

Zadatak 1

Za sastav kolubarskog lignita:

* Maseni udeo vlage u radnom gorivu (%) 47.80

* Maseni udeo ugljenika (%) 20.90

* Maseni udeo vodonika (%) 2.05

* Maseni udeo azota (%) 0.40

* Maseni udeo sagorljivog sumpora (%) 0.19

* Maseni udeo kiseonika (%) 9.4

* Maseni udeo pepela (%) 19.00

i višak vazduha 1.4 odrediti maseni i zapreminski udeo CO₂ i SO₂ u dimnim gasovima i ukupnu godišnju emisiju ovih gasova [u kg] pri godišnjem radu od 6500 h jednog bloka TENT B snage 620 MWe. Stepenn korisnosti elektrane je 0,33, temperatura dimnih gasova na ulazu u dimnjak 170 °C, toplotna moć goriva 7500 kJ/kg. Odrediti i zapreminski protok dimnih gasova na ulazu u dimnjak.

$$\frac{W^r}{100}=0,478, \frac{C^r}{100}=0,209, \frac{H^r}{100}=0,0205, \frac{N^r}{100}=0,004, \frac{S_g^r}{100}=0,019, \frac{O^r}{100}=0,094, \frac{A^r}{100}=0,19, \alpha=1,4,$$

$$P=620 \text{ MWe}, \tau=6500 \text{ h}, \eta=0,33, Hd=7500 \text{ kJ/g}, t_{dg}=170^\circ\text{C}$$

$$g_{CO_2}=? , g_{SO_2}=? , r_{CO_2}=? , r_{SO_2}=? , m_{CO_2}=? , m_{SO_2}=?$$

$$r_{CO_2}=\frac{V_{CO_2}}{V_{dg}}, r_{SO_2}=\frac{V_{SO_2}}{V_{dg}}, g_{CO_2}=r_{CO_2}\frac{M_{CO_2}}{M_{dg}}=\frac{m_{CO_2}}{m_{dg}}, g_{SO_2}=r_{SO_2}\frac{M_{SO_2}}{M_{dg}}=\frac{m_{SO_2}}{m_{dg}}, m_{CO_2}=g_{CO_2}m_{dg}, m_{SO_2}=g_{SO_2}m_{dg}$$

$$V_{dg}=V_{CO_2}+V_{SO_2}+V_{N_2}^0+V_{H_2O}+(\alpha-1)\cdot V^0 \text{ m}^3/\text{kg}$$

$$V_{CO_2}=1,867\frac{C^r}{100}=1,867\cdot 0,209=0,39 \text{ m}^3/\text{kg}$$

$$V_{SO_2}=0,7\frac{S_g^r}{100}=0,7\cdot 0,019=0,00133 \text{ m}^3/\text{kg}$$

$$V^0=0,089C^r+0,033S_g^r+0,266H^r-0,033O^r=0,089\cdot 20,9+0,033\cdot 0,19+0,266\cdot 2,05-0,033\cdot 9,4=2,1 \text{ m}^3/\text{kg}$$

$$V_{N_2}^0=0,79\cdot V^0+0,8\frac{N^r}{100}=0,79\cdot 2,1+0,8\cdot 0,04=1,6622 \text{ m}^3/\text{kg}$$

$$V_{H_2O}^0=0,111H^r+0,0124W^r+0,0161V^0=0,111\cdot 2,05+0,0124\cdot 47,80+0,0161\cdot 2,1=0,8541 \text{ m}^3/\text{kg}$$

$$V_{H_2O}=V_{H_2O}^0+0,0161(\alpha-1)V^0=0,8541+0,0161\cdot (1,4-1)\cdot 2,1=0,8676 \text{ m}^3/\text{kg}$$

$$V_{dg}=V_{CO_2}+V_{SO_2}+V_{N_2}^0+V_{H_2O}+(\alpha-1)\cdot V^0=0,39+0,00133+1,6622+0,8676+(1,4-1)\cdot 2,1=3,761 \text{ m}^3/\text{kg}$$

$$r_{CO_2}=\frac{V_{CO_2}}{V_{dg}}=\frac{0,39}{3,761}=0,1037, r_{SO_2}=\frac{V_{SO_2}}{V_{dg}}=\frac{0,00133}{3,761}=0,00035$$

