ABSTRACT AND REFERENCES

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EVALUATION OF CATIONITE EFFICIENCY DURING EXTRACTION OF HEAVY METAL IONS FROM DILUTED SOLUTIONS (p. 4-10)

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Ion exchange is one of the methods that has been successfully employed in industry for extracting heavy metals from wastewater. We conducted research into ion-exchange processes of extraction of heavy metal ions on the weak- and strong-acid cationites from distilled and tap water. Heavy metal ion concentration was less than 1 mg/dm^3. We established that in all cases efficiency of water treatment decreased at a decrease in the starting concentration of a metal. The process took place regardless of the degree of saturation of cationites with the ions of heavy metals or hardness ions when extracting copper from water.

It is proposed to apply filters with combined action. It was established that at a concentration of copper ions of 10^{-2} mkg/dm^3, copper did not sorb even when using filters with combined action. It is shown that effectiveness of the extraction of copper depends on the volume of filtering load. The concentration of copper ions in water was reduced to 0.053 mg/dm^3.

It was established that lead ions are almost completely extracted on a strong-acid cationite at concentrations less than 0.1 mkg/dm^3. When removing lead ions, the degree of extraction grew while lowering the starting concentration of ions. Residual concentrations were below a sensitivity limit of the method – 10^{-3} mkg/dm^3 (10^{-9} g/dm^3). The processes of regeneration of strong- and weak-acid cationite were explored. Regeneration should be conducted applying the 2M solution of hydrochloric acid. Lead ion desorption efficiency reaches 100 %. It was found that the desorption efficiency increases with a decrease in the mass of sorbed lead. The degree of copper ion desorption in some cases reaches about 90 %.

Keywords: heavy metals, ion exchange, sorption, ionite regeneration, filter with combined action.

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EFFECT OF THE IRON-CONTAINING FILLER ON THE STRENGTH OF CONCRETE (p. 11-16)

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The purpose of present research is to determine the impact of a mixture of river and technogenic sand containing iron compounds in the presence of plasticizers on the strength of fine-grained concretes. As a result of the performed research it was established that the technogenic sand, representing mineral complexes containing iron compounds, interacts with Portland cement minerals and the products of their hydration. The studies we conducted showed the possibility of targeted regulation of the processes of formation of structure of fine-grained concretes by joint application of mineral complex with iron ions, river sand and surface-active substances that are substantially different in the structure of molecules. It was established that using a mixture of river and technogenic sand containing iron compounds in the form of a fine aggregate leads to a significant increase in concrete strength. There is a certain ratio between river sand and the technogenic sand containing iron compounds, which provides concrete with the largest strength. An optimal content of the technogenic sand in a fine aggregate depends on the type and amount of minerals within its structure, and the content of particles with different size. It is demonstrated that the effectiveness of using modern superplasticizers in fine-grained concretes increases considerably with the introduction of mineral complexes containing ions of iron to the compositions of concrete.

Keywords: fine-grained concrete, a fine aggregate, iron compounds, plasticizers, concrete strength.

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DEFINITION OF EFFECTIVENESS OF β-$Ni(OH)_2$ APPLICATION IN THE ALKALINE SECONDARY CELLS AND HYBRID SUPERCAPACITORS (p. 17-22)

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Nickel hydroxide is widely used as an active material for alkaline accumulators and hybrid supercapacitors. One of the main parameters of the accumulator and supercapacitor operation is the stability of characteristics. β-$Ni(OH)_2$ is the most stable form of nickel hydroxide. To evaluate the effectiveness of using β-$Ni(OH)_2$ with high crystallinity in secondary cells and supercapacitors, the method of ultracrystalline β-$Ni(OH)_2$ synthesis by slow decomposition of tetraammine nickel hydroxide has been developed. Structural properties of the samples were studied by means of X-ray diffraction and specific surface area was calculated using the BET method from nitrogen desorption experiments. A comparative study of characteristics of ultracrystalline and highly crystalline commercial samples, by means of galvanostatic charge-discharge cycling in the accumulator and supercapacitor regimes was conducted. Low electrochemical effectiveness (coulombic efficiency of 35 %, specific capacity of 101.2 mA·h/g) of ultracrystalline β-$Ni(OH)_2$ in accumulator regime was demonstrated. It was discovered, that ultracrystalline β-$Ni(OH)_2$, prepared with the decomposition method has high specific characteristics in the supercapacitor regime. At high cycling current densities (40–120 mA/cm^2), specific capacities greatly increase, which is explained by the breakdown of hydroxide particle aggregates to smaller ones with an increase of specific surface area. The highest achieved capacities are 120.4 mA·h/g and 276 F/g.

