

## **5. ZADATAK**

Izračunati temperaturu pri kojoj se nalazi 2 kg kisika u spremniku volumena  $0,01 \text{ m}^3$ , 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:

$$T_K = 154,8 \text{ K}; \quad p_K = 5,08 \text{ MPa}$$

Zadatok:

$$m(\text{O}_2) = 2 \text{ kg}$$

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

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

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

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

$$p_r = \frac{p}{p_K} = \frac{10^7}{5,08 \cdot 10^6} = 1,9685$$

## **$zpT$ -dijagram**

### Metoda pokušaja i pogreške

Usporedba računskih i grafičkih rezultata:

Računski:

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

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

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

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

Temperatura:

$$T = T_r T_K = 1,47 \cdot 154,8 = 227,56 \text{ K}$$

Zadatok:

$$m(\text{O}_2) = 2 \text{ kg}$$

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

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

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

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## Izravna (direktna) iteracija

Jednadžba stanja trećeg stupnja  
REDLICH KWONG

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

Parametri:

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

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

Nije eksplicitna po temperaturi!

$$T = f(T)$$

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

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

Prva aproksimacija – idealni plin:

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

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

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

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

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

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

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

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

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

Iteracijska formula za SRK

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

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

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

Iteracijska formula za PR

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

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

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