

**INTERNATIONAL UNION OF
PURE AND APPLIED CHEMISTRY**

**ANALYTICAL CHEMISTRY DIVISION
COMMISSION ON ANALYTICAL NOMENCLATURE**

**RECOMMENDATIONS ON
NOMENCLATURE FOR
CONTAMINATION PHENOMENA
IN PRECIPITATION FROM
AQUEOUS SOLUTIONS**

RULES APPROVED 1973

**LONDON
BUTTERWORTHS**

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This report was prepared for the Commission by Professor W. Fischer, Dr H. Zettler and Professor T. S. West in collaboration with Dr E. Berg. It has been widely circulated and has been discussed at several meetings of the Commission. It is limited in scope to aqueous solutions and the production of precipitates for gravimetric analysis or for collecting traces of materials from dilute solutions.

The terms defined are connected mainly with contamination phenomena which occur during the formation of precipitates and during separation processes in analytical chemistry, i.e. with the phenomena of *Coprecipitation* and *Postprecipitation* which are defined subsequently in the report (34 and 35) following elucidation of the simpler terms. Therefore, aqueous solutions in the temperature range between 0°C and 100°C are considered only. In a few cases two synonymous terms are given for one definition. Some of the terms defined in IUPAC *Information Bulletin*, Appendix No. 3, January 1970, 'Manual of Definitions, Terminology and Symbols in Colloid and Surface Chemistry' and No. 5, January 1970, 'Recommendations on Ion Exchange Nomenclature' have been repeated here, others (e.g. various terms on absorption, isoelectric point, co-ion, etc.) were omitted because they seem to be connected more strongly with Surface and Colloid phenomena than with the topics defined here. In these cases, the terms already defined in the respective IUPAC Recommendations should be taken into account.

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| 1. Surface = Interface | Boundary between two phases. |
| 2. Solution | Homogeneous liquid phase comprising at least two different substances. |
| 3. Solvent | A liquid (usually the major component of a solution) which is used to dissolve a solute or solutes. |
| 4. Solute | The minor component of a solution which is regarded as having been dissolved by the solvent. |
| 5. Dissolution | Mixing of two phases with the formation of one new homogeneous phase (i.e. the solution). |
| 6. Saturated Solution | A solution which has the same concentration of a solute as one that is in equilibrium with |

- undissolved solute at specified values of temperature and pressure.
7. Saturation (noun) The state of a saturated solution.
8. Solubility product The product of the ion activities of an ionic solute in its saturated solution expressed with due reference to the dissociation involved and the ions present. In analytical chemistry, activities are commonly replaced by concentrations.
9. Solubility The analytical concentration of a solute in a saturated solution. The analytical concentration includes those of all the species formed by the dissolved substance in the solution. Numerical data for solubility always have to be defined in relation to the values of temperature, pressure and concentrations of other dissolved substances.
10. Supersaturated solution A labile or metastable solution which contains a higher concentration of solute than a saturated solution at the same temperature and pressure.
11. Supersaturation (noun) The state of a supersaturated solution.
12. Macro-component Substance dissolved in a solution at such concentration that it may be precipitated by the addition of suitable reagents.
13. Micro-component A substance present in solution which is not normally precipitated because of its low concentration or high solubility.
14. Nucleus The smallest solid phase aggregate of atoms, molecules or ions which is formed during a precipitation and which is capable of spontaneous growth.
15. Nucleation The process by which nuclei are formed in a solution. The condensation of a single chemical compound is called homogeneous nucleation. The simultaneous condensation of more than one compound is called simultaneous nucleation. The condensation of a compound on a foreign substance is called heterogeneous nucleation.
16. Rate of nucleation Number of nuclei formed in unit time per unit volume of the liquid phase.
17. Precipitate (i) Noun. A solid phase formed within a liquid phase.
(ii) Verb. To produce a precipitate.
18. Precipitation Formation of a precipitate.
19. Precipitation from homogeneous solution = PFHS Formation of a precipitate which is generated homogeneously and, generally, slowly by a precipitating agent within a solution.

