

Ejercicio 1

Energía 1

Examen 05/12/2022

$$b) W_b = \frac{Q_p^s}{\sqrt{G}}$$

$$G = \frac{P_{Mez}}{P_{Mez}}$$

	PM	G	Qps (KJ/s)	Wb
CH ₄	16	0,5547	890940,59	1199466
H ₂	2	0,0693	286031,29	1089174

$$W_{min} = 0,96 W_{CH_4} = 1151487,374$$

$$[X] = \frac{\text{Kmol H}_2}{\text{Kmol mezcl.}}$$

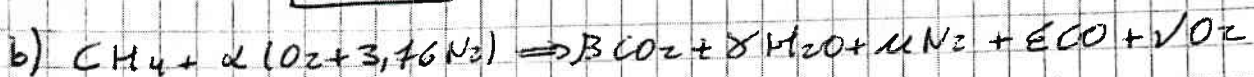
$$G_m = (1-X) G_{CH_4} + X G_{H_2}$$

$$Q_{pm}^s = (1-X) Q_{pCH_4}^s + X Q_{pH_2}^s$$

$$X = 16 \Rightarrow W_b = 1152908 \Rightarrow \text{con } X = 16 \quad W_b > W_{min}$$

$$X = 17 \Rightarrow W_b = 1149993 \Rightarrow W_b < W_{min}$$

$$\text{Tomamos } \boxed{X = 16}$$



$$C] \quad 1 = \beta + \epsilon$$

$$H] \quad 4 = 2\gamma$$

$$O] \quad 2\alpha = 2\beta + \gamma + \epsilon + 2\nu$$

$$N] \quad 3,76\alpha = \mu$$

$$\beta_g = 1 \frac{\text{Kmol CO}_2}{\text{Kmol F}}$$

$$\alpha_g = 2 \frac{\text{Kmol O}_2}{\text{Kmol F}}$$

$$\Rightarrow \boxed{\gamma = 2 \frac{\text{Kmol H}_2\text{O}}{\text{Kmol F}}}$$

$$\left. \begin{aligned} \gamma \cdot O_2 = 3\gamma &= \frac{\nu}{\beta + \mu + \nu + \epsilon} \\ \gamma \cdot CO = 0,5\gamma &= \frac{\epsilon}{\beta + \mu + \nu + \epsilon} \end{aligned} \right\} \Rightarrow \frac{\nu}{\epsilon} = \frac{3}{0,5} \Rightarrow \nu = 6\epsilon$$

$$\nu = 6\epsilon$$

$$\beta = 1 - \epsilon$$

$$\alpha = 2 + 5,5\epsilon$$

$$\mu = 7,52 + 20,68\epsilon$$

$$\Rightarrow \text{sustituyendo en } \gamma \cdot O_2 \Rightarrow \epsilon = 0,049157 \frac{\text{Kmol CO}}{\text{Kmol F}}$$

$$\beta = 0,95 \frac{\text{Kmol CO}_2}{\text{Kmol F}}$$

$$\gamma = 2,0 \frac{\text{Kmol H}_2\text{O}}{\text{Kmol F}}$$

$$\mu = 8,53 \frac{\text{Kmol N}_2}{\text{Kmol F}}$$

$$\epsilon = 0,0492 \frac{\text{Kmol CO}}{\text{Kmol F}}$$

$$\nu = 0,2949 \frac{\text{Kmol O}_2}{\text{Kmol F}}$$

$$\alpha = 2,27 \frac{\text{Kmol O}_2}{\text{Kmol F}}$$

$$\Rightarrow E = \frac{\alpha - \alpha_g}{\alpha_g} \cdot 100 = \boxed{13,5\% = E}$$

Balance de energía

$$\dot{m}_{\text{vapor}} = 1000 \text{ Kg/h}$$

$$h_{f, \text{vapor}} = 2065,61 \text{ KJ/Kg}$$

$$\dot{Q}_{\text{vapor}} = \dot{m}_{\text{vapor}} h_{f, \text{vapor}} = 2065610 \text{ KJ/h}$$

