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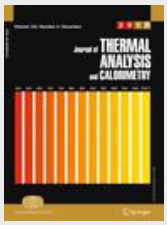

Microcalorimetric investigation of water vapor adsorption on silica gel

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摘要

Abstract
Water vapor adsorption on silica gel was investigated using Tian–Calvet-type microcalorimetry. Differential heat of adsorption data was obtained. The setup of microcalorimetry was used volumetric system to determine adsorption isotherms of water vapor–silica gel. The Langmuir model was used in the interpretation of the adsorption data. The Clausius–Clapeyron diagram was also given. Effective mass diffusivity of water vapor in the silica gel particle as a function of temperature was also determined. The silica gel, which was degassed under vacuum at 10^{-7} mbar and 120 °C for 18 h, was found to adsorb 0.6, 0.98, 1.1, 1.4, 2, 3.5, 11, 13, and 14 wt% water vapor at 120, 110, 100, 90, 75, 60, 40, 35, and 30 °C, respectively. The diffusivities of water vapor inside the silica gel for short- and long-range periods were described using kinetics data as a function of temperature in the Arrhenius form.

Keywords

Microcalorimetry, Diffusivity, Silica gel – water pair, Heat of adsorption

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1. Vieira, Eunice F. S. (2011) The use of freshwater fish scale of the species Leporinus elongatus as adsorbent for anionic dyes : An isothermal calorimetric study. *Journal of Thermal Analysis and Calorimetry* [CrossRef]

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Abstract Water vapor adsorption on silica gel was investigated using Tian–Calvet-type microcalorimetry. Differential heat of adsorption data was obtained. The setup of microcalorimetry was used volumetric system to determine adsorption isotherms of water vapor–silica gel. The Langmuir model was used in the interpretation of the adsorption data. The Clausius–Clapeyron diagram was also given. Effective mass diffusivity of water vapor in the silica gel particle as a function of temperature was also determined. The silica gel, which was degassed under vacuum at 10^{-7} mbar and 120 °C for 18 h, was found to adsorb 0.6, 0.98, 1.1, 1.4, 2, 3.5, 11, 13, and 14 wt% water vapor at 120, 110, 100, 90, 75, 60, 40, 35, and 30 °C, respectively. The diffusivities of water vapor inside the silica gel for short- and long-range periods were described using kinetics data as a function of temperature in the Arrhenius form.

Keywords Microcalorimetry · Diffusivity · Silica gel–water pair · Heat of adsorption

List of symbols

b	Langmuir constant
C_{∞}	Equilibrium concentration, kg m^{-3}
D_{eff}	Effective diffusivity, m^2 s^{-1}
D_0	Reference diffusivity, m^2 s^{-1}
ΔH_{fg}	Heat of vaporization, kJ kg$_w^{-1}$
ΔH^{in}	Integral heat of adsorption, kJ kg^{-1}
Δh^{in}	Differential heat of adsorption, kJ mol^{-1}
E	Diffusion activation energy, J mol^{-1}
n	Eigen value
n^a	Amount of adsorbate mol kg^{-1}
P	Pressure, kPa
r_p	Radius of adsorbent granule, m
R	Ideal gas constant, J mol^{-1} K^{-1}
t	Time, s
T	Temperature, K
W	Average adsorbate concentration, kg$_w$ kg$_s^{-1}$
W_m	Monolayer adsorption coverage, kg$_w$ kg$_s^{-1}$
$\bar{W}_i$	Average adsorption coverage at time t, kg$_w$ kg$_s^{-1}$
W_{∞}	Adsorbate concentration in equilibrium, kg$_W$ kg$_s^{-1}$

Introduction

The adsorption of an adsorptive on an adsorbent depends on several factors such as crystalline structure of the adsorbent, pore dimensions, porosity, surface energy, surface area, types of adsorbate, etc. The properties of adsorbent–adsorbate pair are important for some areas for such as adsorption heat pumps that provide heating and cooling by utilizing thermal energy sources such as solar energy, geothermal energy, peak electricity, and waste heat from industrial processes [1–4]. The properties of

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