

THE EXERGY ANALYSIS OF ENERGY EFFICIENCY OF THE TECHNOLOGY OF GRANULATED PHOSPHORUS-POTASSIUM FERTILIZERS (p. 4-10)

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The need for creating of complex mineral fertilizers was demonstrated, namely, granulated phosphorus and potassium fertilizers, which are a certain alternative to basic superphosphate. The advantages of the semi-dry method of granulation of phosphorus and potassium fertilizers were defined, which consist in the agglomeration of phosphorite powder with the help of the plasticizer based on the compounds of potassium at humidity of the charge not exceeding 12 %. The structural scheme of the technology of obtaining phosphorus and potassium fertilizers was presented with indication of the amounts and temperatures of material flows.

It was demonstrated that the technology of phosphate mineral fertilizers by the method of granulation of pulp and drying of granules possesses increased energy expenditures for their production. It is indicated that the technology of phosphorus and potassium fertilizers, obtained by the semi-dry method, is based on the fabrication of granules by the method of agglomeration, that is why we may expect that this technology will have lower energy consumption, and, therefore, the important question is the analysis of completeness of the use of supplied thermal energy to the main technological equipment, i. e., the exergy analysis.

We proposed the method of the exergy analysis of technological flows, which makes it possible, by the represented analytical dependences, to determine the exergy expenses and losses by each technological stage in the technology of phosphorus and potassium fertilizers. The summary exergy balance of the technology of phosphorus and potassium fertilizers is presented and analyzed. The comparison of energy costs for the production of phosphorus and potassium fertilizers and ammoniated superphosphate was carried out, as a result of which we demonstrated the decrease in the expenses when obtaining phosphorus and potassium fertilizers by 30 % in comparison to the widely used ammoniated superphosphate.

Keywords: phosphorus and potassium fertilizers, technological stages, exergy losses, energy efficiency, exergy performance efficiency.

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ANALYSIS OF PROPERTIES OF MODIFIED KAOLINS AND WATER-DISPERSION PAINTS DEVELOPED ON THEIR BASE (p. 11-16)

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Analysis of the effect of modified kaolins on the formation of properties of water-dispersed paints was conducted.

It was determined that, as a result of the kaolin modification by 3-aminopropyltriethoxysilane, their adsorption and physical and chemical properties (wettability and specific effective surface by water and benzene) were changed. Specific effective surface of kaolin from Glukhovetskiy deposit was increased by benzene by 26.47 %, from Prosiyanivskiy deposit – by 5.9 %. The same indicator by water was decreased by 26.1 % for the kaolin from Glukhovetskiy deposits and 3.4 % for the kaolin from Prosiyanivskiy deposit. The adsorption of acrylic-styrene polymer by respective kaolins was increased by 32.1 % and 23.8 %.

The processes of interaction of kaolins with a modifier and styrene-acrylic film former were studied; the parameters of the main characteristic bands responsible for valence fluctuations of reactive capable groups of kaolins and film former were analyzed. The results of the study demonstrated that, due to the modification of kaolins by 3-aminopropyltriethoxysilane, their polymeric philicity was increased.

The pre-modified kaolins, characterized by the most complete interaction with styrene-acrylic film former, are proposed to use as fillers for water-dispersion paints. This will ensure the higher performance properties of paints and coatings: elasticity at the level of 2–4 mm, the edge angle of wetting at the level of 89–95 degrees, tensile strength in the range of 5.53–6.81 MPa, which is by 18–51 % larger than when using non-modified fillers. It was determined that improving the compatibility of kaolins with the film former of water-dispersion paints allow forming coatings more resistant to corrosive liquids, with low water absorption at the level of 8.1–9.7 % mass %, i. e., by 17.9 % – 10.4 lower than when adding non-modified kaolins.

Keywords: water-dispersion paint, kaolin, modification, styrene-acrylic film former, 3-aminopropyltriethoxysilane.

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DEFINITION OF FACTORS INFLUENCING ON Ni(OH)₂ ELECTROCHEMICAL CHARACTERISTICS FOR SUPERCAPACITORS (p. 17-22)

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Nickel hydroxide is widely used as an active material for hybrid supercapacitors. To improve the characteristics of supercapacitors, Ni(OH)₂ with the optimal parameters to be determined should be synthesized. For this, Ni(OH)₂ samples were prepared by various methods: decomposition, homogeneous precipitation, electrochemical synthesis using slit diaphragm electrolyzer under various current densities, with diaphragm or membrane, carbonate activation, immediate ultrasound post-treatment and an industrial sample, prepared by chemical route. Structural properties of the samples were studied by X-ray phase analysis, specific surface area – BET method by nitrogen adsorption, electrochemical characteristics – galvanostatic charge-discharge cycling in the supercapacitor mode. It has been demonstrated that high specific capacity is the most affected by α (or layered $\alpha+\beta$) structure, optimal (average or low) crystallinity, introduction of activating additive and the ability of particle agglomerates to undergo breakdown into smaller particles during charge-discharge. Specific surface area has little influence on specific capacity. The sample prepared in slit diaphragm electrolyzer at 15.7 A/dm² has a layered type of crystal structure, and the ability of particle agglomerates to undergo breakdown into smaller particles during charge-discharge, and showed the highest specific capacity of 650 F/g.

