ABSTRACT AND REFERENCES
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RESEARCH OF THE INTRAMOLECULAR INTERACTIONS AND STRUCTURE IN EPOXYAMINE COMPOSITES WITH DISPERSED OXIDES (p. 4-12)

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With the help of the software package HyprChem, using a method of quantum-chemical modeling, research into intermolecular interactions between epoxyamine grid and oxides of different chemical nature Al_2O_3, Fe_2O_3, TiO_2, CaO was carried out. To take into account hydroxyl-hydrate surface layer of oxides, molecular complexes of the fragment of epoxyamine grid and hydroxides of metals $Al(OH)_3$, $Fe(OH)_3$, $Ti(OH)_4$, $Ca(OH)_2$ were used as models. As a result of modeling, it was established that $Ca(OH)_2$ molecule forms strong intermolecular bonds and has the greatest influence on the spatial conformation of the epoxyamine fragment. It was shown that a calcium atom is oriented to π-electron cloud of the benzene ring with formation of donor-acceptor bond, and OH-groups form hydrogen bonds with OH-groups of the residue of a molecule of epoxy oligomer in the grid. The studied intermolecular interactions of epoxyamine grid and hydroxides of amphoteric metals $Al(OH)_3$, $Fe(OH)_3$, $Ti(OH)_4$ indicate the formation of low-energy inductive and dipole-dipole (orientation) bonds. It was established that existence of amphoteric hydroxides does not cause a change of the spatial conformation of the grid's fragment. It was shown that the ability of hydroxides of metals to affect the spatial conformation of a fragment of the epoxyamine grid increases in the series: $Ti(OH)_3<Al(OH)_3<Fe(OH)_3<Ca(OH)_2$. The resulting series coincides with the series, in which basic properties of active Branstad centers (OH-groups) with the central elements $Ti^{4+}<Al^{3+}<Fe^{3+}<Ca^{2+}$ increase (acidic properties decrease). The influence of the oxide filler on the structure and spatial conformation of epoxyamine grid increases with an increase of basicity (alkalinity) of an oxide. Resistance of composites to aqueous aggressive media depends on the surface acidic-basic properties, dispersion and package density of fillers' particles in the polymer matrix. When adding strongly basic calcite oxide (CL), chemical resistance of composites decreases by 5 times. In this case, composites with non-homogeneous structure and non-uniform distribution of compacted areas are formed. It was found that when adding amphoteric rutile oxides (RT), alumina (AL) and hematite (HM), the main factors that affect chemical resistance of filled composites include dispersion and package density of fillers' particles. The calculated parameter a of composites, which describes package density of the filler in the polymer matrix, increases in the series of fillers HM<RT<AL. This series coincides with the series, in which resistance of filled composites in all aggressive media decreases. At an increase in package density of a filler, probability of pegridration of aggressive medium into the material decreases, which is associated with extension of the diffusion path.

Keywords: intermolecular interaction, epoxyamine polymer composite, dispersed oxide filler, acidic-basic properties.

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TRIBOTECHNICAL RESEARCH INTO FRICTION SURFACES BASED ON POLYMERIC COMPOSITE MATERIALS (p. 12-19)

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The technique of controlling coefficients of friction and temperature was developed. As a result of application of a tribometer, which excludes misalignment of the sample and the counter sample, it was possible to avoid the macro-alignment. Applicability of the Euler's formula for calculating friction coefficients was proved both when operating by the scheme "shaft – sleeve" and when operating with a flexible steel belt – the counter sample. The developed technique of controlling the mode of friction and lubrication by the character of oscillograms and by measuring temperature change rate $\Delta T/\Delta t$ allowed determining the region of boundary friction. This is the range of small velocities of up to 0.1 m/s, on which at an increase of sliding velocity V, temperature increase rate $\Delta T/\Delta t$ also grows.

