

10. ZADATAK

Izračunati gustoću smjese etena (1) i kisika (2) sastava $y_1=0,254$ pri temperaturi od 25 °C i tlaku od 100 atm, uz pretpostavku da se plinska smjesa pri tim uvjetima vlada prema korigiranoj općoj plinskoj jednadžbi stanja. Faktor kompresibilnosti promatrati kao dvoparametarsku veličinu, $z_M=f(p_{rM}, T_{rM})$

- a) Faktor kompresibilnosti računati kao aditivno svojstvo s obzirom na sastav plinske smjese
- b) Faktor kompresibilnosti računati na temelju prethodno izračunatih pseudokritičnih parametara u skladu s Prausnitz-Gunnovim pravilom

Podaci:

	T_K/K	p_K/atm	$v_K/(cm^3 mol^{-1})$	z_K	$M/(g mol^{-1})$
eten(1)	282,9	50,8	130,4	0,280	28,054
kisik(2)	154,8	49,7	73,4	0,288	31,999

Zadatak a):

ETEN (1) – KISIĆ (2)

$$T = 25\text{ °C} = 298,15\text{ K}$$

$$p = 100\text{ atm}$$

$$y_1 = 0,254$$

Aditivni faktor kompresibilnosti:

$$pv = zRT$$

$$z_M = \sum y_i z_i$$

Reducirani parametri

$$p_{r1} = \frac{p}{p_{K1}} = \frac{100}{50,8} = 1,97$$

$$p_{r2} = \frac{p}{p_{K2}} = \frac{100}{49,7} = 2,01$$

$$T_{r1} = \frac{T}{T_{K1}} = \frac{298,15}{282,9} = 1,05$$

$$T_{r2} = \frac{T}{T_{K2}} = \frac{298,15}{154,8} = 1,93$$

Očitavanje z_i :

- Grafički prikaz $z=f(p_r, T_r)$
- Tablični prikaz: Lee-Kesler (tablica $z^{(0)}=f(p_r, T_r)$) interpolacija?

Grafički prikaz $z=f(p_r, T_r)$

$$z_1 = 0,34 \quad z_2 = 0,955$$

$$z_M = \sum y_i z_i = 0,254 \cdot 0,34 + (1 - 0,254) \cdot 0,955 = 0,80$$

$$v = \frac{z_M RT}{p} = \frac{0,80 \cdot 8,314 \cdot 298,15}{100 \cdot 101325} = 1,957 \cdot 10^{-4} \text{ m}^3 \text{ mol}^{-1}$$

$$\bar{M} = \sum y_i M_i = 0,254 \cdot 28,054 + (1 - 0,254) \cdot 31,999$$

$$\bar{M} = 30,997 \text{ g mol}^{-1}$$

$$\rho = \frac{\bar{M}}{v} = \frac{30,997 \cdot 10^{-3}}{1,957 \cdot 10^{-4}} = 158,4 \text{ kg m}^{-3}$$

Tablični prikaz $z=f(p_r, T_r)$

$$p_{r1} = 1,97 \Big|_{1,500}^{2,000} \quad p_{r2} = 2,01 \approx 2,00$$

$$T_{r1} = 1,05 \quad T_{r2} = 1,93 \Big|_{1,9}^{2,0}$$

$$z(p_{r1} = 1,97) = 0,3131 + \frac{0,3452 - 0,3131}{2,000 - 1,500} (1,97 - 1,500)$$

$$z(p_{r1} = 1,97) = 0,3433$$

$$z(T_{r2} = 1,93) = 0,9456 + \frac{0,9599 - 0,9456}{2,00 - 1,90} (1,93 - 1,90)$$

$$z(T_{r2} = 1,93) = 0,9499$$

$$z_M = \sum y_i z_i = 0,254 \cdot 0,3433 + (1 - 0,254) \cdot 0,9499 = 0,7958$$

$$v = \frac{z_M RT}{p} = \frac{0,7958 \cdot 8,314 \cdot 298,15}{100 \cdot 101325} = 1,9468 \cdot 10^{-4} \text{ m}^3 \text{ mol}^{-1}$$