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origem } água vapor
 $T = 25^\circ\text{C}$

$$\dot{m}_{\text{fuel}} \cdot \dot{Q}_p = \dot{Q}_{\text{agua}} + \dot{m}_{\text{fuel}} [B h_{\text{CO}_2} + \gamma h_{\text{H}_2\text{O}} + \mu h_{\text{H}_2} + \nu h_{\text{O}_2} + E (\dot{Q}_p + h_{\text{CO}_2})]$$

$$\dot{Q}_p \text{CH}_4 = 802359 \text{ KJ/Kmol}$$

$$h_{\text{CO}_2} = 4870 \text{ KJ/Kmol}$$

$$h_{\text{H}_2\text{O}} = 4247,4 \text{ KJ/Kmol}$$

$$h_{\text{H}_2} = 3648,8 \text{ KJ/Kmol}$$

$$h_{\text{O}_2} = 3725,1 \text{ KJ/Kmol}$$

$$h_{\text{CO}} = 3656,2 \text{ KJ/Kmol}$$

$$\dot{Q}_p \text{CO} = 283178,82 \text{ KJ/Kmol}$$

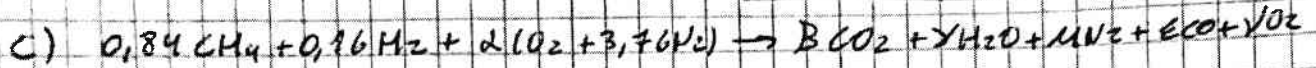
$$\Rightarrow \dot{m}_{\text{fuel}} = 2,78 \text{ Kmol/h}$$

$$P \cdot V = nRT$$

$$T = 273,15 \text{ K}$$

$$P = 101300 \text{ Pa}$$

$$\Rightarrow \dot{V}_1 = 62,3 \text{ Nm}^3/\text{h}$$



$$C) 0,84 = B + E$$

$$\Rightarrow B = 0,84 - E$$

$$H) 3,68 = 2\gamma$$

$$\Rightarrow \gamma = 1,84 \text{ Kmol/Kmol}$$

$$O) 2\alpha = 2B + \gamma + 2\nu + E$$

$$N) 3,76\alpha = \mu$$

$$\Rightarrow \mu = 7,51 \text{ Kmol/Kmol}$$

$$\alpha_f = 1,76$$

$$E = 13,5\%$$

$$\alpha = 1,998 \text{ Kmol/Kmol}$$

$$\gamma_{\text{CO}} = 0,5 = \frac{E}{B + \mu + E + \nu} \Rightarrow 200E = B + \nu + \mu + E \Rightarrow \nu = 200E - 8,35$$

$$\Rightarrow 2(1,998) = 2(0,84 - E) + 1,84 + 2(200E - 8,35) + E$$

$$\Rightarrow \begin{matrix} E = 0,043045 \text{ KmolCO/Kmol} \\ B = 0,79695 \text{ KmolCO}_2/\text{Kmol} \\ \gamma = 1,84 \text{ KmolH}_2\text{O/Kmol} \\ \mu = 7,51 \text{ KmolN}_2/\text{Kmol} \\ \nu = 0,259 \text{ KmolO}_2/\text{Kmol} \end{matrix}$$