Comparative research into tribotechnical characteristics of the polymeric material "Moglice" and the developed new polymeric composite material DC-6 were conducted. Coefficients of sliding friction of the couples "cast iron – DC-6" and "cast iron – moglice" are close in magnitude and are within 0.050...0.058. Temperature of friction of materials "Moglice" and "DC-6" increases with an increase in sliding velocity up to 0.078 m/s and reaches 60 °C and 70 °C, respectively.

Thus, to restore damaged or worn friction surfaces of metal-cutting machine tools, it is possible to apply such polymeric materials as "Moglice" and "DC-6". The composite polymeric material "DC-6" has friction coefficients and thermal resistance, which are similar to those of the polymer "Moglice" and can replace the more expensive repair material "Moglice".

This result opens up broad prospects for the application of new polymeric material that would significantly reduce the cost of repairing and restoration work of the guides of machine tools.

Keywords: metal-cutting machine tools, slide guides, tribotechnical characteristics, polymeric composite materials, friction coefficient.

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STUDY INTO FORMATION OF COBALT-CONTAINING PEO-COATINGS ON AK12M2MGN FROM A PYROPHOSPHATE ELECTROLYTE (p. 19-27)

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We studied the process of formation of cobalt-containing oxide coatings using plasma-electrolytic oxidizing of the aluminum alloy AK12M2MgN in pyrophosphate electrolytes. It was established that the use of given type solutions contributes the homogenization of silumin surface and creates preconditions for the dopants incorporation to the growing oxide coating. It is shown that PEO parameters depend on the concentration ratio of cobalt sulfate and potassium pyrophosphate in a working solution. Based on the results of experimental study, we demonstrated the ways to control the structure and surface morphology of cobalt-containing PEO-coatings through the variation in the concentrations of electrolyte components.

The composition of a pyrophosphate electrolyte for the formation of oxide PEO-coatings with a high cobalt content and developed surface morphology is substantiated. It is noted that the obtained oxide coatings could be used in catalytic reactions in order to decompose natural and technogenic toxicants.

Keywords: oxide coating, silumin, plasma-electrolytic oxidizing, pyrophosphate electrolyte, surface morphology.

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ANALYSIS AND CHOICE OF COATINGS FOR INCREASING THE DURABILITY OF PARTS OF DIFFUSION UNITS OF SUGAR PLANTS (p. 27-34)

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We carried out the study on properties of coatings made of powder materials, which have a high wear and corrosion resistance, to increase durability of parts of diffusion apparatus, which operate in aggressive technological media of sugar beet production. We studied electrochemical properties of the selected coatings and determined the influence of temperature, composition of a technological medium of beet sugar production and electrochemical characteristics of coatings on processes of corrosion and mechanical wear of equipment parts.

When the temperature of acidic diffusion juice increases, the electrode potential of friction surfaces moves to the negative side, corrosion currents increase, which indicates an increase in the rate of corrosion.

A rate of electrochemical processes on friction surfaces determines the intensity of corrosion and mechanical wear of metals and protective coatings. One of the reasons for slowing down the intensity of wear of materials is the presence of sucrose in the solution. An increase in the concentration of sucrose in diffusion juice leads to the passivation of surfaces of friction of parts, increases the carrying capacity of sliding bearings and reduces the intensity of corrosion and mechanical wear. PN55T45 coating has the highest corrosion resistance according to the obtained values of electrochemical characteristics and corrosion rates under conditions of corrosion and mechanical wear.

We established that the intensity of wear of all coatings reduces with the increase in the load on a friction contact at the selected range, and the intensity of wear of all investigated coatings remains approximately the same at the maximum sliding rate. The highest wear resistance at low loads and sliding rates has PN85U15 covering.

We can recommend all investigated protective coatings for the protection of parts in neutral technological media with abrasive wear. In particular, PN55T45 coating can be used to protect cases and screws, and PN85U15 coating - to strengthen sliding bearings of diffusion apparatus.

