ABSTRACT AND REFERENCES

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A STUDY OF THE INCREASED TEMPERATURE INFLUENCE ON THE ELECTROCHROMIC AND ELECTROCHEMICAL CHARACTERISTICS OF $Ni(OH)_2$-PVA COMPOSITE FILMS (p. 6-12)

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Electrochromic devices, as an element of "smart" windows, can be exposed to extreme temperatures due to their purpose and location. Exposure to high temperatures can change the characteristics of electrochromic devices and lead to malfunction. The present study is intended to fill in the gaps related to the stability of electrochemical and electrochromic parameters of one of the known materials – nickel hydroxide (II).

The present study highlights changes in some physico-chemical characteristics that occur during prolonged exposure to high temperature in different media. $Ni(OH)_2$-polyvinyl alcohol, prepared using the cathodic template method, was aged at 80 °C under the air atmosphere and in the working electrolyte solution – 0.1 M KOH for 8 hours. The temperature was chosen based on the maximum registered temperature on Earth, possible film heat up and possible rapid degradation of electrochromic films.

As a result, it was found that degradation does occur in a basic solution, while on air some improvement was observed instead. The authors propose the mechanism that explains experimental results, which lies in "ageing" of active material Ni(OH)2. The latter occurs in the active mass of alkaline batteries. Possible methods for preventing degradation are also proposed, which can be realized with the use of thickened electrolytes or special films that are deposited onto the electrochrome.

Keywords: electrochromic device, electrochemical deposition, nickel hydroxide, template, polyvinyl alcohol, degradation, re-crystallization, basic solution, coloration, bleaching.

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SURFACE MODIFICATION OF MAGNETIC TiO_2 CORE-SHELL WITH DOPED CERIUM FOR ENHANCEMENT OF PHOTOCATALYTIC PERFORMANCE (p. 13-20)

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The core-shell structure of Ce-doped TiO_2@SiO_2@(Ni-Cu-Zn) ferrite noted of CTSF as composite nanoparticles (NPs) was synthesized using a modified sol-gel method. The physicochemical properties of as-prepared products were characterized completely by X-ray diffraction (XRD), Brunauer-Emmit-Teller (BET), X-ray photoelectron spectroscopy (XPS) and superconducting quantum interference device (SQUID), serially. Meanwhile, assessment of the photocatalystic activity of catalyst was performed by ultraviolet-visible spectrometry (UV-vis). The results of the study show that the anatase phase related to the TiO_2 structure was constructed on the outer shell coating of composite NPs. However, the second phase associated with the Ce structure was not easy to be detected on the XRD pattern, confirming that the doping Ce had been incorporated into the TiO_2 crystal structure. The mesoporous structure of Ce-doped TiO_2 layers was demonstrated by the type IV isotherm and H3 type hysteresis loop. The homogenous pore size was generated with the specific surface area up to 111.916 m^2/g and 0.241 cc/g of pore volume. The stoichiometry of the chemical composition formed with fewer defects on the surface of TiO_2 layers was exhibited by the symmetry curve of Ti $2p_{3/2}$ and Ti $2p_{1/2}$ peaks of XPS

spectra. Meanwhile, the redox couple corresponding to Ce^{3+}/Ce^{4+} was incorporated inside the thin TiO_2 coating. Furthermore, the catalyst magnetic NPs can be also separated by using an external magnetic field from the reaction system. The product performance associated with the degradation efficiency was achieved to be 50 % in the aqueous solution of methylene blue (MB).

Keywords: Magnetic photocatalyst, Photodegradation, Cerium doped TiO_2, surface modification, photocatalytic performance.

