

9.6 ELECTROPHORESIS

Electrophoretic separation techniques have been developed and refined over decades, and are now widely used. Various kinds of quantities used for the descriptions of electrophoretic separation procedures consistent with the International System of Units (SI) and standards of the International Organization for Standardization (ISO) are listed as follows. See also the corresponding subsections of 1.3.

Charge number (of an ion B) (z ; 1)

Charge number of an ion equals the *electric charge* of the ion divided by the *elementary charge* of a proton. This definition below applies to specified entity B:

$$z_B = Q_B/e$$

The value is positive for cations and negative for anions. The symbol z is also used for *net electric charge* number of a particle.

Electric charge (Q ; C)

Electric charge (positive or negative) equals the integral of *electric current* over time. It is a synonym for the quantity of electricity. The SI unit for electric charge is the coulomb (C = sA).

Electric current (I ; A)

Electric current is a base quantity. The symbol I may carry one of the subscripts: a for anodic, c for cathodic, e or o for exchange, or l for limiting: I_a is the anodic partial current (the anode is the electrode which is positively charged in comparison to the cathode). Note that I is also the symbol for *ionic strength*.

Electric current (area) density (j , J ; A m⁻²)

Electric current density is the *electric current* divided by the area, $J = I/A$. Note that J is also the symbol for flux. This kind-of-quantity was named electric current (area) density. It is a vector quantity.

Electric field strength (E ; V m⁻¹)

Electric field strength equals the *force* exerted by an electric field on an electric point charge divided by the *electric charge* $E = F / Q$. Note that in electrophoresis F is counteracted by a counter-force F' . This counter-force is expressed by Stokes' law: $F' = 6 \pi r \eta v$ where r is the ionic radius of the medium, η the *viscosity* of the electrophoresis medium, and v the *velocity* of the particle. Electric field strength is a vector quantity.

Electric potential (V ; V)

Electric potential is for electrostatic fields a scalar quantity, the gradient of which, with reversed sign, is equal to the *electric field strength*. The name of the SI unit for electric potential is volt ($V = J C^{-1} = J s^{-1} A^{-1}$).

Electric potential difference (U or ΔV ; V)

Electric potential difference is the difference in electric potential $U = V_2 - V_1$. The name of the SI unit for the electric potential difference is volt again Green book. The commonly used word *voltage* is not recommended.

Electrokinetic potential (ζ ; V)

Electrokinetic potential is the *electric potential difference* between the fixed charges of the immobile support and the diffuse charge in the solution. It is also called *zeta potential*.

Electromotive force (E ; V)

Electromotive force of a source is the energy supplied by the source divided by the *electric charge* transported through the source. The abbreviation EMF is not recommended.

Electrophoretic mobility (μ ; $m^2 s^{-1} V^{-1}$)

Electrophoretic mobility is the observed *rate of migration* of a component (v) divided by *electric field strength* (E) in a given medium. The symbol μ applies to entities B. It is also used for *friction coefficient*.

Notes:

- (1) Mobilities are sometimes expressed with a negative sign, because migration of the solutes or particles generally occurs in the direction opposite to the electrophoretic field (which is taken as reference for the direction).
- (2) In a solid support medium, only apparent values can be determined.

Elementary charge (e ; C)

Elementary charge is the *electric charge* of the proton.

Energy (Q ; J)

The name of the SI unit for energy is joule ($J = m^2 kg s^{-2}$).

Note: Q is also the symbol for *electric charge*.

Force (F ; N)

The resultant force acting on a body is equal to the rate of change of the momentum of the body. The name of the SI unit for force is newton ($\text{N} = \text{m kg s}^{-2}$). Force is a vector quantity.

Note: F is also the symbol for Faraday constant.

Friction coefficient (μ ; 1)

Friction coefficient is the ratio of frictional forces to normal *forces* for a sliding body. Note that μ is also the symbol for *electrophoretic mobility*.

Ionic strength (of a solution) (I, I_c ; mol m^{-3})

Ionic strength of a solution is half the sum of the products of the ionic charge squared and substance concentration of each ion [$I_c = \frac{1}{2}\sum(z_B^2 c_B)$]. Ionic strength may be expressed on a molality basis in mol kg^{-1} , using the symbol I or I_m . (See Chapter 1 and 8.)

Isoelectric point (of an elementary entity) (pI ; 1)

The isoelectric point of an elementary entity is the pH value at which the *net electric charge* of the entity is zero. pI is a commonly used symbol for this kind-of-quantity. It should be replaced by $\text{pH}(I)$ because it is a pH determined under that particular condition.

Isoionic point (of an elementary entity) (1)

The isoionic point of an elementary entity is the pH value at which the *net electric charge* of the entity in pure water equals zero.

Molar mass (of a component B) (M ; kg mol^{-1})

Molar mass of a component B is the mass of the component divided by its amount of substance ($M_B = m/n_B$).

Net electric charge (of a particle) (z ; 1)

Net electric charge of a particle equals the algebraic sum of the charges present at the surface of the particle divided by the *elementary charge* of the proton. The symbol z is also used for *charge number* of an ion.

pH gradient (m^{-1})

pH gradient is the differential change of pH with distance (dpH/dl).

Rate of migration (v ; m s^{-1})

Rate of migration is the distance of migration divided by time. The rate of migration is sometimes called velocity of migration.

Note: v is also the symbol for *velocity*.

Velocity (of migration) (v ; m s^{-1})

Velocity of migration is the distance traveled divided by time of travel ($v=d/t$). Velocity is a vector quantity.

Viscosity, dynamic (η ; $\text{Pa s} = \text{kg m}^{-1} \text{s}^{-1}$)

Viscosity is the constant proportionality for shear stress, τ_{xz} in a fluid moving with a velocity gradient, dv_x/dz , perpendicular to the plane of shear $\tau_{xz} = \eta dv_x/dz$. This definition applies to laminar flow for which $v_z = 0$.

Volume rate of flow (q_v, V ; $\text{m}^3 \text{s}^{-1}$)

Flow is the rate at which volume crosses a surface. Mass flow rate (q_m) and substance flow rate (q_n) may be defined analogously. The subscripts v , m and n indicate that volume, mass and amount of substance are quantities in the numerator.

Volume flux (J_v ; m s^{-1})

Volume flux is volume flow rate divided by the area ($J_v = q_v/A$). Mass flux and substance flux may be defined analogously.