

9. ZADATAK

Izračunati fugacitivnost amonijaka pri temperaturi od 200 °C i tlakovima od a) 100 atm; b) 400 atm, na temelju izraza:

$$\ln f = \ln p - \frac{1}{RT} \int_0^p \alpha dp$$

Integral riješiti grafički na temelju mjernih podataka navedenih u tablici. Površinu odrediti primjenom trapezne jednačbe. Ordinatu $p \rightarrow 0$ odrediti linearnom ekstrapolacijom.

Podaci:

p/atm	20	60	100	150	200	250	300	400
$v/\text{cm}^3 \text{mol}^{-1}$	1866	570,8	310,9	176,7	107,4	74,2	59,6	47,7

Približna metoda:

(iz 6. zadatka)

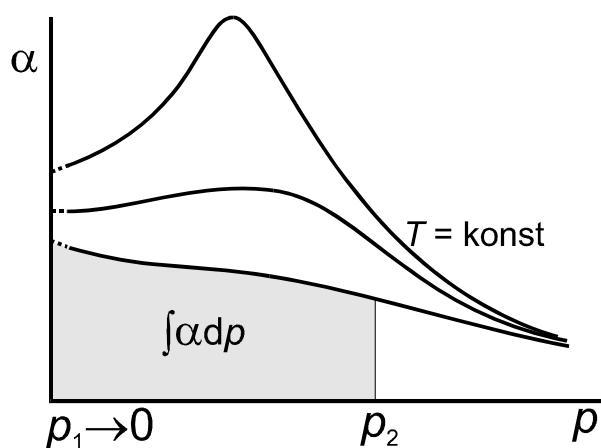
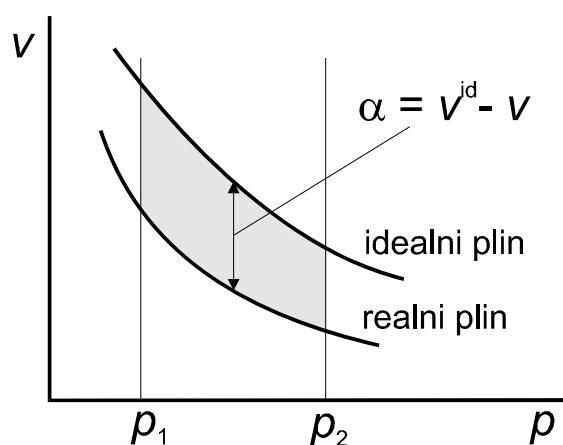
$$RTd \ln f = vdp$$

$$RT \ln \varphi = - \int_0^p \alpha dp$$

$$\ln f = \ln p - \frac{1}{RT} \int_0^p \alpha dp$$

Definicija odstupanja

$$\alpha = v^{\text{id}} - v = \frac{RT}{p} - v = \frac{RT}{p} (1 - z)$$



Zadatok:

