IEQB Fichas 2021.1 - Resolução

Felipe B. Pinto 61387 - MIEQB

23 de junho de 2021

Conteúdo

V Balanços de Energia **2**

Questão 5.1 $\mathrm{E}_c \cong 868.67\,\mathrm{mJ\,s^{-1}}$ 2
Questão 5.2 2
Questão 5.3 $\widehat{\mathrm{H}} \cong 6\,\mathrm{kJ\,mol^{-1}}$ 2
Questão 5.4 $Pot_{\max} \cong -6.82\,\mathrm{MW}$ 2
Questão 5.5 $\Delta\dot{H}$ 2
Questão 5.6 $W\,(\mathrm{kW}) \cong 292.22\,\mathrm{kW}$ 2
Questão 5.7 $\Delta\dot{H}_o\,(\mathrm{kJ\,h^{-1}}) \cong 9.07\,\mathrm{GJ\,h^{-1}}$ 2
Questão 5.8 $\mathrm{Q} \cong 37.68\,\mathrm{kcal/T}$ 2
Questão 5.9 $\dot{\mathrm{Q}} \cong 4.30\,\mathrm{kcal\,mol^{-1}}$ 2
Questão 5.10 $\mathrm{t}_o \cong 512.26\,\mathrm{K}$ 3
Questão 5.11 $\dot{\mathrm{Q}} \cong 7.43\,\mathrm{kcal}$ 3
Questão 5.12 $\dot{\mathrm{Q}} \cong 2.35\,\mathrm{Mcal\,h^{-1}}$ 3
Questão 5.13 $\dot{\mathrm{Q}} \cong 69.68\,\mathrm{MJ\,h^{-1}}$ 3
Questão 5.14 $\widehat{\mathrm{Q}} \cong 20.76\,\mathrm{MJ\,mol^{-1}}$ 3

V | Balanços de Energia

Questão 5.1 $\mathrm{E}_c \cong 868.67\,\mathrm{mJ\,s^{-1}}$

$$= 0.5\,m\,u^2 = 0.5\,Q\,\rho_{\mathrm{Agua}}\left(\frac{Q}{\pi\,r^2}\right)^2 =$$
$$= 0.5 * 2\,\mathrm{m^3\,h^{-1}}\,1000\,\mathrm{kg\,m^{-3}}\left(\frac{2\,\mathrm{m^3\,h^{-1}}}{\pi\,(2\,\mathrm{cm})^2}\right)^2 =$$
$$= 0.5 * 2 * 1000\left(\frac{2}{\pi\,(1\,\mathrm{c})^2}\right)^2 *$$
$$* \left(\frac{\mathrm{m^2kg}}{\mathrm{h^3}}\left(\frac{\mathrm{h}}{3600\mathrm{s}}\right)^3\frac{\mathrm{J}}{\mathrm{m^2\,kg/s^2}}\right) = 869\,\mathrm{mJ\,s^{-1}}$$

Questão 5.2

(i) $\Delta\mathrm{E_g} \cong 35.30\,\mathrm{kJ\,s^{-1}}$

$$= m\,g\,\Delta h =$$
$$= 15\,\mathrm{kg\,s^{-1}} * 9.81\,\mathrm{m/s^2} * (20\,\mathrm{m} - (-220\,\mathrm{m})) =$$
$$= 15 * 9.81 * (20 - (-220))\left(\frac{\mathrm{kg\,m^2}}{\mathrm{s^3}}\frac{\mathrm{J}}{\mathrm{kg\,m^2/s^2}}\right) \cong$$
$$\cong 35.30\,\mathrm{kJ\,s^{-1}}$$

(ii) $\mathrm{P_{min}} \cong 35.30\,\mathrm{kW}$

$$= \mathrm{E_g} = 35.30\,\mathrm{kJ\,s^{-1}}\frac{\mathrm{W}}{\mathrm{J\,s^{-1}}} = 35.30\,\mathrm{kW}$$

Questão 5.3 $\widehat{\mathrm{H}} \cong 6295\,\mathrm{J\,mol^{-1}}$

$$= \widehat{\mathrm{U}} + \mathrm{P}\,\widehat{\mathrm{V}} = 3800\,\mathrm{J\,mol^{-1}} + 1\,\mathrm{atm}\,24.63\,\mathrm{L\,mol^{-1}} *$$
$$* \frac{8.31\,\mathrm{J}}{0.08\,\mathrm{L\,atm}} \cong 6295\,\mathrm{J\,mol^{-1}}$$