$$g_{CO_2}=r_{CO_2}\cdot \frac{M_{CO_2}}{M_{dg}}, g_{SO_2}=r_{SO_2}\cdot \frac{M_{SO_2}}{M_{dg}}$$

$$M_{dg}=r_{CO_2}\cdot 44+r_{SO_2}\cdot 64,07+r_{H_2O}\cdot 18+r_{N_2}\cdot 28+r_{O_2}\cdot 32$$

$$r_{H_2O}=\frac{V_{H_2O}}{V_{dg}}=\frac{0,8676}{3,761}=0,2307, r_{N_2}=\frac{V_{N_2}}{V_{dg}}=\frac{V_{N_2}^0+0,79\cdot (\alpha-1)\cdot V^0}{V_{dg}}=\frac{1,6622+0,79\cdot (1,4-1)\cdot 2,1}{3,761}=0,6184,$$

$$r_{O_2}=\frac{V_{O_2}}{V_{dg}}=\frac{0,21\cdot (\alpha-1)\cdot V^0}{V_{dg}}=\frac{0,21\cdot (1,4-1)\cdot 2,1}{3,761}=0,0469$$

$$M_{dg}=0,1037\cdot 44+0,00035\cdot 64,07+0,2307\cdot 18+0,6187\cdot 28+0,0469\cdot 32=27,557 \text{ kg/kmol}$$

$$g_{\text{CO}_2} = 0,1037 \cdot \frac{44}{27,557} = 0,1656,$$

$$g_{\text{SO}_2} = 0,00035 \cdot \frac{64,07}{27,557} = 0,000814$$

$$m_{\text{dg}} = ?$$

$$\dot{m}_{\text{dg}} = (1,0 - \frac{A^r}{100} + 1,306 \cdot \alpha \cdot V^0) \cdot \dot{m}_{\text{gor}}$$

$$m_{\text{dg}} = \dot{m}_{\text{dg}} \cdot \tau$$

$$\eta = \frac{P}{\dot{m}_{\text{gor}} H d}$$

$$\dot{m}_{\text{gor}} = \frac{P}{\eta H d} = \frac{620 \cdot 10^3}{0,33 \cdot 7500} = 250,51 \text{ kg/s}$$

$$\dot{m}_{\text{dg}} = (1,0 - 0,19 + 1,306 \cdot 1,4 \cdot 2,1) \cdot 250,51 = 1164,78 \text{ kg/s}$$

$$m_{\text{dg}} = 1164,78 \cdot 6500 \cdot 3600 = 2,726 \cdot 10^{10} \text{ kg/god}$$

$$m_{\text{CO}_2} = g_{\text{CO}_2} m_{\text{dg}} = 0,1656 \cdot 2,726 \cdot 10^{10} = 4,514 \cdot 10^9 \text{ kg/god},$$

$$m_{\text{SO}_2} = g_{\text{SO}_2} m_{\text{dg}} = 0,000814 \cdot 2,726 \cdot 10^{10} = 2,219 \cdot 10^7 \text{ kg/god}.$$

$$\dot{V}_{\text{dg ul.dim.}} = \dot{V}_{\text{dg}}^t = \frac{\dot{m}_{\text{dg}}}{\rho_{\text{dg}}^t}$$

$$pV = nRT = \frac{m}{M} RT, \rho = \frac{m}{V} \rightarrow \rho = \frac{pM}{RT}$$

$$p = 1 \text{ bar}, R = 8,314 \frac{\text{J}}{\text{molK}}$$

$$\rho_{\text{dg}}^t = \frac{pM_{\text{dg}}}{RT_{\text{dg}}} = \frac{10^5 \cdot 27,557 \cdot 10^{-3}}{8,314 \cdot (170 + 273,15)} = 0,748 \frac{\text{kg}}{\text{m}^3}$$

$$\dot{V}_{\text{dg}}^t = \frac{\dot{m}_{\text{dg}}}{\rho_{\text{dg}}^t} = \frac{1164,78}{0,748} = 1557,19 \frac{\text{m}^3}{\text{s}}$$