The Essence of Physical and Chemical Methods of Analysis

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Abstract:
This article is devoted to physicochemical methods (PhCMA) analysis, based on the dependence of the physical properties of a substance on its nature, and the analytical signal is the value of the physical property, functionally related to the concentration or mass of the determined component.

Key words: Physicochemical analysis, method, agrochemistry, photometry, potentiometry, chromatography, composition and property, luminescence analysis, spectral analysis, nephelometry, turbidimetry, titrimetric analysis, flow-injection analysis.

Basic concepts. Physicochemical analysis combines a large number of quantitative methods based on the measurement of various physical properties of compounds or simple substances using appropriate instruments. These properties include: density, surface tension, viscosity, absorption of radiant energy, haze, radiation, Raman scattering of light, rotation of the plane of polarization of light, refractive index, dispersion, fluorescence and phosphorescence, X-ray and electron diffraction, nuclear and electron magnetic resonance, half-electrode potentials, decomposition potentials, electrical conductivity, dielectric constant, magnetic susceptibility, phase transformation temperature, heat of reaction, thermal conductivity, radioactivity and other physical properties.

Analysis methods in agrochemistry are evaluated not only from the standpoint of expressiveness, productivity and information content, but also, if possible, performing automated, remote observations using computer technology.

Laboratory methods for the analysis of plants, soil and fertilizers include biochemical, microbiological methods. The quantitative agrochemical analysis of plants, soils and fertilizers is based on the methods of chemical quantitative analysis, but it also has a certain specificity due to the characteristics of the objects of research. The variety of organic and inorganic compounds in the composition of plants, soils, and fertilizers creates significant difficulties in the analysis. In agrochemical research, all existing methods of quantitative analysis are used, various types of photometry, potentiometry, and chromatography are especially common.

The problem of physicochemical analysis based on the works of D.I. Mendeleev, Ya.X. Vant-Hoffa, H.C. Kurnakov and other scientists, is to study the relationship between the composition and properties of chemically equilibrium systems. The results of such studies are expressed in "composition - property" diagrams, the study of which makes it possible to detect the formation of new stable and unstable chemical compounds between the studied components, to study the effect of individual components on the properties of the entire system. A special case of physicochemical analysis is the use of various properties of complex systems to determine their composition. This area of physicochemical analysis is especially important in analytical agrochemistry.

Physicochemical methods (PhCMA) analysis can include chemical transformation of the analyte, sample dissolution, concentration of the analyte, masking of interfering substances, and others.

Unlike "classical" chemical methods of analysis, where the mass of a substance or its volume serves as an analytical signal, in physicochemical methods of analysis, radiation intensity, current strength, electrical conductivity, potential difference and others are used as an analytical signal.

Methods based on the study of emission and absorption of electromagnetic radiation in various regions of the spectrum are of great practical importance. These include spectroscopy (for example, luminescence analysis, spectral analysis, nephelometry and turbidimetry, and others).

Important physicochemical methods of analysis include electrochemical methods that use the measurement of the electrical properties of substances (coulometry, potentiometry, and so on), as well as chromatography (for example, gas chromatography, liquid chromatography, ion exchange chromatography, thin layer chromatography).

Methods based on measuring the rates of chemical reactions (kinetic methods of analysis), heat effects of reactions (thermometric titration, see Calorimetry), as well as separation of ions in a magnetic field (mass spectrometry) are being successfully developed.

When performing physicochemical methods of analysis, special, sometimes rather complicated, measuring equipment is used, in connection with which these methods are often called instrumental. Many modern devices are equipped with built-in computers that allow you to find the optimal analysis conditions (for example, the spectral range for obtaining the most accurate results when analyzing a mixture of colored substances). In almost all physicochemical methods of analysis, two main methods are used: methods of direct measurements and titration.

Direct methods use the dependence of the analytical signal on the nature of the analyte and its concentration. The dependence of the signal on the nature of the substance is the basis of a qualitative analysis (half-wave potential in polarography, and so on). In some methods, the connection between the analytical signal and the nature of the substance is established strictly theoretically. For example, the spectrum of a hydrogen atom can be calculated using theoretically derived formulas. In quantitative analysis, the dependence of the signal intensity on the concentration of the substance is used.

The numerical values of the constants in the bond equation are determined experimentally using standard samples, standard solutions, and so on. Only in coulometry based on Faraday's law, the definition of constants is not required. The most widespread in practice are the following methods for determining the constants of the constraint equation or, what is the same, methods of quantities, analysis using physicochemical measurements:

1) Calibration graph method. Measure the intensity of the analytical signal for several standard samples or standard solutions and build a calibration graph in the coordinates I = f (c) or I = f (logc), where c - is the concentration of the component in the standard solution or standard sample. Under the same conditions, the signal intensity of the analyzed sample is measured and the concentration is found from the calibration graph.

2) The molar property method is used in cases where the bond equation I = bc is observed quite strictly. Measure the analytical signal for several standard samples or solutions and calculate $b = I_{ct} / c_{ct}$; if cct is measured in mol / l, then b - is the molar property.

3) Additive method. Measure the intensity of the analytical signal of the sample I_x, and then the intensity of the signal of the sample with a known addition of the standard solution $I_{x + stt}$.

Titration methods. Measure the intensity of the analytical signal I depending on the volume V of the added titrant. The equivalence point is found from the titration curve I = f (V) and the result is calculated using the usual formulas for titrimetric analysis.

Physicochemical methods of analysis are often used when determining low concentrations (of the order of 10^{-3} % or less), where classical chemical methods of analysis are usually inapplicable.

In the area of medium and high concentrations, chemical and physicochemical methods of analysis successfully compete with each other, mutually complementing each other. Physicochemical methods of analysis are developing in the direction of searching for new chemical analytical properties of a substance, increasing the accuracy of analysis, designing new precision analytical instruments, improving existing methods and automating analysis. Recently, flow-through injection analysis has been developing intensively - one of the most versatile options for automated analysis, based on the discrete introduction of microvolumes of the analyzed solution into the flow of a liquid carrier with a reagent and subsequent detection of the mixture by one or another physicochemical method.

The division of analytical methods into physical, chemical and physicochemical is rather arbitrary. Often, physicochemical methods of analysis include, for example, nuclear physical methods. Recently, there has been a tendency to divide the methods of analysis into chemical, physical and biological - without physicochemical at all.

Conclusion.

There are a number of objective reasons forcing to periodically revise the organizational structure, bring it in line with new tasks and changed conditions. The main factors stimulating a change in the organizational structure include: a change in the goals of the enterprise, a decrease in the efficiency of the enterprise, due to the imperfection of its organizational structure.

Carrying out measures to improve the organizational structure will allow the plant to achieve its goals with higher efficiency.

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