Ellis Horwood Series in PHYSICAL CHEMISTRY

GAS CHROMATOGRAPHY IN ADSORPTION AND CATALYSIS

T. Paryjczak

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List of the More Important Symbols

a	— quantity of adsorbed substance
a_A, a_B	— quantity of adsorbed component A and B
a_m	— quantity of substance adsorbed in the monolayer — the monolayer capacity
a_{mg}	— quantity of poison required to cover the catalyst surface with a monolayer
A	— constant characterizing the eddy diffusion coefficient in the van Deemter equation
A_0	— activity of an unpoisoned catalyst
A_g	— activity of a poisoned catalyst
b_g	— adsorption coefficient of a poison at active sites
B	— constant characterizing the molecular diffusion coefficient in the van Deemter equation
B	— the distance between atomic centres or groups of atoms and the centre of surface atoms of graphite under equilibrium conditions
B_{11}	— second virial coefficient for the sorbate
B_{12}	— second virial coefficient of sorbate vapour (1) and carrier gas (2)
c	— concentration of adsorbate in the mobile phase
c_A^0, c_B^0	— initial concentrations of components A and B in the gaseous mixture
c_A, c_B	— concentrations of components A and B in the gaseous phase
c_x	— mole fraction of adsorbate in the carrier gas
c_s	— concentration of adsorbate in the adsorption layer

c_{av} — average concentration of adsorbate in the gaseous phase
c_g — resistance to mass transfer in the gaseous phase
c_k — expression characterizing the kinetics of adsorption
C — constant characterizing the resistance to mass transfer in the van Deemter equation
C — constant in the BET equation
C_k — constant C in the van Deemter equation after having taken the "wall" effect into account
d — density
d_p — average diameter of particles in the column packing
d_e — edge of metal crystallite
d_ε — dispersion of metal
D_g — molecular diffusion coefficient of adsorbate in the carrier gas
D_l — diffusion coefficient in the liquid phase
D_{ef} — effective diffusion coefficient
D_K — Knudsen diffusion coefficient
D_s — surface diffusion coefficient
E — activation energy
E_d — activation energy of desorption
E_p — porosity of column packing particles
E_{pack} — porosity of column packing
F_c — volumetric flow rate of carrier gas through the column
F_c^0 — volumetric flow rate of carrier gas corrected to normal conditions
F_m — volumetric flow rate of gas through the flow-meter
F_{cal} — volumetric flow rate of gas during calibration
F_{ads} — volumetric flow rate of adsorbate
F_{cx} — average volumetric flow rate of the mobile phase in the presence of adsorbate
G_0 — quantity of substance introduced into the reactor
$\Delta G^\ominus$ — change in the standard energy of a system during adsorption
$\bar{h}$ — Planck's constant
h — height measured (perpendicular to the time axis) from the baseline to a point on the chromatogram
H — height equivalent to a theoretical plate (HETP)
H_M — peak height at maximum c_g
$\Delta H^\ominus$ — change in the standard enthalpy during adsorption

j — pressure gradient correction factor
k — detector constant
$\bar{k}$ — Boltzmann constant
k_a — adsorption rate constant
k_d — desorption rate constant
k_n — rate constant for irreversible activated adsorption
k_f — coefficient of mass transfer from gas to particle surface
k_1, k_2 — rate constants of reactions
k_{ef} — effective rate constant of a reaction
k_{hom} — rate constant of a homogeneous reaction
$K, K_{a,p}, K_{a,c}$ — Henry's constant
K_0 — Henry's constant during the adsorption of a molecule not forming a complex on the surface of a solid
K_A, K_B, K_C — adsorption equilibrium constants
K_A^{ef} — effective Henry's constant for substrate A
K_v — volume partition coefficient
K_p — partition coefficient
K_s — adsorption coefficient at the solid-liquid partition boundary
K_L — adsorption coefficient at the liquid–gas partition boundary
K_{AB} — stability constant of a complex
l_0 — length of recorder tape from the instant of sample injection to the outflow of carrier gas
l_h — length of recorder tape from the instant of sample injection to the outflow of adsorbate at concentration c (to the appropriate deflection h)
L — length of column
m — mass of adsorbent or catalyst in the column
m_L — mass of a unit length of adsorbent layer
Δm_A — quantity of reacted substance A in the microreactor
m_g — quantity of poison introduced into the microreactor
m_{st} — mass of standard
Me_s — surface atoms of a metal which are available for chemisorption
M — molecular weight (relative molecular mass)
n — order of reaction
n_a — number of atoms or chemisorbed molecules on the surface of a metal

n_s — number of moles of adsorbate in the sample
n_L — number of moles of test substance in the liquid phase
n_g — number of moles of test substance in the gaseous phase
N — number of theoretical plates in the column
N_a — number of active sites
N_A — Avogadro's number
N_g — number of adsorbate molecules in the gas space of the column
N_0 — constant dependent on the number of active sites per unit of surface
N_L — number of moles of stationary liquid phase per unit of volume
N_t — number of adsorbed molecules
N_∞ — monolayer capacity
p — vapour pressure of adsorbate at the temperature of measurement
p_s — saturated vapour pressure of adsorbate at the temperature of measurement
p_i — column inlet pressure
p_o — column outlet pressure
p_c — mean column pressure
p_b — barometric pressure
p_m — gas pressure in the flow-meter
p_A, p_B — partial pressures of components A and B
p_{eq} — equilibrium pressure
q — cross-sectional area of the column
q_{st} — isosteric heat of adsorption
$q_{st\,A}$ — isosteric heat of adsorption of substance A
q_{int} — integral heat of adsorption
q_d — differential heat of adsorption
q_0 — differential heat of adsorption at zero packing of adsorbent surface
Q_1 — heat of adsorption in the first layer
Q_c — heat of condensation of adsorbate
r — column radius
R — gas constant
S — specific surface area
S_{st} — specific surface area of standard
S_{ads} — adsorption surface area