Keywords: nickel hydroxide, specific capacity, supercapacitor, crystallinity, particle agglomerate breakdown.

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OBTAINING STABILIZED NANODISPERSED IRON BASED ON ORGANOFILIZED MONTMORILLONITE (p. 23-28)

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The synthesis of zero-valent nano-dimension iron on the surface of montmorillonite and organomontmollonite by reducing aqueous solutions of Fe^{2+} salts by sodium borohydride was conducted. The results of RFA and IR-spectroscopy indicate formation of a monolayer of SAS (HDTMA) both on the outer surface of the particles of montmorillonite and among structural packages of montmorillonite. In this case, organofilization of the surface contributes to the formation of more dispersed particles of zero-valent iron.

The physical and chemical features of the processes of sorption cleaning of contaminated waters from chromium(VI) compounds using the obtained nanodispersed material were explored. It was established that the sorption of ions $\text{Cr}(\text{VI})$ by the composite adsorbent based on zero-valent iron and organomontmorillonite amounts to 120 mg/g of Fe, which significantly exceeds sorption for the original montmorillonite, organomontmorillonite, nano-dimension iron and the composite sorbent based on montmorillonite and nano-dimension iron.

Based on the study of structural and rheological properties, it was established that with the content of iron in sorbent equal to 0,037÷0,146 %, the suspension remains resistant to aggregation and sedimentation. This, together with their rather high sorption characteristics, makes it appropriate to use aqueous dispersions of organomontmorillonite with the applied layer of the synthesized highly dispersed reactive material when cleaning ground waters from ions of heavy metals (chromium) using the latest environmental technologies based on pumping aqueous dispersions of nanomaterial into contaminated layers of soil.

Keywords: stabilized nanodispersed iron, montmorillonite, organomontmorillonite, sorption, chromium (VI), rheological properties.

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THEORETICAL AND EXPERIMENTAL RESEARCH INTO MANUFACTURING OF SILICATE PRODUCTS WITHOUT THERMAL TREATMENT (p. 29-36)

Varvara Vinnichenko, Alexander Krot, Natalia Vizenko

We conducted thermodynamic studies of creation of the compounds of calcium hydrosilicates. The comparison was performed of the use of calcium hydroxide and calcium oxide in the calcium-silicate mixture. It is demonstrated that the higher thermodynamic probability of reaction is characteristic for calcium oxide. The values of enthalpy of reaction with calcium oxide were examined. Reaction with calcium oxide has an exothermic character. The use of calcium hydroxide leads to the endothermic nature of reaction. The effect of mechanical activation and chemical activation on strength of the samples of silicate brick is confirmed. The joint action of these types of activation is more effective. The occurrence of a synergetic effect with the joint action on the mixture of mechanical and chemical activation is shown. It was established that the joint action of mechanical and chemical activation creates conditions for reactions of the creation of calcium hydrosilicates without an autoclave. This is important since this makes it possible to create more energy-efficient technologies for silicate building articles.

Keywords: silicate brick, enthalpy of reactions, calcium oxide, calcium hydroxide, activation, energy-saving.

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REGULARITIES OF THE PROCESS OF SULFATION OF THE MIXTURES OF ORGANIC SUBSTANCES (p. 37-43)

Alyona Dzevochko, Mykhaylo Podustov

The main advantages and disadvantages of sulfating agents in the technology of obtaining surface active substances are presented. Characteristics of the apparatus-technological schemes of sulfating process of organic raw materials are given.

The results are represented of research into the process of sulfation of the mixtures of organic substances by low-concentrated gaseous sulphur trioxide in a volumetric reactor. Materials and methods of the research process are described. We experimentally found the ratio of higher alcohols of fraction C₈–C₁₀, higher alcohols of fraction C₁₂–C₁₄ and monoethanolamides of fatty acids of coconut oil (FA MEA) in the original mixture of organic raw materials. We demonstrate dependency of surface tension of aqueous solutions of SAS on the content of FA MEA. Dependencies of surface active substances quality on the main technological parameters are defined: molar ratio of the reagents, concentration of sulfur trioxide and temperature of the process of sulfation. It is demonstrated: at molar ratio of reagents 1.08:1, the maximum degree of sulfation is achieved with a slight increase in pastes chromaticity; the concentration of SO₃ in the gas air flow must be maintained within 3.5–4.5 % by volume, the recommended temperature of the process is 318 K with a gradual decrease to 303 K. The data are presented on the change in magnitudes of density and viscosity of the reaction masses in the course of this process. Density of the reaction masses depends linearly on the degree of sulfation and decreases with increasing temperature. Dynamic viscosity of the reaction masses has an extremum at the degree of sulfation 70 % and a minimum at the degree of sulfation 85 %.

