

Problem 16-06 Gas adsorption on solids – Freundlich isotherm

The adsorption of certain gas on silica which was studied at constant temperature of 52°C, is well described by Freundlich equation. Using the following results of two experiments

Equilibrium pressure	Adsorbed amount
$p_1 = 27.5 \text{ kPa}$	$a_1 = 3.1 \cdot 10^{-3} \text{ mol/g}_{\text{silica}}$
$p_2 = 52 \text{ kPa}$	$a_2 = 3.76 \cdot 10^{-3} \text{ mol/g}_{\text{silica}}$

calculate what amount of the studied gas (in grams) will be adsorbed on 56 g of silica at equilibrium pressure of 37 kPa.

$$[\Delta m = 16.34 \text{ g on 56 g silica } (1/n = 0.303, k = 1.136 \cdot 10^{-3}, a_3 = 3.3916 \cdot 10^{-3} \text{ g/g}_{\text{silica}})]$$

Solution:

$$a = k \cdot p^{1/n}$$

$$\ln a = \ln k + \frac{1}{n} \cdot \ln p$$

$$\frac{1}{n} = \frac{\ln \frac{a_2}{a_1}}{\ln \frac{p_2}{p_1}} = \frac{\ln \frac{3.76 \cdot 10^{-3}}{3.1 \cdot 10^{-3}}}{\ln \frac{52}{27.5}} = 0.303$$

$$k = \frac{a_1}{p_1^{1/n}} = \frac{3.1 \cdot 10^{-3}}{27.5^{0.303}} = 1.13565 \cdot 10^{-3}$$

$$a_3 = k \cdot p_3^{1/n} = 1.13565 \cdot 10^{-3} \cdot 37^{0.303} = 3.39164 \cdot 10^{-3} \text{ g}_{\text{gas}}/\text{g}_{\text{silica}}$$

$$\Delta n = 56 \cdot 3.39164 \cdot 10^{-3} = 0.1899318 = 0.19 \text{ mol of gas adsorbed on 56 g of the solid adsorbent}$$

$$\Delta m = \Delta n \cdot M = 86 \cdot 0.19 = 16.34 \text{ g of gas on 56 g of the solid adsorbent}$$