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TECHNOLOGY OF THE COMPREHENSIVE DESALINATION OF WASTEWATER FROM MINES (p. 21-27)

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The issue of desalination is relevant for many countries of the world; the most promising technology for demineralization appears to be membrane technology. The stabilizing treatment of water before feeding it to the membrane filters involved the ion exchange softening of the solution based on the weakly acidic cation exchanger DOWEX MAC-3 in the H^+ and Na^+ forms. This makes it possible to improve the efficiency of baromembrane desalination and the service time of membranes. The nanofiltration membrane OPMN-P ensures the purification of low mineralized waters from sulfates (by 74–93 %) and hardness ions (67–90 %); at the same time, the membrane has low selectivity in terms of bicarbonate anions and does not retain chlorides. This avoids the accumulation of these in the concentrates at the nanofiltration purification of low mineralized waters. The inverse osmotic membrane Filmtec TW30-1812-50 shows selectivity for sulfates and hardness ions of over 99 %. The selectivity for chlorides is 83–94 % for low mineralized water, and 90–95 % for highly mineralized water. The concentrates contain hardness ions, sulfates, chlorides, and bicarbonate anions in significant concentrations. We have defined conditions for the effective softening of the formed concentrates at the comprehensive treatment by lime and aluminum coagulants. When desalinizing the concentrate of low- and highly mineralized waters, the sulfate concentration decreased to 2.55–6.53 mg-equiv./dm^3 and 3.31–9.02 mg-equiv./dm^3, respectively. At the same time, the concentration of hardness ions was 3.31–9.02 mg-equiv./dm^3 and 4.20–10.65 mg-equiv./dm^3. Creating comprehensive technologies for the purification of mineralized waters makes it possible to ensure the proper efficiency of water desalination and to utilize the waste formed with obtaining useful products. That could reduce anthropogenic pressure on the environment and solve the problem of freshwater shortage for people and industry.

Keywords: mineralized water, nanofiltration, reverse osmosis, selectivity, productivity, sulfates, hardness ions.

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THE EFFECT OF METHYL HYDROXYETHYL CELLULOSE ON THE CEMENT MATRIX PROPERTIES (p. 28-33)

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The effect of a methyl hydroxyethyl cellulose additive on the technical and physical-mechanical properties of the cement matrix has been investigated. The study involved cellulose ether of low (11,000–16,000 MPa·s), medium (17,000–23,000 MPa·s), and high (20,000–30,000 MPa) viscosity. The additives were introduced into cement in the amount of 0.25, 0.5, and 0.75 % by weight. It has been established that the introduction of cellulose ether in cement leads to an increase in the normal density of the slurry and extends the duration of the mortar setting. The normal density of cement slurry increases with the introduction of cellulose ethers of low viscosity (LV) and medium viscosity (MV) by 5.4–16.8 %; when introducing the ether of high viscosity (HV), by 21.3–41.4 %. This confirms the high water-retaining capacity of methyl hydroxyethyl cellulose, which increases with increasing viscosity of the additives. The setting duration of cement slurry increases, depending on the concentration and viscosity of the additives, by 2–4 times, compared with an additive-free material. There is also a significant reduction in the strength of the cement matrix in the early periods of hardening (1–7 days) depending on the concentration of the additives, by 2.2–4.2 times. The strength of the samples is least affected by the cellulose ether of low viscosity, largest – by that of high viscosity. The reduction of strength is observed at the age of 28 days, although not very much pronounced. Compared to the additive-free cement, the strength amount to: for the ester of low viscosity at concentrations: 0.25 % by weight – 14.3 %, 0.50 % by weight – 23.9 %, 0.75 % by weight – 40.5 %; for the ether of medium viscosity, respectively, 23.8, 26.2, and 33.3 %; for the ether of high viscosity, 28.6; 45.2, and 61.0 %. The corrosion resistance of the cement matrix with methyl hydroxyethyl cellulose additives is increased at a concentration of up to 0.25 % by weight and then gradually decreases. The above results make it possible to recommend using, in the production of dry construction mixtures, the cellulose ethers of low and medium viscosity, which would ensure the required time to maintain the solution mobility and the sufficient strength of the resulting material.