Keywords: sulfating agent, sulfation, reactor, reaction mass, density, viscosity, surface active substance.

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SYNTHESIS OF ACRYLATES FROM METHYL PROPIONATE, PROPIONIC ACID AND FORMALDEHYDE IN THE GAS PHASE ON SOLID CATALYSTS (p. 44-48)

Nazariy Lapychak, Volodymyr Ivasiv, Roman Nebesnyi, Zorian Pikh, Iryna Shpyrka

Development of active and selective catalysts for the process of obtaining methacrylic acid and methyl methacrylate from methyl propionate, propionic acid and formaldehyde is one of important stages to industrial implementation of this process. In order to solve this problem, we designed catalysts based on oxides of boron and phosphorus that were promoted by oxides of zirconium, tungsten and bismuth with varied content of oxides. The effect of temperature was examined on the conversion of reagents, the selectivity of formation and the yield of methyl methacrylate and methacrylic acid on the created catalysts. With increasing temperature, the conversion increases, the selectivity of formation of acrylates decreases and the total yield of acrylates has the maximum. It was found that without adding methanol, the optimal catalyst by acrylates yield is the one, in which the molar ratio of the $ZrO_2:WO_3$ promoters is 0.15:0.15. The total yield of the target products at optimum temperature of 593 K is 52.3 % with the total selectivity of their formation at 96.4 % and the conversion of reagents of 54.2 %. We determined the effect of adding methanol to the reagent mixture. Adding methanol increases the ratio of products MMA/MAA, and the optimal catalyst by the total selectivity of formation of the target products is the one promoted by bismuth oxide with the molar ratio of $Bi_2O_3/P_2O_5 = 0.3$, which at a temperature of 593 K provides for the selectivity of formation of acrylates of 100 % with the yield of 33 %. The maximum total single-pass yield of MMA and MAA on this catalyst at a temperature of 623 K is 51.5 %, at the total selectivity of their formation of 91.6 %. However, the share of MMA in products is lower in comparison to the catalyst, promoted by the mixture of tungsten and zirconium oxides.

Keywords: methacrylic acid, methyl methacrylate, propionic acid, aldol condensation, catalyst, methyl propionate, formaldehyde.

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OPTIMIZATION OF LEATHER MATERIAL FILLING-PLASTICIZING PROCESS USING DISPERSE SYSTEM (p. 49-55)

Anatoliy Danylkovych, Olga Sanginova, Vasyl Chervinskyi

The second-order mathematical model is obtained on the basis of experimental data at the PJSC Chinbar (Ukraine) using experimental design techniques. The model describes the semi-finished leather filling- plasticizing process adequately. The filling-plasticizing leather material is obtained from cattle raw material using chrome tanning method and slicing the material to 1.5–1.6 mm thickness. The dispersing mixture of natural fats and oils: beef tallow, sunflower oil, and fish oil in a ratio of 1:1.75:2.25 % was used

for plasticizing the semi-finished material. The nonionic surface active agent was used to emulsify the fats. The diagrams of single-factor dependencies for simulation models are obtained, and the influence of disperse system ingredients on basic technological properties of the leather material are analysed. The studied ingredients were plasticizer, modified filler, nonionic surfactant. The studied quality parameters were the output area of the semi-finished product, the total content of fatty substances in the tanning material and the hardness of material.

The software calculation module in the Visual basic for Application environment is developed to automate the calculation of the optimal dispersed system composition. The module allows converting multi-criteria task into single-criterion task using maximin convolution and Hooke-Jeeves method to solve the optimization task. As a result, the optimum values of the factors that influence the semi-finished leather filling-plasticizing process conditions are found. The optimum values of the concentration parameters of disperse system ingredients using multi-criteria constrained optimization task of the filling-plasticizing process are found. The output area of the leather material with a minimum hardness of 19.0 sN is increased as compared to the control technology by 7.0 % with 115.3, 22.5, 23.9 concentrations in the solution of plasticizer, modified filler and a nonionic surfactant, respectively. In addition, the fatty substances content in the finished material is 7.6 %, that complies with DSTU 3115-95 "Leather for Garments. General Specifications". The developed software module can be applied for the optimization of technological processes of composite materials formation.

Keywords: Hooke-Jeeves method, optimization of filling-plasticizing process, leather material, technological properties.

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