Keywords: nickel hydroxide, high crystallinity, specific capacity, supercapacitor, alkaline accumulator, particle aggregate breakdown, decomposition method.

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DESIGN OF THE MODIFIED OXIDE-NICKEL ELECTRODE WITH IMPROVED ELECTRICAL CHARACTERISTICS (p. 23-28)

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The influence of lithium hydroxide was examined on the characteristic features of charge and discharge and electrical parameters of the sintered oxide-nickel electrode in a solution of potassium hydroxide. It is shown that the introduction of LiON to the composition of electrolyte does not lead to a change in the specificity of charge and discharge processes of the electrode. The experimental work conducted allowed us to establish dependences that connect the magnitude of analytical concentration of the Li^+ ions to specific capacity and capacity output of the electrode. The results obtained show that an increase in the content of Li^+ ions in the electrolyte from 1 to 100 $g \cdot l^{-1}$ causes a growth of the electrode's specific capacity from 0.79 $(A \cdot h) \cdot cm^{-2}$ to 1.84 $(A \cdot h) \cdot cm^{-2}$. It is optimal to introduce LiOH to the electrolyte in the amount of 30–50 $g \cdot l^{-1}$. It was established that the magnitude of specific capacity of the oxide-nickel electrode depends on the number of charge-discharge cycles and increases with an increase in the number, which is related to the slow character of the course of mass transfer processes in the volume of active mass of the electrode.

Keywords: oxide-nickel electrode, charge-discharge characteristics, active mass, lithium hydroxide.

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EXAMINING THE INFLUENCE OF ELECTROSYNTHESIS CONDITIONS ON THE COMPOSITION OF TIN-OXIDE CATALYST (p. 29-34)

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Tin dioxide can serve as an active material in micro- and optoelectronics, energy generation, and catalysis. Its synthesis method is determined by the scope of its application. We established regularities in the electrochemical synthesis of a catalytically-active oxide mixture on the surface of tin in alkaline solutions. By employing the original coulometric method we determined quantitative composition of the electrochemically-obtained oxide films in a wide range

of formation potentials. At an electrode potential of –0.3, the molar ratio of Sn(II)/Sn(IV) is equal to unity. Based on the analysis of processes that might occur under the specified conditions of electrosynthesis, it can be assumed that the surface of tin is coated with a thin layer of $SnSnO_3$.

Amorphous nature of the electrode surface, passivated at –0.3 V, indirectly confirms this assumption. At a potential of 3.0 V, the oxide film's content of Sn(IV) is 59 % (mol), Sn(II) – 41 % (mol). Consequently, the film contains 18 % (mol) of SN(IV), which is not included in the composition of $SnSnO_3$. In other words, active tin dioxide is formed exactly at such a potential. Catalytic activity of the obtained materials is demonstrated on the example of methyl tert-butyl ether electrooxidation. The starting concentration of MTBE on the tin electrode, oxidized at 3.0 V, is reduced by 98 % within 180 minutes, while only 73 % of MTBE is decomposed over the same time on a nickel electrode.

Keywords: electrosynthesis, tin dioxide, tin electrode, catalytic activity, composition of oxide mixture.

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DEVELOPMENT OF STYRENE-ACRYLIC POLYMERIC COMPOSITIONS FOR THE COATING OF TEXTILE MATERIALS USED FOR PACKING (p. 35-41)

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As a result of the determination of the chemical, physical-chemical and physical and mechanical properties of individual styrene-acrylic polymers and their compositions with crosslinking agents, it has been found that the formation of a strong three-dimensional spatial structure of films provides the styrene-acrylic polymer Lacrytex 430. It is possible to use this polymer without crosslinking agents. The additional introduction of Laproxide and Appretta ECO into the composition lowers the degree of structuring of polymer films.