$$T = 200 \text{ } ^\circ\text{C}$$

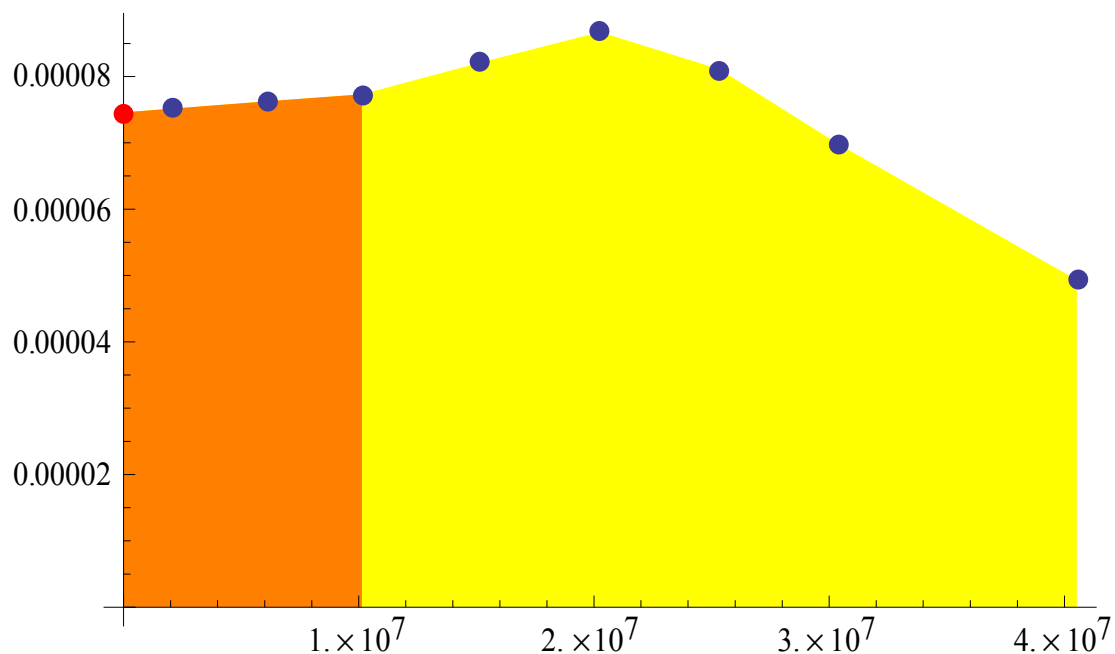
$$p = 100 \text{ atm (400 atm)}$$

p/atm	20	60	100	150	200	250	300	400
$v/\text{cm}^3\text{mol}^{-1}$	1866	570,8	310,9	176,7	107,4	74,2	59,6	47,7

$$v^{\text{id}} = \frac{RT}{p} = \frac{8,314 \cdot (200 + 273,15)}{20 \cdot 101325} = 1,94116 \cdot 10^{-3} \text{ m}^3\text{mol}^{-1}$$

$$\alpha = v^{\text{id}} - v = 1,94116 \cdot 10^{-3} - 1,866 \cdot 10^{-3} = 7,51641 \cdot 10^{-5} \text{ m}^3\text{mol}^{-1}$$

$v^{\text{id}}/\text{cm}^3\text{mol}^{-1}$	1941,16	647,055	388,233	258,822	194,116	155,293	129,411	97,0582
$\alpha/\text{cm}^3\text{mol}^{-1}$	75,1641	76,2547	77,3328	82,1219	86,7164	81,0931	69,8109	49,3582



Linearna ekstrapolacija

$$\alpha(p=0) = 75,1641 \cdot 10^{-6} + \frac{(76,2547 - 75,1641) \cdot 10^{-6}}{(60 - 20) \cdot 101325} (0 - 20) \cdot 101325$$

$$\alpha(p=0) = 7,46188 \cdot 10^{-5} \text{ m}^3 \text{ mol}^{-1}$$

Trapezna formula:

$$A = (p_{i+1} - p_i) \frac{\alpha_i + \alpha_{i+1}}{2}$$

$$A_1 = (20 - 0) \cdot 101325 \frac{7,46188 \cdot 10^{-5} + 75,1641 \cdot 10^{-6}}{2}$$

$$A_1 = 151,768$$

$$A_2 = 306,85$$

$$A_3 = 311,245$$

$$A_4 = 403,919$$

$$A_5 = 427,689$$

$$A_6 = 425,083$$

$$A_7 = 382,259$$

$$A_8 = 603,741$$

a)

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

$$\int_0^{100 \text{ atm}} \alpha dp = 151,768 + 306,85 + 311,245 = 769,863$$

$$\ln f = \ln p - \frac{1}{RT} \int_0^p \alpha dp$$

$$f = \exp \left(\ln p - \frac{1}{RT} \int_0^p \alpha dp \right) =$$
$$= \exp \left(\ln (100 \cdot 101325) - \frac{769,863}{8,314 \cdot (200 + 273,15)} \right)$$

$$f = 8,33149 \text{ MPa}$$

$$\varphi = \frac{f}{p} = 0,822254$$

b)

$$p = 400 \text{ atm}$$

$$\int_0^{400 \text{ atm}} \alpha dp = 3012,55$$

$$\ln f = \ln p - \frac{1}{RT} \int_0^p \alpha dp$$

$$f = \exp \left(\ln p - \frac{1}{RT} \int_0^p \alpha dp \right) =$$
$$= \exp \left(\ln (400 \cdot 101325) - \frac{3012,55}{8,314 \cdot (200 + 273,15)} \right)$$

$$f = 18,8446 \text{ MPa}$$

$$\varphi = \frac{f}{p} = 0,464953$$