ХИМИЧЕСКИЕ НАУКИ

INVESTIGATION OF THE STABILITY OF AQUEOUS AND ELECTROLYTE SUSPENSIONS BASED ON CARBON MATERIAL IN DISPERSING MEDIA

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Introduction. One of the most dynamically developing areas of modern science is associated with the obtainment and research of new materials. Composite electrochemical coatings (CEC) are obtained by co-precipitation of metals with dispersed particles from suspension electrolytes [1]. The process of stability of suspensions (containing carbon material obtained from the hazelnut shells) in time in water, aqueous solutions of surfactants, and in a nickel-plating electrolyte after dispersion has been investigated. It was found that dispersing has a positive effect on the stability of aqueous suspensions. The addition of an ionic surfactant does not affect the stability of the suspension. Non-ionic surfactants increase the stability of the medium and electrolyte solutions sharply reduce the stability.

Modification of the electrolyte by the dispersed phase results in CEC with improved physicochemical and mechanical properties. Various materials (nitrides, borides and powders of metals and nonmetals) can act as materials for modification.

Aim. Currently, the use of carbon material is increasing rapidly. Carbon particles have a layered structure, good chemical resistance and electrical conductivity. Due to these properties, carbon material (CM) is used in various industries, including for obtaining wear-resistant composite electrochemical coatings (CEC) [2]. The process of CEC formation is first of all associated with the preparation and state of suspensions, in particular with their stability [3-4].

The aim of this work is to study the stability of suspensions containing carbon material obtained from secondary raw materials (hazelnut shells), to study the effect of surface-active substances on the stabilization process of this system in aqueous and electrolyte suspensions.

Materials and methods. Carbon material (particle sizes: 50-100 nm), obtained by the authors of the article, using the original method, from recycled cellulose-containing raw materials (hazelnut shell), which is a dry, loose, black powder was used during the experiment.

The characteristics of this product were measured on an ASAP 2020 Plus - physisorption (specific surface, area and volume of micropores), the composition of the product was determined on a - Scanning Electron Microscope (SEM). Ash content was measured by standard - ASTM D1506-15 USA and product moisture was also measured. Tables 1-2 show the physicochemical characteristics of the carbon material obtained from hazelnut shells. For comparison, the characteristics of birch activated carbon of factory production are given.

Table 1

Characteristics of the carbon material obtained from hazelnut shells

Sample	specific surface, m^2/g	Volume of micropores, m^3/g	Area of micropores m^2/g	Ash content, %	Moisture, %
Hazelnut shells	637.33	427.65	0.20	2.95	8.4
Birch activated carbon (BAC-A)	708.70	473.78	0.21	8.95	3.55

Table 2

The composition of the carbon material obtained from the hazelnut shells (weight%)

Sample	C	O	Ca	K	Si	S	Fe	Ni	Cu	Zn	Al	F
Hazelnut shells	86.71	10.07	0.64	0.56	0.05	0.37	0.49	0.37	0.20	0.43	0.11	-
Birch activated carbon (BAC-A)	89.55	8.69	0.70	0.36	0.01	-	0.09	-	0.38	0.01	0.04	0.17

As can be seen from the table, the physical characteristics of the carbon material obtained from recycled materials do not differ much from the parameters of birch activated carbon obtained by the factory method. It should also be noted that the product we received is cheap, because feedstock-cellulose-containing agricultural waste, is thermochemically processed with a cheap reagent, without additional activation.

Suspensions of carbon material were obtained by ultrasonic dispersion on disperser (UC-STP 1200) in a bath for 10 minutes at a frequency of 40 kHz and a power of 60 watts. As the liquid phases, water, aqueous surfactant solutions, and dilute nickel-plating electrolyte (Watts) were used. The dispersion intensity and stability of the system were estimated by spectrophotometric method in the visible region of the spectrum on a spectrophotometer (HITACHI TM 300-plus) with a wavelength of 520 nm, corresponding to the absorption maximum. We used surfactants — sodium dodecyl sulfate (SDS) and polyethylene glycol (PEG).

