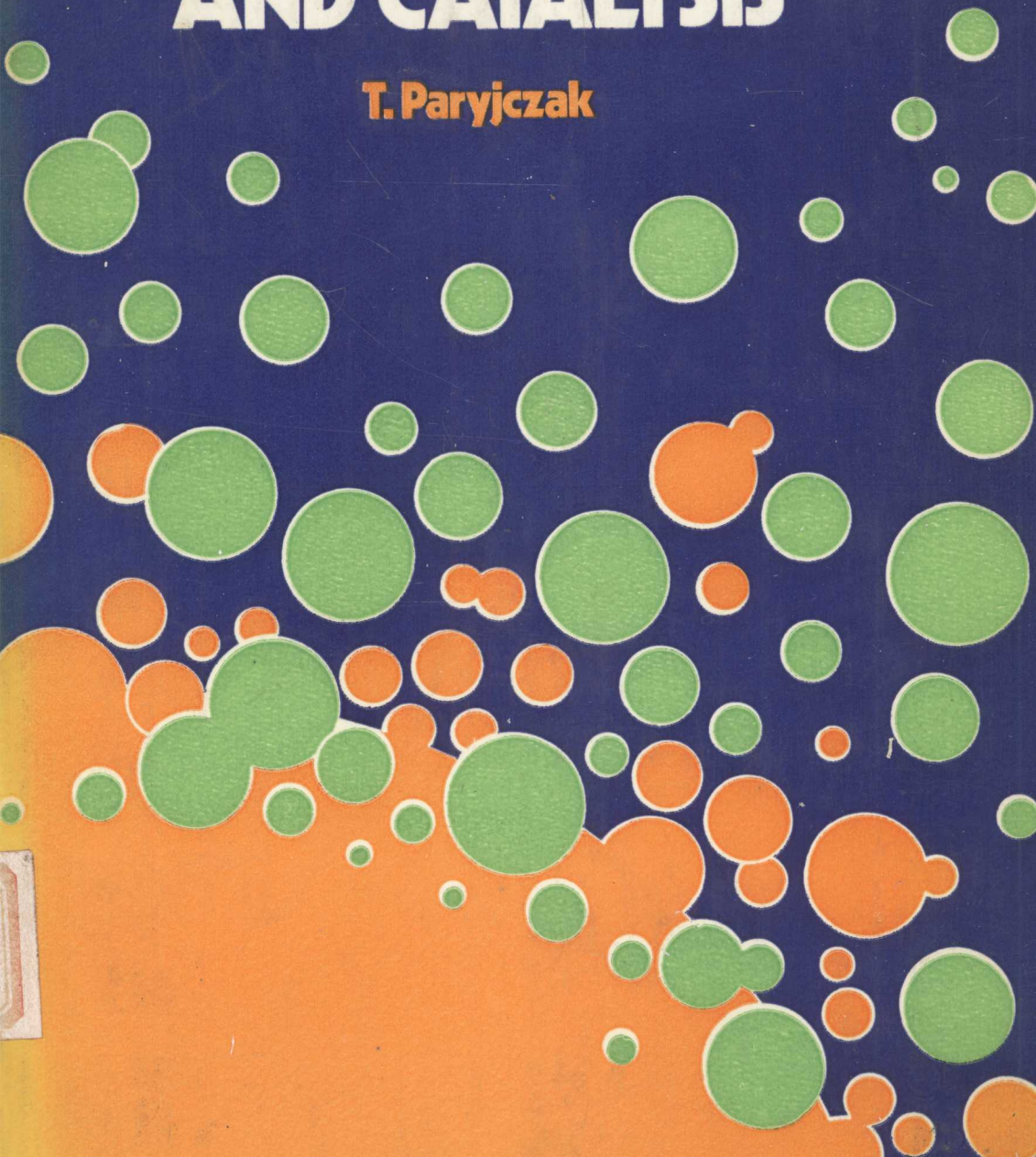


Ellis Horwood Series in **PHYSICAL CHEMISTRY**

GAS CHROMATOGRAPHY IN ADSORPTION AND CATALYSIS

T. Paryczak



GAS CHROMATOGRAPHY IN ADSORPTION AND CATALYSIS

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AND CATALYSIS**



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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_o	— edge of metal crystallite
d_c	— 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
ΔG^\ominus	— change in the standard energy of a system during adsorption
\hbar	— 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
ΔH^\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_{stA}	— 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
$S_{\text{peak st}}$	— peak area of standard
S_v	— surface area of sorbent per unit volume of column
ΔS^\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'_{Ralkene}	} — adjusted retention times of an alkene and an alkane
t'_{Ralkane}	
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_R^0	— 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_{RA}	— adjusted retention volume of substance A if there is no chemical reaction

$V'_{R\text{A react}}$	— adjusted retention volume of substance A if a chemical reaction takes place
$V_{A\text{eq}}$	— 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
$\varphi_{C...A}$	— 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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