13. ZADATAK

Izračunati tlak pod kojim se nalazi jedan mol zraka približnog sastava y(dušik)=0,79 i y(kisik)=0,21 pri temperaturi od 298 K, uz pretpostavku da se zrak vlada prema Redlich-Kwongovom modelu. Molarni volumen zraka pri tim uvjetima iznosi $v=2{,}48\cdot10^{-2}$ m^3mol^{-1}.

Parametre plinske smjese računati primjenom pravila miješanja.

Termodinamički parametri čistih tvari:

	T_K/K	p_K/bar
dušik(1)	126,2	33,9
kisik(2)	154,6	50,4

REDLICH KWONG (1949)

Prva moderna jednadžba stanja trećeg stupnja

Prva moderna jednadžba stanja trećeg stupnja

Jednadžba

$$p = \frac{RT}{v-b} - \frac{a}{\sqrt{T}\,v\left(v+b\right)}$$

$$v^3 - \frac{RT}{p}v^2 - \left(b^2 + \frac{RTb}{p} - \frac{a}{p\sqrt{T}}\right)v - \frac{ab}{p\sqrt{T}} = 0$$

$$z^3 - z^2 - \left(\frac{b^2p^2}{R^2T^2} + \frac{pb}{RT} - \frac{ap}{R^2T^2\sqrt{T}}\right)z - \frac{abp^2}{R^3T^3\sqrt{T}} = 0$$

$$z^3 - z^2 + \left(A - B^2 - B\right)z - AB = 0$$

Parametri

$$a = \frac{\Omega_a R^2 T_{\mathrm{K}}^{5/2}}{p_{\mathrm{K}}} \qquad b = \frac{\Omega_b R T_{\mathrm{K}}}{p_{\mathrm{K}}}$$

$$\Omega_a = \frac{1}{9\left(2^{1/3}-1\right)} = 0{,}427480$$

$$\Omega_b = \frac{\left(2^{1/3}-1\right)}{3} = 0{,}086640$$

$$A = \frac{ap}{R^2T^{5/2}} = \frac{\Omega_a p_{\mathrm{r}}}{T_{\mathrm{r}}^{5/2}} \qquad B = \frac{bp}{RT} = \frac{\Omega_b p_{\mathrm{r}}}{T_{\mathrm{r}}}$$

SMJESE REALNIH PLINOVA

Pravila miješanja
Redlich-Kwong

$$a = \sum_i \sum_j y_i y_j a_{ij}$$

$$b = \sum_i y_i b_i$$

$$A = \sum_i \sum_j y_i y_j A_{ij}$$

$$B = \sum_i y_i B_i$$

Dvokomponentne smjese

$$a_{\mathrm{M}} = a_{11} y_1^2 + a_{12} y_1 y_2 + a_{21} y_2 y_1 + a_{22} y_2^2 =$$

$$= a_1 y_1^2 + 2 a_{12} y_1 y_2 + a_2 y_2^2$$

$a_{11} = a_1$ $\qquad$ $a_{22} = a_2$ $\qquad$ $a_{12} = a_{21}$

$$b = b_1 y_1 + b_2 y_2$$

Zadatak:

DUŠIK(1) – KISIK(2)

$T = 298\ \mathrm{K}$

$v = 2,48 \cdot 10^{-2}\ \mathrm{m^3 mol^{-1}}$

$y_1 = 0,79$

Parametri *a* i *b* pojedinačnih fluida

$$a_1 = \frac{\Omega_a R^2 T_{\mathrm{K1}}^{2,5}}{p_{\mathrm{K1}}} = \frac{0,42748 \cdot 8,314^2 \cdot 126,2^{2,5}}{33,9 \cdot 10^5} = 1,5595$$

$$b_1 = \frac{\Omega_b R T_{\mathrm{K1}}}{p_{\mathrm{K1}}} = \frac{0,08664 \cdot 8,314 \cdot 126,2}{33,9 \cdot 10^5} = 2,6816 \cdot 10^{-5}$$

$$a_2 = \frac{\Omega_a R^2 T_{\mathrm{K2}}^{2,5}}{p_{\mathrm{K2}}} = \frac{0,42748 \cdot 8,314^2 \cdot 154,6^{2,5}}{50,4 \cdot 10^5} = 1,7423$$

$$b_2 = \frac{\Omega_b R T_{\mathrm{K2}}}{p_{\mathrm{K2}}} = \frac{0,08664 \cdot 8,314 \cdot 154,6}{50,4 \cdot 10^5} = 2,2096 \cdot 10^{-5}$$

Pravila miješanja

$$a_{12} = \sqrt{a_1 a_2} =$$

$$= \sqrt{1,5595 \cdot 1,7423} = 1,6484$$

$$a_{\mathrm{M}} = \sum_i \sum_j y_i y_j a_{ij} =$$

$$= y_1^2 a_{11} + 2 y_1 y_2 a_{12} + y_2^2 a_{22} =$$

$$= 0,79^2 \cdot 1,5595 + 2 \cdot 0,79 \cdot 0,21 \cdot 1,6484 + 0,5^2 \cdot 1,7423 =$$

$$= 1,5971$$

$$b_{\mathrm{M}} = \sum_i y_i b_i =$$

$$= y_1 b_1 + y_2 b_2 = 0,79 \cdot 2,6816 \cdot 10^{-5} + 0,21 \cdot 2,2096 \cdot 10^{-5} =$$

$$= 2,5825 \cdot 10^{-5}$$

Tlak

$$p = \frac{RT}{v - b_{\mathrm{M}}} - \frac{a_{\mathrm{M}}}{\sqrt{T}\, v \left(v + b_{\mathrm{M}} \right)}$$

$$p = \frac{8,314 \cdot 298}{2,48 \cdot 10^{-2} - 2,5825 \cdot 10^{-5}} -$$

$$- \frac{1,5971}{\sqrt{298} \cdot 2,48 \cdot 10^{-2} \left(2,48 \cdot 10^{-2} + 2,5825 \cdot 10^{-5} \right)}$$

$$p = 100006,24 - 150,58$$

$$p = 99855,66 \text{ Pa}$$