Results and discussion. The optical density of the resulting suspensions indicates the quality of dispersion. The stability of the obtained suspensions was evaluated by comparing the results every hour and one day after ultrasonic treatment.

Our research shows that the dependence of the optical density of aqueous suspensions on the concentration of carbon material is linear.

It was noted in work [3] that to increase the stability of fullerenes and carbon nanotubes (CNT), an anionic surfactant (sodium dodecyl sulfate) is used. In our case, the analogous additive for the material under study does not practically change the stability of the aqueous suspension with a carbon material content of 0.04 g/L (Fig.1). Apparently, this is due to structural specifics on the one hand of fullerenes, carbon nanotubes (CNT) and, on the other, carbon material (CM).

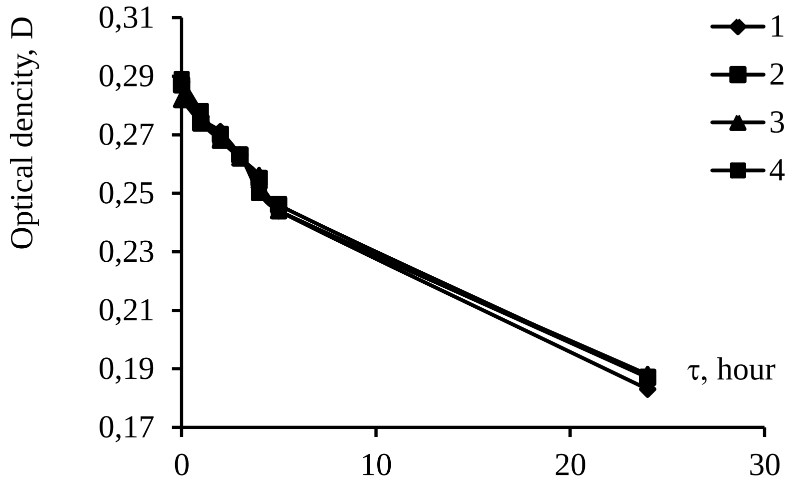

Fig. 1 Dependence of the optical density D, of aqueous suspension of CM (C=0.04 g/L) during the day. The concentration of surfactant (sodium dodecyl sulfate) mol/L: 1 - 0; 2-10^{-4}; 3-10^{-3}; 4-10^{-2}

The effect of nonionic surfactants (polyethylene glycol) on the stability of this system was studied. The results of the study are shown in Fig. 2.

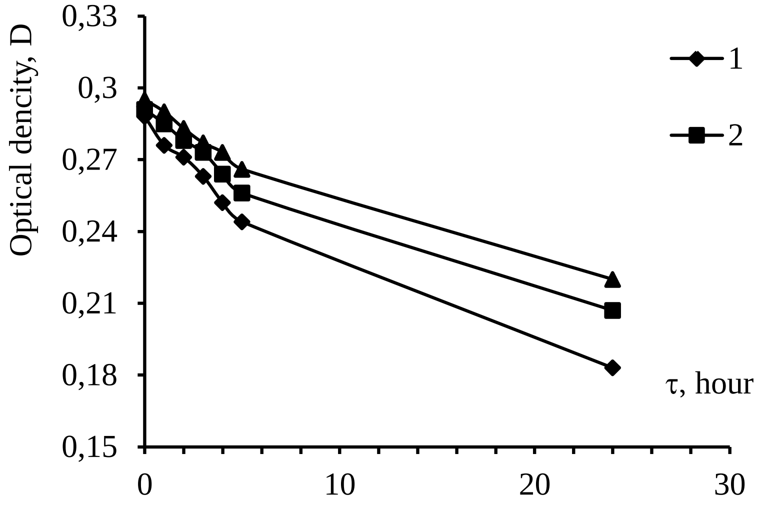

Fig. 2. Effect of the concentration of polyethylene glycol (g/L) on the stability of an aqueous suspension after dispersion: 1 - 0; 2 - 2; 3-6

From the presented data it is seen that the addition of a nonionic surfactant leads to an increase in the optical density of the system. It was found that the introduction of 2 and 6 g/L of this surfactant increases the stability of the suspension by 7.6 and 11.5%, correspondingly.