CONTAMINATION PHENOMENA IN PRECIPITATION

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| 20. Contamination (of a precipitate) | Presence of minor amounts of at least one chemically different species in a precipitate. |
| 21. Collection | The planned removal from solution of a micro- or macro-component by the intentional formation of a contaminated host precipitate, or by the adsorption or entrapment of the component by an added solid. |
| 22. Collector = Scavenger | A solid substance added to or formed within a solution to collect a micro- or macro-component. |
| 23. Aggregate | Group of particles held randomly together. |
| 24. Aggregation | Formation of an aggregate. |
| 25. Coagulation = Flocculation | Formation and growth of aggregates ultimately leading to phase separation on a macroscopic scale. |
| 26. Agglomeration | Formation and growth of aggregates ultimately leading to phase separation by formation of precipitates of larger than colloidal size. |
| 27. Adsorption | Increase in concentration of dissolved substances at the interface of a condensed and a liquid phase due to the operation of surface forces. |
| 28. Adsorbent | A condensed phase at the surface of which adsorption may occur. |
| 29. Adsorbate | Material accumulated on the surface of an adsorbent by the process of adsorption. |
| 30. Occlusion (Molecular) | Process of incorporation of foreign substances as molecular species within precipitates as they are formed. |
| 31. Mechanical entrapment | <p>(a) Process of random incorporation of comparatively small quantities of other phases (e.g. water, dust particles, etc.) in the bulk of a precipitate during its formation.</p> <p>(b) Deliberate capture of small quantities of such phases by the deliberate addition of solids to a liquid phase.</p> |
| 32. Mixed crystal or Solid solution | <p>The term 'Inclusion' is not recommended.</p> <p>A crystal which contains a second constituent which fits into and is distributed in the lattice of the host crystal. (The use of 'solid solution' for amorphous materials is not recommended.)</p> |
| 33. Laws of distribution | During formation of a mixed crystal from a solution containing two components 'A' and 'B' the latter may be distributed according to the equation |

$$K_{A, B} = \frac{b(a_0 - a)}{a(b_0 - b)}$$

(homogeneous distribution), where ' a_0 ' and ' b_0 ' are the respective concentrations in the solution before crystallization and ' a ' and ' b ' are the respective concentrations in the solution after crystallization. $K_{A, B}$ is usually called the separation factor. The term *homogeneous distribution coefficient* is not recommended. Alternatively the distribution of the micro-component may follow the equation of Doerner and Hoskins

$$\ln \frac{a_0}{a} = \lambda \ln \frac{b_0}{b}$$

(logarithmic distribution) where λ is usually called the *Logarithmic distribution coefficient*, the meaning of the other symbols remaining as above.

Exactly homogeneous or logarithmic distributions are extreme cases and are very seldom encountered.

34. Coprecipitation

Simultaneous precipitation of a normally soluble component with a macro-component from the same solution by formation of mixed crystals, by adsorption, occlusion or mechanical entrapment.

35. Postprecipitation

Subsequent precipitation of a chemically different species upon the surface of an initial precipitate usually, but not necessarily, including a common ion.

36. Reprecipitation

Planned repetition of a precipitation in order to remove chemically different species from a previous precipitate, or to improve its stoichiometry.

37. Ageing

Time-dependent change of the properties of a precipitate, e.g. loss of water, growth of crystals, recrystallization, decrease of the specific surface, loss of coprecipitated substances or improvement of the filtering properties. The process of ageing is frequently promoted by maintaining the precipitate and precipitation medium together at elevated temperatures for a period of time.

The terms 'chemical-', 'physical-' and 'thermal-' ageing may be used in cases in which some of the (usually combined) effects named above are to be emphasized specifically.

38. Ostwald ripening

Growth of larger crystals from those of smaller size which have a higher solubility than the larger ones.