The study carried out makes possible to substantiate and rationally choose materials for strengthening of surfaces of equipment parts of sugar factories, which operate under conditions of active liquid medium under the action of corrosion and mechanical wear.

Keywords: protective coatings, diffusion juice, electrochemical properties, corrosion and mechanical wear.

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A STUDY OF ENVIRONMENTALLY SAFE OBTAINING OF MOLYBDENUM-BASED ALLOYING MATERIAL BY SOLID PHASE EXTRACTION (p. 35-40)

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The study has determined an increase of the degree of thermal carbon extraction of the molybdenum oxide concentrate from 11 % to 97 % with an increase in the processing temperature from 873 K to 1373 K, respectively. A further rise in temperature to 1473 K led to a reduction in the degree of recovery to 89 %. The recovery products after treatment at 873–1073 K mostly consisted of MoO_2 with some Mo and Mo_2C manifestations. Treatment at 1223–1473 K provided a predominance of Mo and Mo_2C as to the oxide component. The microstructure of the recovery products was spongy and disordered with varying degrees of sintering, depending on the processing temperature. The alloying of R6M5 steel with the new molybdenum material in experimental industrial conditions provided an increase in the Mo uptake rate from 88.9 % to 95.0 % compared with the standard technology. Improvement of environmental safety is achieved by replacing carbon monoxide and aluminothermic melting of ferroalloy production of Mo with the latest methods of powder metallurgy.

Keywords: molybdenum concentrate, thermal carbon extraction, metallization, sublimation, phase analysis, microstructure, resource sparing.

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HIGH-ENERGY ULTRASOUND TO IMPROVE THE QUALITY OF PURIFYING THE PARTICLES OF IRON ORE IN THE PROCESS OF ITS ENRICHMENT (p. 41-51)

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The iron-magnetite raw material extracted in Ukraine is characterized by a complex texture, structure, and a high content of harmful impurities such as silicon dioxide, potassium oxides, sodium, magnesium, and sulfur. At the same time, the requirements for the quality of iron ore concentrates entering the further metallurgical processing are increasing, as the high quality of magnetite concentrates can significantly reduce the cost of metallurgical production.

Meanwhile, the quality of concentrates decreases mainly due to the formation of technogenic micron splices in the iron ore pulp. The main reason for the formation of gaps is the presence of ion-electric and molecular fields on the surface of the ore particles. The formation of technogenic gaps reduces the difference in the properties of the surface of the ore and nonmetallic grains; it changes their magnetic susceptibility and, consequently, the efficiency of separation methods.

Analysis of the results of studying the influence of the dynamic effects of high-energy ultrasound on the ore pulp showed the promising use of this approach.

To improve the efficiency of cleaning the surfaces of minerals, it is proposed to pre-treat the iron ore slurry with the help of high-energy ultrasound. The optimum values of the intensity and the duration of ultrasonic treatment in the purification of mineral particles have been determined. When cleaning mineral particles, the intensity should be 1.2 W/cm^2, and the processing time should not exceed 60 seconds. In this case, the yield of the purified product is increased by 0.8 %, and its quality grows by 0.9 %. It has been proven that the efficiency of ultrasonic treatment is associated with the renewal of particles surfaces, which leads to an increase in the contrast of magnetic and flotation properties of minerals.

The study has shown that ultrasonic treatment of the iron ore pulp in the Kremenchuk iron ore region of Ukraine allows reducing the content of harmful impurities: potassium oxide – from 0.19 to 0.035–0.04 %; sodium oxide – from 0.14 to 0.027 %.

Keywords: ultrasonic influence, mineral purification, iron ore, cavitation mode, technogenic splices.