Questão 5.4 $Pot_{\max} \cong -6.82\,\mathrm{MW}$

$$= -\dot{E}_c = -417\,\mathrm{m^3min^{-1}}\frac{1000\,\mathrm{kg}}{\mathrm{m^3}}\frac{60\,\mathrm{s}}{\mathrm{min}}9.81\,\mathrm{m\,s^{-2}} *$$
$$* 100\,\mathrm{m} \cong -6.82\,\mathrm{MW}$$

Questão 5.5 $\Delta\dot{H}$

$$= \dot{Q} - \dot{W} - \Delta\dot{E}_c - \Delta\dot{E}_p = -41.8\,\mathrm{MJ\,h^{-1}}\frac{\mathrm{h}}{3600\,\mathrm{s}} -$$
$$- 700\,\mathrm{kW} - 0.5 * 500\,\mathrm{kg\,h^{-1}}\frac{\mathrm{h}}{3600\,\mathrm{s}} *$$
$$* \left(360^2 - 60^2\right)\mathrm{m\,s^{-1}} - 500\,\mathrm{kg\,h^{-1}}\frac{\mathrm{h}}{3600\,\mathrm{s}} *$$
$$* 9.81\,\mathrm{m\,s^{-2}}\,(0 - 5)\,\mathrm{m} \cong -720.35\,\mathrm{kW}$$

Questão 5.6 $W(\mathrm{kW}) \cong 292.2\,\mathrm{kW}$

$$= -\Delta\dot{\mathrm{H}} = 2000\,\mathrm{kg\,h^{-1}}\frac{\mathrm{h}}{3600\,\mathrm{s}}\,(3201 - 2675)\ \mathrm{J\,g^{-1}} \cong 292.2\,\mathrm{kW}$$

Questão 5.7 $\Delta\dot{H}_o\,(\mathrm{kJ\,h^{-1}}) \cong 9.067 * 10^6\,\mathrm{kJ\,h^{-1}}$

$$= \Delta\dot{\mathrm{H}}_{i1} + \Delta\dot{\mathrm{H}}_{i2} = 1000\,\mathrm{kg\,h^{-1}}\,2675\,\mathrm{J\,g^{-1}} + 1950\,\mathrm{kg\,h^{-1}}\,3278\,\mathrm{J\,g^{-1}} \cong$$
$$\cong 9.067 * 10^6\,\mathrm{kJ\,h^{-1}}$$

Questão 5.8 $\mathrm{Q} \cong 37.68\,\mathrm{kcal/T}$

$$= \Delta\dot{\mathrm{H}} = ((132.0 - 93.67)\ 0.4 + (117.41 - 80.17)\ 0.6)\ \mathrm{cal\,g^{-1}} *$$
$$* 1\,\mathrm{kg/T} \cong 37.68\,\mathrm{kcal/T}$$

Questão 5.9 $\dot{\mathrm{Q}} \cong 4.302\,\mathrm{kcal\,mol^{-1}}$

$$\Delta\dot{\mathrm{H}} = 6.713\,\mathrm{cal\,mol^{-1}\,K^{-1}}\,\Delta t\,\mathrm{K}\Big|_{673}^{1273} + 0.04697 * 10^{-2}\,\mathrm{cal\,mol^{-1}\,K^{-1}} *$$
$$* \int_{673}^{1273} t\,\mathrm{d}t\,\mathrm{K} = 4.028\,\mathrm{kcal\,mol^{-1}} + 0.5 * 0.04697 * 10^{-2}\ * \Delta t^2\Big|_{673}^{1273} \cong$$
$$\cong 4.302\,\mathrm{kcal\,mol^{-1}}$$

