ABSTRACT AND REFERENCES

TECHNOLOGY ORGANIC AND INORGANIC SUBSTANCES

A MATHEMATICAL MODELING OF CROSSLINKING BETWEEN COMPONENTS OF A POLYMER COMPOSITION (p. 4-12)

Maria Pasichnyk, Elena Kucher

The paper presents a method of mathematical modeling as a most promising way to determine the structural parameters of the polymer network. In polymer systems, modeling is developed in different directions, although its capacity in studying the processes of crosslinking polymer networks is not used to full extent.

We used the interpolation method to build the 4^{th}-degree Lagrange interpolation polynomial that allowed determining the optimal amount of a crosslinking agent. A three-factor model of crosslinking polymeric components was constructed with the use of the multiple regression equation. The model showed the main concentration of the composition components that would ensure the degree of crosslinking at an optimal level of 25–50 %. The research resulted in designing four polymer compositions. It was found that films with a crosslinking degree of 20–25 % have the relative elongation rate of 682 % and the breaking load value of 18 H.

The findings of the physical and mechanical research of films were used to build the deformation and strength curves. It was determined that when the optimal degree of crosslinking is 20–21 %, urethane-based polymer compositions (PC-2 and PC-3) have a relative elongation rate of 300–700 % and the breaking load of 40–50 MPa, which proves the dependence of the deformation the strength characteristics of films on the degree of crosslinking between the components.

The paper presents charts of the degree of crosslinking dependence on the component concentration. The constructed graphs of the response surface allow selecting the required concentrations of ingredients for obtaining polymer films with a desired crosslink density. The calculated structures of networks have proved the relevance of the suggested mathematical models (the coefficient of determination R2 equaling 0.92 and 0.98).

Keywords: degree of crosslinking, polymer compositions, deformation and strength curves of polymeric films.

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SYNTHESIS AND STUDY OF OPTICALLY TRANSPARENT BENZGUANAMINE OLIGOMERS WITH LUMINESCENT PROPERTIES (p. 12-18)

Vladimir Lebedev

The study of the synthesis of transparent BF oligomers and polymers with luminescent properties, which is an important issue in terms of obtaining new optically transparent luminescent polymers with high operational and spectral properties was carried out. It is shown that modification of benzguanamine oligomers by glycerol with a content of 20 wt %, allows obtaining materials with high light transmittance, low residual stress, shrinkage and water absorption and high physical–mechanical characteristics. At the same time, such an important characteristic of scintillation plastics as BAL, in the aforementioned materials is at level with the PS and PMMA – 40 – 60 to 50 cm – 200 cm. The basic spectral–luminescent properties of transparent oligomers and polymers were investigated. It is shown that they are characterized by the extinction coefficient of up to 9000–12000 and intensity of luminescence with the relative quantum yield of up to 10 % in the range of 360–365 nm. The resulting polymers may be used as the basis of highly transparent products, plastic scintillators and other materials of the optical-luminescent materials science.

Keywords: synthesis, study, transparency, luminescence, oligomers, polymers, benzguanamine, formaldehyde, spectra, detectors.

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INVESTIGATION OF SPECTRAL CHARACTERISTICS OF CHOLESTERIC LIQUID CRYSTALS AT CARBOHYDRATES INFLUENCE (p. 18-22)

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The concept of cholesteric liquid crystal interaction with carbohydrates to create the active medium of the primary sensor converter is considered. It is proposed to use the cholesteric liquid crystal with the reflection band in the visible spectrum as the sensing element of optical carbohydrate sensors. The information signal in such sensors is formed by selective reflection (transmission) of light in the sensitive medium of primary converters of optical sensors. The analysis of the data shows that the reason for the areas of abnormal behavior of the pitch at high concentrations of the aqueous carbohydrate solution is the interface. It is shown that there is a general tendency to reduce the pitch of the supramolecular helical structure with increasing concentration of aqueous solutions in all investigated carbohydrates. Furthermore, the maximum sensitivity of the cholesteric matrix is observed at low concentrations of the solution used for their detection. The highest spectral sensitivity is observed in aqueous fructose solutions.

Keywords: spectral studies, cholesteric liquid crystals, carbohydrates, primary converter, optical sensor.