Balanco energético análogo a parte b

$$\dot{m}_{\text{fuel}} \dot{Q}_{p \text{mezcla}} = \dot{Q}_{\text{agua}} + \dot{m}_{\text{mezcla}} [B_2 h_{\text{CO}_2} + \gamma_2 h_{\text{H}_2\text{O}} + \mu_2 h_{\text{H}_2} + \nu_2 h_{\text{O}_2} + E (\dot{Q}_p + h_{\text{CO}_2})]$$

$$\dot{Q}_{p \text{mezcla}} = (1-x) \dot{Q}_p \text{CH}_4 + x \dot{Q}_p \text{H}_2 = 712699,7 \text{ KJ/Kmolmezcla}$$

$$\Rightarrow \dot{m}_{\text{mezcla}} = 3,128 \text{ Kmolmezcla/h}$$

$$\dot{m}_{\text{CH}_4} = 0,84 \dot{m}_{\text{mezcla}}$$

$$\begin{matrix} \dot{m}_{\text{CH}_4} = 2,628 \text{ Kmol/h} \\ \dot{V}_2 = 58,9 \text{ Nm}^3/\text{h} \end{matrix}$$

$$A_{\text{horro}} = \frac{V_2 - V_1}{V_1} \cdot 100$$

$$A_{\text{horro}} = 5,5\%$$

$$d) L_{\text{Imezcla}} = \frac{1}{\sum \frac{x_i}{L_i}}$$

	LII	LSI
CH ₄	5	15
H ₂	4	74,6
mezcla	4,8	17,2

$$\begin{matrix} L_{II} = 4,8 \\ L_{SI} = 17,2 \end{matrix}$$

$$\text{mezcla Fuelaire} \Rightarrow \frac{1 \times 100}{1 + 4,7\alpha} = 9,5\%$$

$$\frac{1F}{1F + 1A_{\text{horro}}} = 9,5\%$$

Verifica

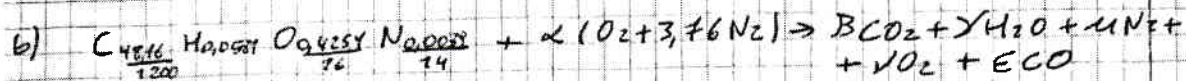
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Ejercicio 2

Energía 3.1

Examen 05/12/2022

$$\left. \begin{array}{l} C = 49,7\% \\ H = 6\% \\ O = 43,9\% \\ N = 0,4\% \\ A_{sh} = 3,1\% \text{ (bs)} \\ 7 H_2O = 30 \times bh \end{array} \right\} \text{bssc} \rightarrow \left. \begin{array}{l} C = 48,16\% \\ H = 5,81\% \\ O = 42,54\% \\ N = 0,39\% \\ A_{sh} = 3,1\% \\ H_2O = 42,86\% \end{array} \right\}$$



$$C] \quad \frac{0,4816}{12} = B + E$$

$$H] \quad 0,0581 = 2\gamma$$

$$O] \quad \frac{0,4254}{16} + 2\alpha = 2B + \gamma + 2\nu + E$$

$$N] \quad \frac{0,0039}{14} + 2 \cdot 3,76 \alpha = 2\mu$$

$$E = \frac{\alpha - \alpha_g}{\alpha_g} \times 100 = 30$$

$$\gamma CO = \frac{E \times 100}{B + \mu + \gamma + E} = 0,1$$

$$\alpha_g = 0,0414 \text{ kmol/kg F}$$



$$\alpha = 0,05319 \text{ kmol/kg F}$$

$$B = 0,0399 \text{ kmol CO/kg F}$$

$$\gamma_F = 0,02904 \text{ kmol H}_2\text{O/kg F}$$

$$\gamma_C = 0,02381 \text{ kmol H}_2\text{O/kg F}$$

$$\mu = 0,20238 \text{ kmol N}_2/kg F$$

$$\nu = 0,01254 \text{ kmol O}_2/kg F$$

$$E = 0,000255 \text{ kmol CO/kg F}$$

Balanza General a todo el sistema origen { zona vapor líquida
T = 25°C

$$\dot{m} F Q_p^s = \dot{Q}_{\text{agua}} + \dot{Q}_{\text{perdido}} + \dot{m} F [B CO_2 + \gamma_F (H_2O + 18 \cdot h_{F,25^\circ}) + \mu H_2 + \nu H_2 + E (h_{CO} + Q_{p,CO}^s)]$$