It was established that for the Lacrytex 640 preparation, which has a low structuring index, the introduction of the glycidyl ester of the Laproxide 703 trade mark leads to an increase in the degree of crosslinking to 7.9 % and, as a result, to an increase in the resistance to organic solvents, to a reduction of hydrolytic degradation at high temperatures and to an increase in the physical-mechanical indicators.

Taking into account the need to obtain low-content compositions that provide a complex of necessary properties to the final product, the use of individual styrene-acrylic polymer Lacrytex 430 and Lacrytex 640/Laproxide 703 composition, which provides obtaining elastic coatings, is actual and economically sound.

Keywords: textile coatings, styrene-acrylic polymers, glycidyl esters, degree of structuring, elasticity.

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NEW VEGETABLE OIL BLENDS TO ENSURE HIGH BIOLOGICAL VALUE AND OXIDATIVE STABILITY (p. 42-47)

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The compositions of fatty acids of 15 types of vegetable oils of cold pressing have been studied to develop and justify the blends of sunflower oil with camelina oil, flaxseed oil and walnut oil as those

that have reasonable ratios of ω-3:ω-6 polyunsaturated fatty acids. The autocatalytic oxidation of the blends was studied at a storage temperature of (20±2) °C with free access of light and air. A significant slowdown in the rate of accumulatng peroxides and free fatty acids was established when blending 45 % of walnut oil or 40 % of camelina oil with the appropriate amount of sunflower oil.

The developed blend of 55 % of sunflower oil plus 45 % of walnut oil has been found to have a ratio of ω-3:ω-6 polyunsaturated fatty acids close to that recommended for daily nutrition. Blends of vegetable oils with a higher ratio of ω-3:ω-6 fatty acids (75 % of sunflower oil plus 25 % of flaxseed oil and 60 % of sunflower oil plus 25 % of camelina oil) are recommended by the authors for therapeutic nutrition.

Blending of traditional sunflower oil with other types of vegetable oils makes it possible to solve two problems – to increase the biological value of fat by optimizing the fatty acid composition and to increase resistance to oxidative spoilage. The developed blends of sunflower oil with walnut oil or camelina oil are stable to oxidation, so they can be recommended for making health-improving products.

Keywords: sunflower oil, walnut oil, camelina oil, gas chromatography, blending, ω-3 polyunsaturated fatty acids, ω-6 polyunsaturated fatty acids, biological value, peroxide number, antioxidant resistance.

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STUDY OF THE FORMATION MECHANISM OF GAS HYDRATES OF METHANE IN THE PRESENCE OF SURFACE-ACTIVE SUBSTANCES (p. 48-55)

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The process of hydrate formation of methane in the presence of SAS in the temperature range of 274–281 K was examined. The aim of the research conducted was to establish the effect of SAS on the process of GH formation, as well as to study kinetic features of their formation in the three-phase system "gas"–"water+SAS"→"solid body (GH)".

We applied a stalagmometric method with automated photoelectron counting of drops (measurement error is 0.1 %), a conductometric method, with electrical conductivity measured using the Wheatson bridge (measurement error is 0.05–0.1 %). Interphase electric potential was measured by a potentiometric method using the potentiometer PPTV 1.

Based on an analysis of the isotherms, by the indicators of surface tension of the aqueous solutions of SAS, we plotted isotherms of surface tension in the logarithmic σ–lgC_{SAS} coordinates. The isotherms in the region of low concentrations demonstrate a curvilinear section, on which, in accordance with the Gibbs equation, adsorption at the interphase boundary increases with an increase in the concentrations. The curvilinear section of the isotherm passes into a straight line; in this case, the adsorption reaches its maximum

value. Based on kink of the isotherm, we determined the value of CMC, which corresponds to the concentration of SAS equal to $1.75–2.00\cdot10^{-2}$ mol/l. The addition of SAS leads to a decrease in the magnitude of CMC.