S_{peak} — peak area
$S_{peak\,st}$ — peak area of standard
S_v — surface area of sorbent per unit volume of column
$\Delta S^{\ominus}$ — change in standard entropy during adsorption
t — time
t_R — uncorrected retention time
t_M — carrier gas retention time
t'_R — adjusted retention time
t_0 — duration of a pulse of gas at concentration c_0 being adsorbed
T_c — column temperature
T_m — temperature of gas in the flow-meter
T_{ch} — characteristic temperature at $u_A = u_p$
$t'_{R\,alkene}$, $t'_{R\,alkane}$ — adjusted retention times of an alkene and an alkane
t_{max} — time required for complete catalyst regeneration
u — linear velocity of carrier gas
u_c — linear migration velocity of adsorbate at concentration c along the column
u_A — linear velocity of substance A along the column
u_{opt} — optimum linear velocity
u_p — rate of temperature field shift (thermodesorption)
$\bar{u}_{mol}$ — average thermal velocity of adsorbate molecules
u'_1 — first moment
u_2 — second central moment
V — volume of mobile phase per unit length of column
V'_s — volume of adsorption layer per unit length of column
V_{cat} — volume of catalyst
V_R — uncorrected retention volume
V'_R — adjusted retention volume
V_N — net retention volume
V^0_R — corrected retention volume
V_M — retention volume of unsorbed gas (gas hold-up)
V_g — specific retention volume
$V_{g(c)}$ — specific retention volume for adsorbate concentration c
V_s — "net retention volume" — V_g/S
V_m — volume of adsorbate equivalent to a monolayer
V'_{R_A} — adjusted retention volume of substance A if there is no chemical reaction

$V'_{R_{A\,react}}$ — adjusted retention volume of substance A if a chemical reaction takes place

$V_{A\,eq}$ — volume of carrier gas required for the complete transfer of A from plate N to plate $N+1$

$\Delta V'$ — volume of gas adsorbed in unit time

V_1^{∞} — solute molar volume at infinite dilution in stationary phase

V_1^0 — solute bulk molar volume

W — peak width at base

w — recorder tape speed

$\bar{w}$ — rate of reaction in the microreactor for an average concentration of reagent in a pulse

Z — number of collisions between the molecules of adsorbate and the adsorbent surface (in the column)

Z_a — number of collisions leading to adsorption of molecules

z — distance from the centre of the molecular mass of the adsorbate to the principal plane of the solid (assuming a flat surface)

Φ, Ψ — normal Euler angles determining the orientation of molecules with respect to the adsorbent surface

ν — angle between the principal axis of the molecule and the axis perpendicular to the surface

α — quantity of adsorbed substance per unit surface area or surface concentration of the adsorbed substance

α — coefficient accounting for the probability of adsorption during a collision between an adsorbate molecule and the surface (so-called condensation coefficient)

α — total polarizability of an adsorbate molecule

α — degree of conversion

α_0 — degree of transformation of reacting substance on an unpoisoned catalyst

β — rate of programmed heating

λ — constant characterizing the statistical heterogeneity of the column packing

λ — energy of desorption

$\chi(\varepsilon)$ — differential distribution of adsorption energy

$\Delta\lambda$ — heat of adsorption per carbon atom in a hydrocarbon

γ — structural factor describing the labyrinth of gas flow channels in the column

γ_p — transmission coefficient
γ — activity coefficient
γ^∞ — activity coefficient at infinite dilution
ε — that part of the column cross-section not occupied by the stationary phase
ϱ_0 — density of adsorbate in the free gaseous phase
ϱ_p — apparent particle density
$(1-\varepsilon)$ — that part of the column cross-section not occupied by the stationary phase
θ — coverage of the adsorbent surface with adsorbate molecules
θ_A — coverage of active sites by molecules of A
μ — chemical potential
$\Delta\mu^\ominus$ — standard change of chemical potential of adsorbate
ν_g — number of poison molecules which can be adsorbed at an active site on the catalyst surface
σ — standard deviation
τ — mean hold-up time of an adsorbate molecule at an active site
$\Phi_{(z)}$ — potential energy of adsorbate–adsorbent interaction
$\varphi_{C\ldots A}$ — potential energy of the interaction between a lattice carbon atom (graphite black) and an atom or molecule of adsorbate
χ — stoichiometry of interaction between the adsorbate and surface atoms of a metal
$\psi_{(t)}$ — function describing the type of pulse introduced into the microreactor
$\omega_{1/2}$ — peak width at half the height
ω — average area occupied by one surface atom of a metal
ω_m — surface area occupied by one adsorbate molecule in the monolayer, or sitting surface

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