Questão 5.10 $\quad \mathrm{t}_o \cong 512.3\,\mathrm{K}$

$$\Delta\dot{\mathrm{H}} = \dot{m}\int_{\mathrm{t}_i}^{\mathrm{t}_o} \mathrm{C}_p(\mathrm{t})\,\mathrm{dt} = 2\,\mathrm{kL(STP)/min}\,\frac{\mathrm{mol}}{22.711\,\mathrm{L}} *$$
$$* \left(19.87\,\mathrm{J\,mol^{-1}\,K^{-1}} * \Delta t\,\mathrm{K}\big|_{293}^{t_o} + 0.5 * 5.021 * 10^{-2}\,\mathrm{J\,mol^{-1}\,K} *\right.$$
$$\left. * \int_{293}^{t_o} t\,\mathrm{d}t\,\mathrm{K}\right) \cong \left(t_o^2\,2.211 + t_o\,1.750 * 10^3 - 702.5 * 10^3\right)\,\mathrm{J\,min^{-1}} \cong$$
$$\cong \dot{\mathrm{W}}_s = 12.9\,\mathrm{kW}\,\frac{\mathrm{min}}{60\,\mathrm{s}} \implies \mathrm{t}_o \cong$$
$$\cong \frac{-1.750 * 10^3 \pm \sqrt{(1.750 * 10^3)^2 - 4 * 2.211 * (1.476 * 10^6)}}{2 * 2.211}\,\mathrm{K} \cong$$
$$\cong (-395.7 \pm 908.0)\,\mathrm{K} \implies \mathrm{t}_o \cong 512.3\,\mathrm{K}$$

Questão 5.11 $\quad \dot{\mathrm{Q}} \cong 7.4\,\mathrm{kcal}$

$$= \Delta\dot{\mathrm{H}}_{(s\to v,(0\to 150)^\circ\mathrm{C})} = \dot{m}\left(\Delta\widehat{\mathrm{H}}_{(s\to l)} + \Delta\widehat{\mathrm{H}}_{(0\to 100)^\circ\mathrm{C}} + \Delta\widehat{\mathrm{H}}_{(l\to v)} +\right.$$
$$\left. +\Delta\widehat{\mathrm{H}}_{(100\to 150)^\circ\mathrm{C}}\right) = 10\,\mathrm{g}\,\frac{\mathrm{mol}}{18\,\mathrm{g}}\left(-1436\,\mathrm{cal\,mol^{-1}} +\right.$$
$$+ \left(18\,\mathrm{cal\,mol^{-1}\,K^{-1}}\,\Delta t\,\mathrm{K}\right)\big|_{273}^{373} + 9729\,\mathrm{cal\,mol^{-1}} +$$
$$\left. + \left(8.22\,\mathrm{cal\,mol^{-1}\,K^{-1}}\,\Delta t\,\mathrm{K} + 0.5 * 0.15 * 10^{-3}\,\mathrm{cal\,mol^{-1}\,K^{-1}}\ *\right.\right.$$
$$\left.\left. *\Delta\left(t^2\right)\ \mathrm{K}\right)\big|_{373}^{423}\right) \cong 7.4\,\mathrm{kcal}$$

Questão 5.12 $\quad \dot{\mathrm{Q}} \cong 2.35\,\mathrm{Mcal\,h^{-1}}$

$$= \Delta\dot{\mathrm{H}}_{(l\to g,(25\to 300)^\circ\mathrm{C},1\mathrm{atm})} = \dot{\mathrm{m}}\left(\Delta\widehat{\mathrm{H}}_{(l,(25\to 68.7)^\circ\mathrm{C},1\mathrm{atm})} +\right.$$
$$\left. +\Delta\widehat{\mathrm{H}}_{(l\to g,68.7^\circ\mathrm{C},1\mathrm{atm})} + \Delta\widehat{\mathrm{H}}_{(g,(68.7\to 300)^\circ\mathrm{C},1\mathrm{atm})}\right) = 100\,\mathrm{mol\,h^{-1}} *$$
$$* \left((51.6\Delta t)\big|_{298}^{341.7} + 6921 +\right.$$
$$\left. + \left(1.657\,\Delta t + 0.5 * 13.19 * 10^{-2}\,\Delta(t^2)\right)\big|_{341.7}^{573}\right)\,\mathrm{cal\,mol^{-1}} \cong$$
$$\cong 2.35\,\mathrm{Mcal\,h^{-1}}$$

Questão 5.13 $\quad \dot{\mathrm{Q}} \cong 69.7\,\mathrm{MJ\,h^{-1}}$

$$= \Delta\dot{\mathrm{H}} = -\sum \Delta\dot{\mathrm{H}}_{o\,\mathrm{H_2O}} + \sum \Delta\dot{\mathrm{H}}_{i\,\mathrm{H_2O}} + \Delta\dot{\mathrm{H}}_{Ac,(90\to 6)^\circ\mathrm{C}} =$$
$$= (-2700 * 209.3 - 1600 * 25.2 + 2700 * 8.4 + 1600 * 376.9 +$$
$$+400 * 1.47\ \ \Delta t\big|_{279}^{363})\,\mathrm{kJ\,h^{-1}} \cong 69.7\,\mathrm{MJ\,h^{-1}}$$