While studying the mechanism of hydrate formation of methane in the presence of SAS, it was discovered that the hydrate formation mechanism includes the following stages: micellization and solubilization. However, an increase in the volume of absorbed methane in the presence of SAS, as well as the activation effect, indicate the micellar catalysis.

It is shown that the presence of SAS increases the amount of gaseous methane in GH by several times, as well as improves its quality (friability).

Keywords: gas hydrates of methane, micellization, surface tension, interphase electric potential, the rate of formation.

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MÖSSBAUER STUDIES OF SPINELLIDES OF MG(Fe_XCr_{2-X})O_4 SYSTEM OBTAINED BY THE HYDROXIDE CO-PRECIPITATION METHOD (p. 56-63)

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To establish regularities in formation of the magnetic microstructure in magnesium ferrite-chromites by the method of co-precipitation of hydroxides from chlorides of corresponding salts, ferrite spinels were synthesized with Mg(Fe_xCr_{2-x})O_4 composition. It was found by the method of X-ray diffraction analysis that the resulting spinel occupies an intermediate position between normal and inverse spinels. Substitution of chromium for a part of trivalent iron ions in the spinel phases leads to normalization of the spinel structure. The magnetic microstructure of the resulting samples, distribution of iron among sublattices and presence of Fe^{2+} ions were investigated by the method of Mössbauer spectroscopy.

It was established that the magnetically ordered phase is only present in samples with x>1.6. Due to the non-high sintering temperature, low symmetry of the near surrounding and continuous distribution of effective magnetic fields on the Fe^{3+} nuclei were observed in the samples. Analysis of the results of Mössbauer and X-ray structural studies has shown deviation of the real near surrounding of the iron ion from the most probable surrounding. No Fe^{2+} ions were detected by the Mössbauer method in these samples. There is a good agreement in the relation between population of the iron ions among octahedral and tetrahedral sublattices (≈2.0) found by methods of X-ray and Mössbauer analysis. The obtained information confirms significant dependence of the properties of ferrite-spinels on the features of synthesis and shows necessity of checking the sample characteristics during changes or modifications in the production methods.

Keywords: Mössbauer spectroscopy, magnesium ferrite-chromites, spinel, crystalline structure, precipitation method.

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RESEARCH INTO COMPLEXING PROPERTIES OF POLYACRYLONITRILE COMPLEXITE IN THE MIXTURES OF WATER-DIOXANE (p.63-69)

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We studied complexing properties of a fibrous complexite based on polyacrylonitrile relative to copper(II) ions taking into consideration solvation parameters of polymer ligands in the mixed solvent of water-1.4-dioxane. The object was obtained through chemical modification of the industrial fiber nitron; it has in the grafted chains the complexing groups of amidoxime, hydroxamic acid and carboxylic groups. Complexation equilibria and stability of the complexes of copper(II) with the complexite were studied using the potentiometric titration methods, infrared spectroscopy, spectroscopy of diffuse reflection, swelling. Complexing properties of the polyacrylonitrile complexite have been identified relative to copper(II) ions in the mixtures of water-1.4-dioxane. Complexation takes place with the participation of hydroxamic groups of the polymer. In the range of pH 3.8–6.2, along with hydroxamic groups, in the mixtures with a molar share of dioxane at 0.17 and 0.32, the formation of HMCC-Cu^{2+} involves amidoxime groups. The character of change in the stability constants of HMCC-Cu^{2+} with an increase in the content of dioxane is due to the structural characteristics of mixtures, particle over-solvation, restructuring of the coordination centers of HMCC by introducing to their coordination sphere the DO molecules, and reveals the essential role of specific solvation. It was found that solvation effects in the mixture of water-1.4-dioxane with a molar share of dioxane at 0.00–0.17 reduce stability of the resulting complexes of HMCC-Cu^{2+}. The biggest impact of solvation parameters of the complexite is achieved in the composition of mixture at 0.32.

Keywords: modified polyacrylonitrile fiber, complexation, stability constants, solvent water-1.4-dioxane.

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