Acid-alkaline surface properties of powders: potentiometric research methods

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Abstract - The paper presents two potentiometric methods that can be effectively used to study the acid-alkaline properties of the surface of powders: the direct potentiometric method and the method of potentiometric titration of aqueous suspensions. It was established that the results obtained using these methods complement each other and allow to obtain the most complete characteristics of the acid-alkaline properties of the surface of powder materials.

Key words - powders, surface, acid-alkaline properties, potentiometric method

Introduction

Disperse and powder materials of various origins are in great demand in a wide range of industries. This is due to the unique properties and structure of the surface, which depend on the chemical and mineral composition, the size of the particles, the method of obtaining materials and other factors. The study of acid-alkaline surface properties requires special attention, because during interaction with the environment on the surface of the phase separation, interactions can occur between the surface functionalities of the acidic or alkaline character of the dispersed phase and the substances of the dispersion medium. The regularities of interactions on the surface of the phase separation in any case can be described as reactions between acids and alkalis by Brønsted (protic reactions) or Lewis (aprotic reactions). It is believed that a hydroxyl-hydrate layer is formed on the surface of dispersed materials, which consists of chemically bound water molecules, which form the first lower hydroxyl layer of OH-groups (Brønsted centers) and subsequent hydrate layers of water molecules that are more distant from the solid surface, connected with the hydroxyl layer due to hydrogen and other physicochemical bonds [1-3].

Potentiometric methods of studying the surface of powders and dispersed materials

The task of potentiometric research includes the determination of the isoadsorption state of the surface of a dispersed material, that is, the search for such a state of its suspension in which mass transfer of counterions from the liquid phase to the surface of a solid body does not occur. To characterize acid-alkaline interactions, the reversible process of mass transfer of OH^- or H^+ ions from the dispersion medium to the surface of the dispersed phase is studied. Most often, water is used as the liquid phase of suspensions, which allows determining the isoadsorption state and overall surface characteristics in the pH range from 0 to 14. To expand the pH range, other non-aqueous solvents can be used, for example, ethanol (pH range from –4 to 18).

Currently, several variants of potentiometric determination methods have been developed, which are based on one general principle - the study of the patterns of absorption of OH^- or H^+ ions by the surface of a solid body from electrolytes of different acidity and the selection of such a pH value of the electrolyte solution that does not change upon contact with the solid surface of the dispersed material, that is, it characterizes the equilibrium on the surface of the phase

separation. The availability of various options is related to the search for greater informativeness, expressiveness and accessibility. All methods can be divided into two groups: in some, the isoadsorption state is evaluated by the pH values of the suspensions, in others, by the pH of the filtrates of the suspensions. From the first group, the Nechyporenko method (direct potentiometry) and the Parks-Bobyrenko method (potentiometric titration) are the most important [4].

Nechyporenko's method is the easiest to perform, express and informative. This methodology considers the regularity of changes in the pH value of the suspension over time. Considering the process and regularities of changes in the pH of the suspension over time, it is possible to determine the integral acidity of the solid surface and the distribution and some qualitative characteristics of the surface functional groups. The pH value of the suspension indicates the preference of surface acid or alkaline functional groups. The time factor reflects the processes of hydration and hydrolysis, changes in the composition of the electrolyte and the surface. Therefore, the change in the pH value of the suspension over time makes it possible to consider the "composition - surface properties" diagram with the corresponding features. The Parks-Bobyrenko method with the use of potentiometric titration expands the understanding of the acid-alkaline properties of the solid surface of a dispersed material during potentiometric studies of suspensions. The value of the isoadsorption point is estimated by the point of intersection of the curves of the potentiometric titration of the electrolyte solution (blank test) and the suspension of the dispersed material in this electrolyte (working titration).

Conclusion

As a result of the research, it was established that for determining the acid-base properties of the surface of dispersed materials, the most acceptable, informative and accessible are potentiometric methods according to the Nechyporenko and Parks-Bobyrenko methods using direct potentiometry and potentiometric titration. The proposed methods make it possible to carry out simple experimental studies of suspensions of dispersed materials.

References

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