$$\bar{M} = \sum y_i M_i = 0,254 \cdot 28,054 + (1 - 0,254) \cdot 31,999$$

$$\bar{M} = 30,997 \text{ g mol}^{-1}$$

$$\rho = \frac{\bar{M}}{v} = \frac{30,997 \cdot 10^{-3}}{1,9468 \cdot 10^{-4}} = 159,2 \text{ kg m}^{-3}$$

Zadatok b):

ETEN (1) – KISIK (2)

$$T = 25\text{ °C} = 298,15\text{ K}$$

$$p = 100\text{ atm}$$

$$y_1 = 0,254$$

Prausnitz i Gunn (1958)

$$v_{\text{KM}} = \sum y_i v_{\text{Ki}}$$

$$T_{\text{KM}} = \sum y_i T_{\text{Ki}}$$

$$z_{\text{KM}} = \sum y_i z_{\text{Ki}}$$

$$p_{\text{KM}} = \frac{z_{\text{KM}} R T_{\text{KM}}}{v_{\text{KM}}}$$

$$v_{\text{KM}} = 0,254 \cdot 130,4 + (1 - 0,254) \cdot 73,4 = 87,878\text{ cm}^3\text{mol}^{-1}$$

$$T_{\text{KM}} = 0,254 \cdot 282,9 + (1 - 0,254) \cdot 154,8 = 187,33\text{ K}$$

$$z_{\text{KM}} = 0,254 \cdot 0,280 + (1 - 0,254) \cdot 0,288 = 0,286$$

$$p_{\text{KM}} = \frac{0,286 \cdot 8,314 \cdot 187,33}{87,878 \cdot 10^{-6}} = 5,068162\text{ MPa}$$

Očitavanje z_i :

- Grafički prikaz $z=f(p_r, T_r)$
- Tablični prikaz: Lee-Kesler (tablica $z^{(0)}=f(p_r, T_r)$) interpolacija?

$$p_{rM} = \frac{p}{p_{KM}} = \frac{100 \cdot 101325}{5,068162 \cdot 10^6} \approx 2,00$$

$$T_{rM} = \frac{T}{T_{KM}} = \frac{298,15}{187,33} = 1,5917 \approx 1,6$$

Grafički prikaz $z=f(p_r, T_r)$

$$z_M = 0,89$$

$$v = \frac{z_M RT}{p} = \frac{0,89 \cdot 8,314 \cdot 298,15}{100 \cdot 101325} = 2,1773 \cdot 10^{-4} \text{ m}^3 \text{ mol}^{-1}$$

$$\bar{M} = \sum y_i M_i = 0,254 \cdot 28,054 + (1 - 0,254) \cdot 31,999$$

$$\bar{M} = 30,997 \text{ g mol}^{-1}$$

$$\rho = \frac{\bar{M}}{v} = \frac{30,997 \cdot 10^{-3}}{2,1773 \cdot 10^{-4}} = 142,4 \text{ kg m}^{-3}$$

Tablični prikaz $z=f(p_r, T_r)$

$$z_M = 0,8738$$

$$v = \frac{z_M RT}{p} = \frac{0,8738 \cdot 8,314 \cdot 298,15}{100 \cdot 101325} = 2,128 \cdot 10^{-4} \text{ m}^3 \text{ mol}^{-1}$$

$$\bar{M} = \sum y_i M_i = 0,254 \cdot 28,054 + (1 - 0,254) \cdot 31,999$$

$$\bar{M} = 30,997 \text{ g mol}^{-1}$$

$$\rho = \frac{\bar{M}}{v} = \frac{30,997 \cdot 10^{-3}}{2,128 \cdot 10^{-4}} = 145,0 \text{ kg m}^{-3}$$