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STUDY OF THE ANTICORROSION EFFECT OF POLYMER PHOSPHATES ON STEEL AT ELEVATED TEMPERATURES (p. 52-57)

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Technological greases based on polyphosphates of alkali metals have great prospects for application at high-temperature machining of steel. An important task is to study the anti-corrosive effect of polyphosphates on steel at elevated temperatures. Temperature ranges, in which phase transformations of metaphosphate and sodium tripolyphosphate, as well as interaction with iron oxide, occur, were established using a thermogravimetric method. Composition of products of interaction between metaphosphate and sodium tripolyphosphate and scale is determined employing an X-ray phase analysis. It was established that in the region of temperatures of hot steel deformation the iron oxides, contained in scale, are dissolved in molten metaphosphate and sodium tripolyphosphate. As a result of interaction between sodium metaphosphate and iron oxide, the mixed polyphosphates $Na_3Fe_2(PO_4)_3$ and $Na_9Fe_2(P_3O_{10})_3$ are formed. It is shown that sodium tripolyphosphate almost does not participate in the interaction with the iron oxide of scale. Comparison of the results of corrosion test of the steel surface, treated in the presence of a polyphosphate lubrication and sodium chloride, testifies to the high anti-corrosive effect of polyphosphates. Thus, the time before the emergence of first signs of corrosion in the presence of polyphosphates increased fourfold, while the degree of corrosion damage was reduced by 40 times. It was established that at the deformation treatment of steel at a temperature of 800 °C in the presence of a polyphosphate lubricant, corrosion resistance is due to the formation of a barrier film at the steel surface, consisting of mixed polymer phosphates.

Keywords: sodium metaphosphate, sodium tripolyphosphate, mixed polyphosphates, an anticorrosive effect, scale.

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EFFECT OF FIRE RETARDANT FILLERS ON THERMOPHYSICAL PROPERTIES OF COMPOSITE MATERIALS OF ETHYLENE-VINYL ACETATE COPOLYMER (p. 58-64)

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The influence of composite materials of ethylene-vinyl acetate copolymer that do not maintain combustion and fire-retardant fillers on thermophysical processes was explored. Ethylene-vinyl acetate copolymer was used in the studies. The content of vinyl acetate is 18 % and 28 %; MFI is 2.5 g/10 min. and MFI is 5 g/10 min. Fire retardant fillers included aluminum oxide trihydrates with average diameter of particles of 1.5 μm and 3.0 μm; magnesium oxide dihydrates with average diameter of particles of 3.0 μm and 3.7 μm and hydromagnesite with average diameter of particles of 1.4 μm.

Using the method of thermogravimetric analysis and differential scanning calorimetry TGA/DSC, temperatures of vitrification, melting and decomposition, crystallinity degree, specific thermal capacity, and activation energy were determined. It was found that temperatures of physical transformations (temperatures of vitrification, melting, and decomposition) of polymer compositions that do not maintain combustion depend on properties of ethylene-vinyl acetate copolymer. They increase with decreasing of fluidity indicator of copolymer of ethylene vinyl acetate. EVA 1 has lower values of the indicator of melt fluidity and content of vinyl acetate than EVA 2.

During an increase in content of fire retardant fillers, temperatures of physical transformations are shifted in the direction of increasing: vitrification temperature increases from – 85 °C to 53 °C, melting temperature – from 68 °C to 90 °C. At the same time, crystallinity degree decreases from 8.8 % to 1.0 % and specific thermal capacity increases from 0.4 to 8.6 J/gK. This is due to formation of supermolecular structure of the derived compositions.

The influence of the polymeric matrix, composition and dispersity of fire retardant fillers on thermal-physical characteristics of polymeric compositions was determined. In case of using a polymer matrix with lower MFI and fire retardants fillers with smaller average diameter of particles, temperature characteristics are shifted towards higher temperatures than in the case of selection of polymer matrix with large MFI and fire-retardant fillers with a larger diameter of particles.

Obtained results will be useful during development of formulations of polymer compositions that do not maintain combustion for cable products, considering their thermophysical characteristics.

Keywords: composite materials, fire resistance, ethylene-vinyl acetate copolymer, fire retardant fillers, thermophysical properties.

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