5. ZADATAK

Izračunati temperaturu pri kojoj se nalazi 2 kg kisika u spremniku volumena 0,01 m^3, pod tlakom od 10,0 MPa. Pretpostaviti da se kisik pri tim uvjetima vlada prema:

a) korigiranoj općoj plinskoj jednadžbi stanja
b) Redlich-Kwongovoj jednadžbi stanja (primijeniti postupak direktne iteracije)

Podaci:

T_K=154,8 K; p_K=5,08 MPa

Zadatak:

$$m\left(\mathrm{O}_2\right) = 2\ \mathrm{kg}$$

$$p = 10,0\ \mathrm{MPa} = 10^7\ \mathrm{Pa}$$

$$V = 0,01\ \mathrm{m}^3$$

$$n = \frac{m}{M} = \frac{2}{32 \cdot 10^{-3}} = 62,5\ \mathrm{mol}$$

$$v = \frac{V}{n} = \frac{0,01}{62,5} = 1,6 \cdot 10^{-4}\ \mathrm{m^3 mol^{-1}}$$

$$p_\mathrm{r} = \frac{p}{p_\mathrm{K}} = \frac{10^7}{5,08 \cdot 10^6} = 1,9685$$

zpT-dijagram

Metoda pokušaja i pogreške

Usporedba računskih i grafičkih rezultata:

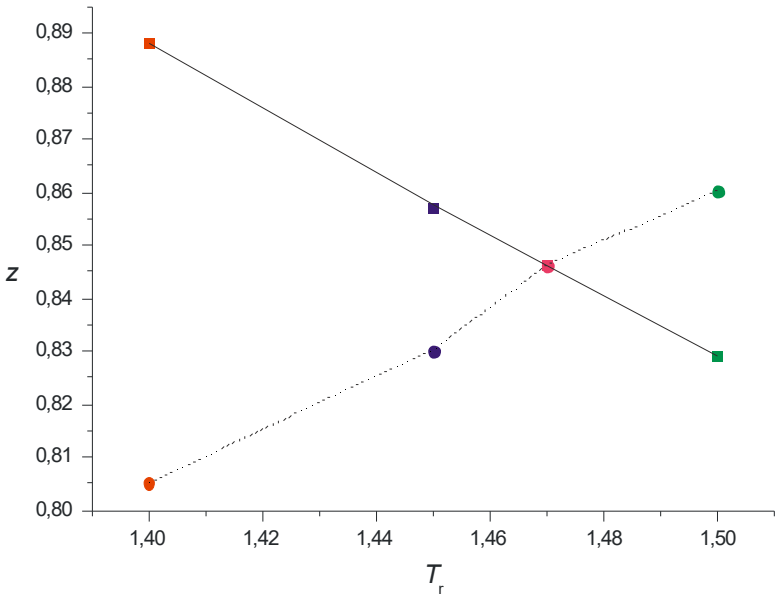
Računski:

$$pv = zRT \qquad T_r = \frac{T}{T_K}$$

$$z = \frac{pv}{RT}$$

$$z = \frac{pv}{RT_K T_r} = \frac{10^7 \cdot 1,6 \cdot 10^{-4}}{8,314 \cdot 154,8 \cdot T_r} = \frac{1,2432}{T_r}$$

T_r	1,4	1,5	1,45	1,47
$z_{\text{računski}}$	0,888	0,829	0,857	0,846
z_{dijagram}	0,805	0,86	0,83	0,846



Temperatura:

$$T = T_{\mathrm{r}} T_{\mathrm{K}} = 1,47 \cdot 154,8 = 227,56 \ \mathrm{K}$$

Zadatak:

$$m\left(\mathrm{O}_2\right) = 2\ \mathrm{kg}$$

$$p = 10,0\ \mathrm{MPa} = 10^7\ \mathrm{Pa}$$

$$V = 0,01\ \mathrm{m}^3$$

$$n = \frac{m}{M} = \frac{2}{32 \cdot 10^{-3}} = 62,5\ \mathrm{mol}$$

$$v = \frac{V}{n} = \frac{0,01}{62,5} = 1,6 \cdot 10^{-4}\ \mathrm{m^3 mol^{-1}}$$

Izravna (direktna) iteracija

Jednadžba stanja trećeg stupnja
REDLICH KWONG

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

Parametri:

$$a = \frac{\Omega_a R^2 T_{\mathrm{K}}^{5/2}}{p_{\mathrm{K}}} = \frac{0,427480 \cdot 8,314^2 \cdot 154,8^{2,5}}{5,08 \cdot 10^6} = 1,734$$

$$b = \frac{\Omega_b R T_{\mathrm{K}}}{p_{\mathrm{K}}} = \frac{0,086640 \cdot 8,314 \cdot 154,8}{5,08 \cdot 10^6} = 2,195 \cdot 10^{-5}$$

Nije eksplicitna po temperaturi!

$$T = f\left(T\right)$$

$$T^{(i+1)} = f\left(T^{(i)}\right)$$

$$T^{(i+1)} = \frac{v-b}{R}\left[p + \frac{a}{\sqrt{T^{(i)}}\,v\left(v+b\right)}\right]$$

Prva aproksimacija – idealni plin:

$$T_0 = \frac{pv}{R} = \frac{10^7 \cdot 1,6 \cdot 10^{-4}}{8,314} = 192,45\ \mathrm{K}$$

$$T_1 = \frac{1,6\cdot 10^{-4} - 2,195\cdot 10^{-5}}{8,314}\left[10^7 + \frac{1,734}{\sqrt{192,45}\cdot 1,6\cdot 10^{-4}\left(1,6\cdot 10^{-4} + 2,195\cdot 10^{-5}\right)}\right]$$

$$T_1 = 1,66\cdot 10^{-5}\left[10^7 + \frac{59563066,78}{\sqrt{192,45}}\right]$$

$$T_1 = 237,27\ \mathrm{K}$$

$$T_2 = 1,66\cdot 10^{-5}\left[10^7 + \frac{59563066,78}{\sqrt{237,27}}\right]$$

$$T_2 = 230,19\ \mathrm{K}$$

$$T_3 = 231,17\ \mathrm{K}$$

$$T_4 = 231,03\ \mathrm{K}$$

$$T_5 = 231,05\ \mathrm{K}$$

Iteracijska formula za SRK

$$\kappa = 0,48508 + 1,55171\omega - 0,15613\omega^2$$

$$\alpha = \left[1 + \kappa\left(1 - \sqrt{\frac{T^{(i)}}{T_\mathrm{K}}}\right)\right]^2$$

$$T^{(i+1)} = \frac{v-b}{R}\left[p + \frac{a\alpha}{v\left(v+b\right)}\right]$$

Iteracijska formula za PR

$$\kappa = 0,37464 + 1,54226\omega - 0,26992\omega^2$$

$$\alpha = \left[1 + \kappa\left(1 - \sqrt{\frac{T^{(i)}}{T_{\mathrm{K}}}}\right)\right]^2$$

$$T^{(i+1)} = \frac{v-b}{R}\left[p + \frac{a\alpha}{v^2 + 2bv - b^2}\right]$$