A study of the stability of a suspension of carbon material (CM) in a dispersive medium based on aqueous solutions of nickel electrolytes (Watts electrolyte) was conducted. To clarify the effect of electrolyte concentration on the coagulation process of CM particles in suspension, experiments were carried out to dilute solutions of salt electrolytes in water. The research results are shown in Fig. 3.

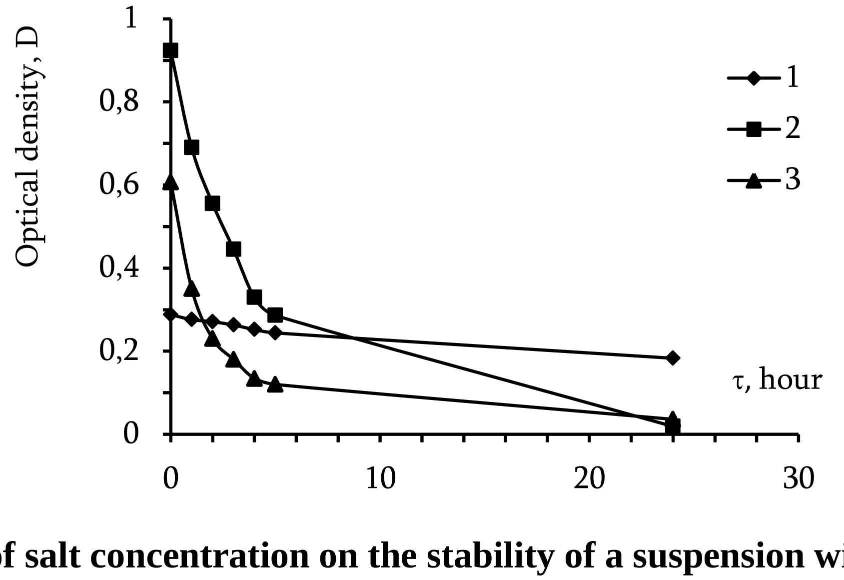

Fig. 3. Effect of salt concentration on the stability of a suspension with a carbon material content (C= 0.04 g/L) in an aqueous solution of nickel electrolyte (g/L): 1 - 0; 2-5.8; 3 - 2.9

If we compare the data on the study of the behavior of CM suspensions in aqueous solutions (curve1) and in electrolyte solutions (curve 2-3), then a fundamental difference is obvious. In an aqueous dispersing medium, the process of coagulation of particles after a certain time and when a certain concentration is reached is slow, and in electrolyte solutions it proceeds continuously, and the concentration of the suspension tends to zero.

Based on the data obtained, it can be concluded that even low salt concentrations sharply change the stability of the suspension.

The experimental data obtained are of great practical importance, since they give an idea of the behavior of CM suspensions in dispersing media.

Conclusions. In conclusion, it can be said that dispersion positively affects the stability of aqueous suspensions of carbon material. Even dilute electrolyte solutions sharply reduce the stability of suspensions. Ionic surfactant (sodium dodecyl sulfate) does not affect the stability of the suspension containing carbon material obtained from secondary raw materials (hazelnut shells). Nonionic surfactant (polyethylene glycol) increases the stability of this system. Dispersion positively affects the stability of the system and can be recommended when receiving Composite electrochemical coatings (CEC).

References

1. Saifulin R.S. Inorganic composite materials. M.: Khimik. 1983, 304 p

2. Kozenkov O.D., Ptashkina T.V., Kosilov A.T. Wear resistance of composite electrochemical coatings hardened by carbon nanomaterials. Bulletin of Voronezh State Technical University. 2015, v.11, №5, pp.135-138.

3. Gataulin A.R., Frantsuzova M.S., Bogdanova S.A. Dispersion of single-walled carbon nanotubes and C_{60} fullerenes in water and aqueous surfactant solutions. Bulletin of Kazan Technological University. 2011, №10, pp.54-57

4. Kozenkov O.D., Juriev V.A., Ptashkina T.V. Development of aqueous suspensions of carbon nanomaterials for electrolytes. Bulletin of Voronezh State Technical University. 2011, v.7, №10, pp. 21-24