Questão 5.14 $\quad \widehat{\mathrm{Q}} \cong 20.76\,\mathrm{MJ\,mol^{-1}}$

- 1: i
- 2: o1
- 3: o2

$$= \Delta\widehat{\mathrm{H}}_{(\mathrm{B_l},(10\to 50)^\circ\mathrm{C})} + \Delta\widehat{\mathrm{H}}_{(\mathrm{T_l},(10\to 50)^\circ\mathrm{C})} + \widehat{\mathrm{M}}_{o1} * \left(\Delta\widehat{\mathrm{H}}_{(\mathrm{B_l},(50\to 80.1)^\circ\mathrm{C})} + \Delta\widehat{\mathrm{H}}_{(\mathrm{B_l}\to\mathrm{B_g},80.1^\circ\mathrm{C})} + \Delta\widehat{\mathrm{H}}_{(\mathrm{B_g},(80.1\to 50)^\circ\mathrm{C})} + \Delta\widehat{\mathrm{H}}_{(\mathrm{T_l},(50\to 110.6)^\circ\mathrm{C})} + \Delta\widehat{\mathrm{H}}_{(\mathrm{T_l}\to\mathrm{T_g},110.6^\circ\mathrm{C})} +\right.$$
$$\left. +\Delta\widehat{\mathrm{H}}_{(\mathrm{T_g},(110.6\to 50)^\circ\mathrm{C})}\right) = \left(0.5\,\left(62.55\,\Delta t + 0.5 * 23.4 * 10^{-2}\,\Delta\left(t^2\right)\right)\big|_{283}^{323} + 0.5\,\left(148.8\,\Delta t + 0.5 * 32.4 * 10^{-2}\,\Delta\left(t^2\right)\right)\big|_{283}^{323} + 35.21\,\% *\right.$$
$$* \left(0.684\left(\left(62.55\,\Delta t + 0.5 * 23.4 * 10^{-2}\,\Delta\left(t^2\right)\right)\big|_{323}^{353.1} + 30.765\,\mathrm{k} - \left(74.06\,\Delta t + (1/2) * 32.95 * 10^{-2}\,\Delta\left(t^2\right) - (1/3) * 25.2 * 10^{-5}\,\Delta\left(t^3\right)\ +\right.\right.\right.$$
$$\left.\left.\left. +(1/4) * 77.57 * 10^{-9}\,\Delta\left(t^4\right)\right)\big|_{323}^{353.1}\right) + 0.4\left(\left(148.8\,\Delta t + 0.5 * 32.4 * 10^{-2}\,\Delta\left(t^2\right)\right)\big|_{323}^{383.6} + 37.47\,\mathrm{k} - \left(94.18\,\Delta t + (1/2) * 38.0 * 10^{-2}\,\Delta\left(t^2\right)\ +\right.\right.\right.$$
$$\left.\left.\left.\left. -(1/3) * 27.86 * 10^{-5}\,\Delta\left(t^3\right) + (1/4) * 80.33 * 10^{-9}\,\Delta\left(t^4\right)\right)\big|_{323}^{383.6}\right)\right)\right)\,\mathrm{kJ\,mol^{-1}} \cong 20.76\,\mathrm{MJ\,mol^{-1}}$$

(i) $\quad \widehat{\mathrm{M}}_{o1} \cong 35.21\,\%\mathrm{mol/mol}$

$$= \widehat{\mathrm{M}}_i - \widehat{\mathrm{M}}_{o2} = \frac{1}{[\mathrm{B}]_{o1}}\left([\mathrm{B}]_i\,\widehat{\mathrm{M}}_i - [\mathrm{B}]_{o2}\,\widehat{\mathrm{M}}_{o2}\right) \implies$$
$$\implies \widehat{\mathrm{M}}_{o1} = 1 - \frac{[\mathrm{B}]_{o1} - [\mathrm{B}]_i}{[\mathrm{B}]_{o1} - [\mathrm{B}]_{o2}} = \left(1 - \frac{0.684 - 0.5}{0.684 - 0.4}\right)\frac{\mathrm{mol}}{\mathrm{mol}} \cong$$
$$\cong 35.21\,\%\mathrm{mol/mol}$$