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IMPROVEMENT OF THE FILLING AND PLASTICIZATION PROCESSES OF FORMING MULTIFUNCTIONAL LEATHER MATERIALS (p. 23-31)

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The study concerns the filling and plasticizing processes in the final stages of forming multifunctional leathers from various raw materials on the basis of using new composite systems. The structure of a tannin-containing composition was found to affect the process of its diffusion throughout the structure of the topographic areas of the semifinished chrome-tanned product. In particular, we have determined that the depth of diffusion of the filling composition in loose areas was close to 100 % with a 5 % use of the mass of the intermediate product; in dense areas even with a bigger use of the mass, it was only 80 % of the thickness of the intermediate product.

The structure of the filling and plasticizing composition was developed to form various leathers from hides of cattle and sheep. A protein hydrolysate and a highly dispersive modified aluminosilicate have proved to influence the process of forming and the physicochemical properties of semifinished leathers. If the filling and plasticizing composition contains optimal amounts of montmorillonite and protein hydrolysate at 4–2 % of the semifinished leather mass, the obtained leather materials have respective tensile strengths of sheepskin and bovine hides of 15–16 MPa and 20–22 MPa, and their stiffness is 15–16 and 21-22 SN.

The use of montmorillonite in the filling and plasticizing compositions in processing semifinished chrome-tanned products proved to ensure stability of the dispersed structure in further processing and its mobility in the cyclic deformation of the products. The complex study of the process of filling and plasticizing semifinished chrome-tanned products was the basis for developing effective technologies to produce elastic materials for footwear leather uppers and apparel and haberdashery articles with the necessary physical and mechanical properties as well as bigger volume and area outputs by 270–310 cm^3/100 g of protein substance and by 5–6 %, respectively, in comparison with the outputs of the industrial technology.

Keywords: semifinished leather product, filling and plasticizing processes, tannins, montmorillonite, technology, physicochemical properties, microstructure.

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INVESTIGATION OF THE BIO-RESISTANCE OF INSULATING PROTECTIVE COATINGS MODIFIED BY POLYMERIC PETROLEUM RESINS (p. 31-39)

Irena Nykulyshyn, Zorian Pikh, Svitlana Gnatush, Zoriana Gnativ, Ruslana Chajkivska

Basic patterns of modification of bitumen composites by polymeric petroleum resins (PPR) are processed. Creation of new highly effective metal protecting compositions and study of their action patterns is an important scientific problem. It is found that introduction of PPR to the insulating petroleum bitumen improves the anticorrosive properties of protective coatings for underground pipelines. The adhesive strength of petroleum bitumen coatings is investigated. The mechanism of influence of the PPR components on the technical and operational properties of the compositions is considered. It is shown that the compositions on the basis of insulation bitumen BNI-IV-3, modified by cooligomeric dark PPR have higher anticorrosive characteristics and demonstrate bio-resistance to soil sulfate-reducing bacteria of the genus Desulfovibriodesulfuricans, especially corrosive for pipeline steel. Polymeric petroleum resins as modifiers significantly increase the inhibitory properties of the bitumen matrix and its resistance to soil bacteria. The absence of the catalyst extraction stage significantly reduces the bitumen modification cost. The results of the study of electroinsulating and anticorrosive characteristics of petroleum bitumen mastics, modified by the products of cooligomerization of hydrocarbon pyrolysis by-products confirmed the efficiency of the above materials and compositions on their basis in the protection of main oil and gas pipelines.

Keywords: polymeric petroleum resins, modification, petroleum bitumen composites, protective coatings, adhesion, inhibitory properties, soil bacteria.

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STUDY OF THE EFFECT OF HIGH-ENERGY DISCRETE PROCESSING ON THE EXTRACTION KINETICS AND PROPERTIES OF WOOL GREASE (p. 40-45)

Olga Semeshko, Alexandra Kunik, Tatiana Asaulyuk, Yulia Saribyekova, Sergey Myasnikov

Wool grease is a valuable raw material for the food, perfume and cosmetic and pharmaceutical industries. The extraction method is selected for wool grease extraction, which will allow extracting the maximum amount of it, but for a long time. The use of high-energy discrete processing as a method of preliminary processing of wool fibers to accelerate the wool grease extraction is proposed.

The effect of the proposed intensification method on the wool grease extraction kinetics is investigated. It is found that the high-speed discrete processing increases the wool grease extraction rate, as evidenced by an increase in the reaction rate constant.

