_2 \ \rightarrow\ c\ CO_2, \quad d\ H_2O, \quad \beta N_2$$

C: $a + 3b = c$

$$n_1 * 0{,}7 + 3 * n_1 * 0{,}3 = c = 393\ mol/h$$

H: $4a + 8b = 2d$

$$\frac{4 * n_1 * 0{,}7 + 8 * n_1 * 0{,}3}{2} = d = 638\ mol/h$$

O: $2\alpha_q = 2c + d \quad \rightarrow \alpha_q = 712\ mol/h$

$$Exc = \frac{n_{2,O2} - \alpha_q}{\alpha_q} = 0{,}2$$

$$n_{2,O2} = 854\ mol/h$$

Balance de materia en el quemador

$$a\ CH_4, \quad b\ C_3H_8, \quad O_2, \quad N_2 \ \rightarrow\ c\ CO_2, \quad d\ H_2O, \quad f O_2, \quad g N_2$$

C: $a + 3b = c$

$n_1 * 0{,}7 + 3 * n_1 * 0{,}3 = c = 393\ mol/h$

H: $4a + 8b = 2d$

$$\frac{4 * n_1 * 0{,}7 + 8 * n_1 * 0{,}3}{2} = d = 638\ mol/h$$

O: $2n_{2,O2} = 2c + d + 2f \quad \rightarrow f = 142\ mol/h$

N: $n_{3,N2} = n_{2,N2} = n_{2,02} * 79/21 = 3214\ mol/h$

Composición de la corriente de humos

$$n_{3,N2} = 3214 \frac{mol}{h} <> 73{,}2\%$$

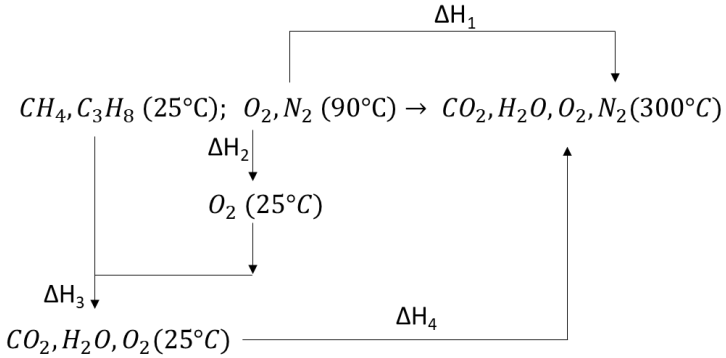
$$n_{3,O2} = 142 \frac{mol}{h} <> 3{,}3\%$$

$$n_{3,CO2} = 393 \frac{mol}{h} <> 8{,}9\%$$

$$n_{3,H2O} = 638 \frac{mol}{h} <> 14{,}6\%$$

<u>Balance energía quemador</u>

Diagrama de Hess



$$\sum \Delta Hi = Q + Qp$$

$$\Delta H_1 = n_{2,N2}\left(\frac{mol}{h}\right) * Cp_{N2}\left(\frac{kJ}{kg\,°C}\right) * (300-90)(°C) * PM_{N2}\left(\frac{kg}{kmol}\right) * \frac{1}{1000}\left(\frac{kmol}{mol}\right)$$
$$= 19.466\frac{kJ}{h}$$

$$\Delta H_2 = n_{2,O2} * Cp_{O2} * (25-90) * PM_{O2} * \frac{1}{1000} = -1439\frac{kJ}{h}$$

$$\Delta H_3 = n_1 * 0{,}7\left(\frac{mol}{h}\right) * \Delta H_{r1}\left(\frac{kJ}{mol}\right) + n_1 * 0{,}3\,(\frac{mol}{h}) * \Delta H_{r2}(\frac{kJ}{mol})$$

$\Delta H_{r1} = \Delta H_{fCO2} + 2 * \Delta H_{fH2O,g} - \Delta H_{fCH4}$ $\quad (CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O)$

$\Delta H_{r1} = -801{,}9\ kJ/mol$

$\Delta H_{r2} = 3 * \Delta H_{fCO2} + 4 * \Delta H_{fH2O,g} - \Delta H_{fC3H8}$ $\quad (C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O)$

$\Delta H_{r2} = -2.042\ kJ/h$

$$\Delta H_3 = -288.285\frac{kJ}{h}$$

$$\Delta H_4 = (n_{3,CO2} * Cp_{CO2} * \frac{PM_{CO2}}{1000} + n_{3,O2} * Cp_{O2} * \frac{PM_{O2}}{1000} + n_{3,H2O} * Cp_{H2O,g} * \frac{PM_{H2O}}{1000}) * (300-25)$$

$$\Delta H_4 = 10.154\frac{kJ}{h}$$

$$Qp = Qcombustión * 0{,}1 = \Delta H_3 * 0{,}1 = -28.828\frac{kJ}{h}$$

$$\sum \Delta Hi - Qp = -260.104 + 28.828 = Q$$

$$Q = -231.276\frac{kJ}{h}$$

<u>Balance de energía en el domo</u>

$$V * Cp_{H2O,l} * (100-35) + V * \Delta Hvap * \frac{1}{PM_{H2O}} + V * Cp_{H2O,g} * (150-100) = Q$$

*Q positivo, el flujo de energía entra al domo de la caldera

$$V = 88\frac{kg}{h}$$