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ELECTROCHEMICAL PROCESSES IN CHEMICAL INDUSTRIES

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by

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ARTIA • PRAGUE

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CONTENTS

INDUSTRIAL APPLICATION

LIST OF SYMBOLS

a	Chemical activity.
A	Unit of electric current, ampere.
A	Atomic weight.
c	Concentration defined in moles per liter (molarity).
c_e	Concentration defined in gram-equivalents per liter.
C	Unit quantity of electricity, coulomb (3.10^9 electrostatic units of charge).
D	Diffusion coefficient.
e	Chemical symbol of electron, or also Charge of an electron ($1.6 \cdot 10^{-19}$ coulombs).
E	Voltage (in volts), mostly electromotive force of a cell.
E_p	Polarization voltage.
E_R	Decomposition voltage.
EMF	Electromotive force of a cell.
f	Fugacity.
f_A	Conductance coefficient.
F	Unit quantity of electricity, faraday, 96500 coulombs.
h	Planck's universal constant ($6,624.10^{-27}$ erg./sec.)
H	Enthalpy.
I	Current in amperes.
I_h	Current density on the electrodes.
K	Equilibrium constant.
K_s	Ionic solubility product.
K_v	Ionic product of water.
ln	Natural logarithm.
log	Decadic logarithm.
m	Concentration defined in moles per 1000 g of solvent (molality).
n	Number of gram-equivalents undergoing electrochemical reaction.
N	Normal concentration (normality).
N	Power.
N	Avogadro's number ($6,023.10^{23}$).
N	(with subscript) Concentration defined in terms of the mole fraction.
p	Gas pressure.

pH Negative decadic logarithm of the H_3O^+ activity (hydrogen ion exponent).
q Quantity of electricity.
Q Heat evolved by the system or supplied to the system.
R Ohmic resistance.
R Gas constant (8,314 joule/mole grad).
S Entropy.
t Time.
t Temperature in °C
t (with subscript). Transference number of an ion.
T Absolute temperature in °K.
v (with subscript). Velocity of ions under unit potencial gradient.
V Unit of potential (volt).
z Number of elementar charges of an ion (valence).
W Work (energy).
α Degree of dissociation; electrochemical equivalent.
γ Activity coefficient.
δ Thickness of the diffusion layer.
ε Elementary quantum of energy. ($\varepsilon = h\nu$).
ε Oxidation electrode potential.
ε_K Liquid junction (diffusion) potential.
φ Volume of the solution in millilitres containing one gram-equivalent of an electrolyte.
η_I Current efficiency.
η_w Energy efficiency.
$\varkappa$ Specific conductivity.
λ (with subscript) Ionic conductance.
Λ Equivalent conductivity.
μ Chemical potential.
μ Molar conductivity.
μ Ionic strength.
ν (with subscript) Number of ions arising from one molecule of electrolyte.
ν Frequency of electromagnetic radiation.
π Reduction electrode potential.
ρ Specific resistance; density.
Σ Summation.
ω Overvoltage.
Ω Unit of electrical resistance, ohm.

I. INTRODUCTION TO ELECTROCHEMISTRY

A. A SURVEY OF THE ATOMIC AND MOLECULAR THEORY

Elements are built of atoms the components of which are the protons (a positively charged hydrogen nucleus of the mass $m = 1.67 \times 10^{-24}$g and a charge $+e = 1.60 \times 10^{-19}$ coulombs), the neutrons (a particle with the mass equalling approximately that of a proton, but without any electric charge), and the electrons (an atom of negative electricity, 1837 times lighter than the proton, with the mass $m = 9.11 \times 10^{-28}$g; its electric charge is of the same value as that of the proton, however with an opposite sign).

Individual atoms of elements vary in number and configuration of these elementary particles, while the total number of electrons and protons is the same, so that the whole is electroneutral to the outside. Elements can be arranged in a series, according to the number of protons in the nucleus (or electrons), in which the following member has always one proton more, than the previous one. The ordinal or atomic number of elements is determined by the number of protons which in turn decides their position in the periodic system.

In the nuclei of atoms neutrons are concentrated, in addition to protons; the presence of neutrons in the nucleus does not change the ordinal number of the element, but it contributes to the growth of its atomic weight. Elements having the same number of protons, but differing in the number of neutrons, are called isotopes. Electrons, being practically particles almost without any mass, move in eliptical paths in one or several shells round the nucleus approximately in the same manner as the planets move round the sun.

In each shell, or on each level (marked by letters K, L, M, N, O, P, Q) only a very definite number of electrons can move as a maximum. As can be seen from Table 1, where Z is the atomic number of each element, the innermost shell is fully saturated with two electrons already. On the highest outer levels the maximum of eight electrons (the octet) can move.

The chemical and electrochemical characteristic properties of elements are determined by the electrons in the last outer shell. Elements with outer levels filled to completion, i. e. the rare gases (helium, neon, argon, crypton, xenon and radon), are noted for the great stability of their electronic structures; atoms of such elements, known for their chemical inactivity, do not show any tendency to form molecules, neither in mutual bonds nor in bonds with other atoms.

In all other elements the outer shells are not fully occupied by electrons; such