The changes in the basic physical and chemical properties of the resulting wool grease under the influence of high-energy discrete processing are examined. It is determined that high-energy discrete processing enhances the wool grease quality.

The mechanism of the intensifying effect of preliminary high-energy discrete processing of wool fibers on the wool grease extraction process is proposed.

Keywords: wool grease, lanolin, wool fiber, extraction rate, high-energy discrete processing.

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CHEMISORPTION OF SULFUR (IV) OXIDE USING THE HORIZONTAL APPARATUS WITH BUCKET-LIKE DISPERSERS (p. 46-52)

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Due to the growing energy consumption and increasing share of fuels with high sulfur content in the global energy balance, there is a need for new, highly efficient methods and apparatus for recycling exhaust SO_2-containing gases. It is found that SO_2-low-concentrated gases are advisable to recycle by the liquid-oxidation method using NaOH as an intermediate absorbent and air oxygen as oxidant. Effective head apparatus – horizontal apparatus with bucket-like dispersers (HABD) is proposed for the cleaning process. To confirm the effectiveness of this apparatus in the processes of chemisorption and liquid phase oxidation of SO_2, a pilot study on enlarged laboratory setup, the head apparatus of which was a scale model of HABD is carried out. The study is conducted in a wide range of concentrations of SO_2 (0,4...34·g/Nm^3) and pH of absorbing solutions (pH=3...13) using modern gas-analyzing devices. It is found that the irrigation density of 0.5 m^3/Nm^3 is technologically feasible. The cleaning process is appropriate to perform under counterflow motion of phases, which will allow combining chemisorption and oxidation in one HABD, provide high degrees of recovery (99.9...100 %) and liquid phase oxidation (80...99 %) of SO^2.

Due to the high velocity of dispersed droplets of ~10 m/s and intensive interphase renewal, it is managed to significantly reduce the diffusion resistance in the gas phase and transfer the process to the liquid film and provide high mass transfer coefficients of $0{,}82\cdot10^{-4}$...$1{,}80\cdot10^{-4}$ (Pa·s·m^3). It is found that at low initial concentrations of SO_2 (0,4...7,74 g/Nm^3), the process rate is limited by SO_2 diffusion, and at high (10.54...33.89 g/Nm^3) – NaOH diffusion. The process under study is described by the first-order reaction equation and is characterized by high values of the process rate constant – 0.46 s^{-1}.

Pilot studies confirm the high efficiency of HABD in the studied processes, prove the possibility of combining dust collection, chemisorption and oxidation stages in one apparatus.

Keywords: exhaust gas cleaning, sulfur (IV) oxide, mass exchange apparatus, chemisorption, reaction order.

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MODELING OF CORROSION PROCESS OF THE HIGH-PERFORMANCE CONCRETES IN SULFATE ENVIRONMENT (p. 53-59)

Artem Pryymachenko, Leonid Sheinich

The main contemporary method for measuring stability of concrete in aggressive environments is to compare the strength of concrete that solidified in an aggressive environment with the strength of concrete that solidified in a non-aggressive environment. This approach to testing has been quite effective in many cases, but it does not allow analysing the impact of corrosion products on the strength of concrete cement matrix. Such data can be obtained after removing corrosion products from the cement matrix of concrete.

The techniques applied in the study involved removal of corrosion products while subjecting the samples to aggressive environments, which helped determine that a cement skeleton of concrete with an integrated active mineral additive (a mixture of acidic ash removal of metakaolin in optimal quantities) has greater strength and corrosion resistance than a cement skeleton of concrete without a complex active mineral additive.

A combination of physical and chemical methods of research – such as phase-contrast X-ray imaging, thermal, and electron microscopy – showed that a complex active mineral additive produces cement structure peculiarities. Thus, it has been determined that frames with a complex active mineral additive can form dense structures with a significant number of low-base calcium silicate hydrates and solid solutions of hydrated aluminium silicate composition (hydrated galena – hydrated anorthite). This is quite different from structures without the complex active mineral additive, which are characterized in an aggressive environment (for example, in a

solution of sulphuric acid) by leaching of soluble compounds such as portlandite; moreover, this process is intensified by smoothing the sample surface. These peculiarities of forming cement matrix structure explain the high corrosion resistance of concretes. The obtained data are important for developing a composition of concretes for reinforced concrete structures that are used in aggressive environments.