$$\dot{Q}_{\text{agua}} = \dot{m}_{\text{agua}} (h_{v,25^\circ} - h_{l,25^\circ}) = 20.000 \cdot (2300,9 - 380,01)$$

$$\dot{Q}_{\text{agua}} = 48411.800 \text{ KJ/h}$$

$$h_{CO_2} = 6249,9 \text{ KJ/kmol}$$

$$h_{CO} = 4540,8 \text{ KJ/kmol}$$

$$h_{H_2O} = 505,7 \text{ KJ/kmol}$$

$$h_{O_2} = 4639,9 \text{ KJ/kmol}$$

$$h_{H_2} = 4529,3 \text{ KJ/kmol}$$

$$Q_{p,CO}^s = 283148,8 \text{ KJ/kmol}$$

$$h_{F,25^\circ} = 2411,1 \text{ KJ/kg}$$

$$\dot{Q}_{\text{perdido}} = \dot{m} F 0,02 \cdot Q_p^s$$

$$\eta = \frac{\dot{Q}_{\text{agua}} \times 100}{\dot{m} F \cdot Q_p^s} \Rightarrow \eta = 78,36\%$$

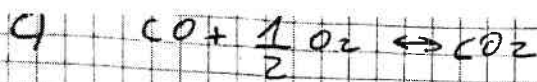
Despejando:

$$\dot{m} F = 3089,64 \text{ kg F/h}$$

Cambio de base

$$\dot{m} F = 4413,8 \text{ kg F/h}$$

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$$K = \frac{X_{\text{CO}_2}}{X_{\text{CO}} (X_{\text{O}_2})^{1/2}} \left(\frac{P}{P_{\text{ref}}} \right)^{-0,5} = \frac{B}{E \cdot Y^{0,5}} (B + \delta_T + M + Y + E)^{0,5}$$

$K = 774,8 \Rightarrow \ln(K) = 6,65 \xrightarrow{\text{Gráfica}} \boxed{T = 2000\text{K}}$

d) Temperatura llama adiabática $T = 1726^\circ\text{C}$

Balance origen agua líquido, 25°C

$$\dot{m}_{\text{fuel}} \cdot Q_p^s + \dot{m}_{\text{aire}} E_{\text{aire}} (T - 25^\circ\text{C}) = \dot{m}_F \cdot [B h_{\text{CO}_2} + \delta_T (h_{\text{H}_2\text{O}} + 18 h_{\text{Fg}}) + M h_{\text{H}_2} + V h_{\text{O}_2} + E (Q_p^s + h_{\text{CO}})]$$

$\xrightarrow{\text{Q}_{\text{aire}} \rightarrow \text{coincide porque } T_{\text{aire in}} = T_{\text{ref}}}$

$h_{\text{CO}_2} = 91386 \text{ KJ/Kmol}$

$h_{\text{CO}} = 56705 \text{ KJ/Kmol}$

$h_{\text{H}_2\text{O}} = 72999 \text{ KJ/Kmol}$

$h_{\text{O}_2} = 59169 \text{ KJ/Kmol}$

$h_{\text{H}_2} = 56105,3 \text{ KJ/Kmol}$

$\Rightarrow \boxed{\dot{Q}_{\text{aire}} = 1750,4 \text{ KW}}$

$T_{\text{aire}} = \frac{\dot{Q}_{\text{aire}}}{\dot{m}_{\text{aire}} \cdot c_{p,\text{aire}}}$

$c_{p,\text{aire}} = 1 \text{ KJ/KgK}$

$\dot{m}_{\text{aire}} = \dot{m}_F \cdot 13,8 = 6,37 \text{ Kg/s} \Rightarrow \boxed{T_{\text{aire}} = 300^\circ\text{C}}$



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