Keywords: dry construction mixes, methyl hydroxyethylcellulose, cement, normal density, setting time, strength, corrosion resistance.

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ANALYZING THE CAUSES OF CRACK FORMATION IN PORCELAIN AND THE WAYS TO ELIMINATE THEM (p. 34-41)

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The studies deal with the porcelain products produced by casting finely-dispersed slips into gypsum molds. The causes of the occurrence of cracks on the edges of products after bisque and glazed firing were established and the ways of their elimination were proposed.

As a result of the comprehensive research into the basic ceramic mass of the assigned composition and products from it, a series of the technological factors that cause cracking were determined.

Determining the fineness of grinding of production slips of various batches showed that the residue on sieve No. 0063 ranged from 0.7 to 3.5 %. The direct correlation between the occurrence of cracks in products and an elevated indicator of the residue that contributed to the stratification of a ceramic slip in the process of settling in gypsum molds was established. This led to the emergence of internal stresses in the structure of a potsherd. It was established that another factor that caused cracking of products was the existence in the composition of the ceramic mass of large quartz grains, which in the heating-cooling process are capable of modification transformations. In addition, the low temperature of bisque firing did not contribute to the completion of the process of dehydration of clay and mica minerals, which strengthened the internal stresses in a potsherd.

The research revealed that to ensure qualitative indicators of ceramic products, it is necessary not only to control the residue on a sieve but also to take into consideration the distribution of the fractional composition of a ceramic slip, while the content of the quartz component of 30–63 μm should not exceed 12 % by weight. This contributes to the formation of a dense homogeneous potsherd with a high content of a mullite phase.

As a result of the research, it was also proposed to change the temperature of bisque firing from 660 to 800 °C. It is at this temperature that the processes of dehydration of layered silicates are completed and the shrinkage processes are stabilized.

The obtained results can be applied at the typical production of household products from low-temperature porcelain.

Keywords: slip, grinding, quartz, water absorption, firing, porcelain, cracking, strength, sintering, shrinkage.

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CLUSTER MODEL OF THE POROSITY OF SPONGY TITANIUM BRIQUETTES AT THE STAGE OF PRESSING (p. 42-52)

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The main factors of the formation of porosity of pressed products based on spongy titanium were studied. Three types of pores were studied and separated – cluster (in the place of particles), inter-cluster, and natural pores of the material. The cluster models of particles packing at the stages of pressing were developed (from bulk density, or the formation of temporary structures to the formation of stable structures). The number of cluster faces in the models depends on coordination number λ, which means tetrahedral (λ=4) clusters at the initial stage and cuboctahedral (λ=12) at the later ones. Based on the Gaussian rule, for spheres packing, it was found that the most correct form of clusters for later pressing stages is cuboctahedral, as the pores between the spheres at the maximum tight packing with the coordination number of 12 have the shape close to cuboctahedrons and octahedrons, but with concave faces. Based on the difference between the volume of spheres, for which particles and clusters in the model were accepted, based on calculated

volumes of intercluster octahedrons and cuboctahedrons, the volume of pores in the shape of the Steiner octahedron or cuboctahedron was calculated. In calculating the strength of adhesion between the particles, the proper porosity of spongy titanium is determined through the assumption that a part of the powder is a conglomerate that is formed from hollow spheres of the regular shape at the stage of titanium reduction by the magnesium thermal method. Accordingly, in the formula for calculating the strength of adhesion, the force that influences a particle will consist of the difference between forces of elastic deformation and the destruction of hollow spheres contained in the deformed volume. The developed models were proved by the results of practical research. Actual measurements show the average exponential ratio of the porosity to pressing pressure, which makes it possible to calculate s maximum inter-cluster porosity at the maximum compaction of 66 % and the compression factor of the studied material of 0.15.

Keywords: composites, powder metallurgy, spongy titanium, packing of particles, pressing, types of pores.

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