Keywords: concrete, cement, new composition, superplasticizer, active mineral additive, corrosion, metakaolin, fly ash.

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STUDY OF THE EFFECT OF COMPOUNDS OF TRANSITION ELEMENTS ON THE MICELLAR CATALYSIS OF STRENGTH FORMATION OF REACTIVE POWDER CONCRETE (p. 60-65)

Alexsander Shishkin

Changes in the rate of cement hydration affect the rate of concrete compressive strength formation. Under certain conditions, an increase in the cement hydration rate improves the concrete compressive strength. This is especially true for reactive powder concretes.

The paper studies the effect of micellar solutions, consisting of a mixture of a micelle-forming surfactant and compounds of transition elements. A feature of the study was investigating the simultaneous effect of micelle-forming surfactants and compounds of transition elements on the change in the concrete strength. The study found that given micellar solutions and compounds of transition elements alter the nature of the concrete strength formation, namely increase the rate of strength formation of reactive powder concretes in the initial period due to micellar catalysis of cement hydration and maintain increased compressive strength at later stages of hardening through the impact of compounds of transition elements, formation of minerals, containing high amount of chemically-bound water.

It is proved that micellar catalysis can be used to control the processes of cement hardening and strength formation of artificial stone, produced in the cement hydration, thereby reducing the time to achieve the concrete design strength and increasing the absolute value of compressive strength of such concretes at 28 days using compounds of transition elements.

Keywords: concrete, strength, surfactants, micellar catalysis, cement, rate, transition elements.

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STUDY OF THE EFFECT OF MICELLE-FORMING SURFACTANTS ON THE STRENGTH OF CELLULAR REACTIVE POWDER CONCRETE (p. 66-70)

Alexsandera Shishkina

Changes in the cement hydration rate affect the concrete compressive strength formation rate. Under certain conditions, an increase in the cement hydration rate improves the concrete strength under compression. This is especially true of foam concrete.

The paper examines the effect of micellar solutions, which are a mixture of the micelle-forming surfactant and conventional molecular surfactant. A feature of the research is the study of the effect of micelle-forming surfactants on the strength of foam concrete, which is commonly manufactured using molecular surfactants. The research revealed that these micellar solutions change the pattern of foam concrete strength formation, namely, increase the strength formation rate, in particular, of reactive powder foam concrete, especially in the initial period, and maintain their high compressive strength at later stages of hardening.

It is proved that the micellar catalysis can be used to manage the processes of cement hardening and strength formation of cement stone, produced in the cement hydration, thereby reducing the time to achieve the design foam concrete strength, or enhancing the absolute compressive strength of such concrete at 28 days.

Keywords: foam concrete, strength, surfactants, micellar catalysis, cement, rate.

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STUDY OF THE SUBSOLIDUS STRUCTURE OF THE SYSTEM $ZnO–Al_2O_3–TiO_2–SiO_2$ (p. 71-76)

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The study of the structure of the system $ZnO–Al_2O_3–TiO_2–SiO_2$ in the field of subsolidus using thermodynamic and geometric-topological methods, as well as the structure of poorly explored three-component systems $ZnO–Al_2O_3–TiO_2$ and $ZnO–TiO_2–SiO_2$, is conducted.

It is found that the four-component system is divided into eight elementary tetrahedra. Their relative volumes, the degree of asymmetry are calculated. The lengths of tie lines, the relative volumes of phase existence, and probability of phase coexistence are determined. The topological graph of the relationship of the elementary tetrahedra is built. The geometric-topological characteristics of the

system phases (volume of existence, probability of coexistence) are provided. The regions of oxide compositions with the largest relative volumes and the lowest degree of asymmetry for manufacturing a wide range of refractories, heat-resistant and technical ceramics, and also glass-crystalline materials and coatings are shown.

The region of oxide compositions with a minimum temperature (1170 K) of melt occurrence, which is promising for producing materials under forced firing is determined.

These data, in addition to identifying common statistical regularities, can be the basis for the synthesis of the given phase composition with the desired set of properties and implementation of energy-saving technologies.

Keywords: subsolidus system structure, elementary tetrahedra, geometric-topological characteristics, topological graph.

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