

4. ZADATAK

Izračunati tlak pod kojim se nalazi 1000 g vode u spremniku volumena 16 dm^3 pri temperaturi od $343 \text{ }^\circ\text{C}$, uz pretpostavku da se voda pri tim uvjetima vlada prema korigiranoj općoj plinskoj jednadžbi stanja. Faktor kompresibilnosti računati kao troparametarsku veličinu (Lee-Kesler)

Podaci:

$$T_K=647 \text{ K}; \quad p_K=218,3 \text{ atm}; \quad \omega=0,344$$

Zadatok:

$$T = 343\text{ }^{\circ}\text{C} = 616,15\text{ K}$$

$$V = 16\text{ dm}^3 = 16 \cdot 10^{-3}\text{ m}^3$$

$$n = \frac{m}{M} = \frac{1}{18 \cdot 10^{-3}} = 55,556\text{ mol}$$

$$v = \frac{V}{n} = \frac{16 \cdot 10^{-3}}{55,556} = 2,88 \cdot 10^{-4}\text{ m}^3\text{mol}^{-1}$$

$$z = f(p_r, T_r, \omega)$$

$$T_r = \frac{T}{T_K} = \frac{616,15}{647} = 0,9523 \Big|_{0,95}^{0,97}$$

Tlak se računa iterativno

$$p_0 = \frac{RT}{v} = \frac{8,314 \cdot 616,15}{2,88 \cdot 10^{-4}} = 17787052,43\text{ Pa}$$

$$p_0 = 175,54\text{ atm}$$

$$p_{0r} = \frac{p_0}{p_K} = \frac{175,54}{218,3} = 0,8041 \Big|_{0,800}^{1,000}$$

Lee-Keslerove tablice

$$y = y_1 + \frac{y_2 - y_1}{x_2 - x_1} (x - x_1) \quad \text{Linearna interpolacija}$$

$$z^{(0)}(0,95) = 0,1410 + \frac{0,1705 - 0,1410}{1,000 - 0,800} (0,8041 - 0,800)$$

$$z^{(0)}(0,95) = 0,1416$$

$$z^{(0)}(0,97) = 0,5580 + (0,1779 - 0,5580) \mathbf{0,0205}$$

$$z^{(0)}(0,97) = 0,5502$$

$$z^{(0)}(0,9523) = 0,1416 + \frac{0,5502 - 0,1416}{0,97 - 0,95} (0,9523 - 0,95)$$

$$z^{(0)}(0,9523) = 0,1886$$

$$z^{(1)}(0,95) = -0,0540 + \mathbf{0,0205} (-0,0607 + 0,054)$$

$$z^{(1)}(0,95) = -0,0541$$

$$z^{(1)}(0,97) = -0,1647 + \mathbf{0,0205} (-0,0623 + 0,1647)$$

$$z^{(1)}(0,97) = -0,1626$$

$$z^{(1)}(0,9523) = -0,0541 + \frac{-0,1626 + 0,0541}{0,97 - 0,95} (0,9523 - 0,95)$$

$$z^{(1)}(0,9523) = -0,0666$$

$$\begin{aligned}
 z_1 &= z^{(0)}(T_r, p_r) + \omega z^{(1)}(T_r, p_r) = \\
 &= 0,1886 + 0,344 \cdot (-0,0666) = \\
 &= 0,1657
 \end{aligned}$$

$$p_1 = \frac{z_1 RT}{v} = \frac{0,1657 \cdot 8,314 \cdot 616,15}{2,88 \cdot 10^{-4}} = 2,94731 \text{ MPa}$$

$$p_1 = 29,09 \text{ atm}$$

Velika razlika tlakova, velika razlika z

Iteracija između pare i kapljevine

Spora konvergencija

$$p_{1r} = \frac{p_1}{p_K} = \frac{29,09}{218,3} = 0,133247 \Big|_{0,100}^{0,200}$$

$$z^{(0)}(0,9523) = 0,9463$$

$$z^{(1)}(0,9523) = -0,0167$$

$$\begin{aligned}
 z_2 &= z^{(0)}(T_r, p_r) + \omega z^{(1)}(T_r, p_r) = \\
 &= 0,9463 + 0,344 \cdot (-0,0167) = \\
 &= 0,9405
 \end{aligned}$$

$$p_2 = \frac{z_2 RT}{v} = \frac{0,9405 \cdot 8,314 \cdot 616,15}{2,88 \cdot 10^{-4}} = 16,72 \text{ MPa}$$

$$p_2 = 165,1 \text{ atm}$$

$$p_{2r} = \frac{p_2}{p_K} = \frac{165,1}{218,3} = 0,7563 \Big|_{0,600}^{0,800}$$

$$z_8 = 0,7030$$

$$p_8 = \frac{z_8 RT}{v} = \frac{0,7030 \cdot 8,314 \cdot 616,15}{2,88 \cdot 10^{-4}} = 12,46 \text{ MPa}$$

$$p_8 = 122,97 \text{ atm}$$