ABSTRACT AND REFERENCES

TECHNOLOGY AND EQUIPMENT OF FOOD PRODUCTION

EXPERIMENTAL INVESTIGATION OF INTENSIFICATION OF THE PROCESS OF DISSOLVED-AIR FLOTATION IN WASTEWATER TREATMENT OF MILK PROCESSING ENTERPRISES (p. 4-12)

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Intensification of operation of the flotation plant for wastewater treatment of dairy enterprises by applying a specially designed mixing insert (diaphragm) in the reactant treatment system is investigated. The optimum parameters of the flotation plant to achieve the required quality of wastewater treatment of dairy enterprises for discharge into the city sewer system are determined. It is found that when applying the aluminum sulfate $Al_2(SO_4)_3$ coagulant, its dose is lower than that of the ferric chloride $FeCl_3$ coagulant by 37.7–38.8 %, and the wastewater treatment efficiency on a laboratory flotation plant, which uses an improved design of the mixing insert (diaphragm) is approximately equal in both cases.

Virtual models of the flow in a mixing device with the diaphragm of special design installed therein, which demonstrate and simulate the velocity diagrams in the cross section of the mixing device and flow turbulence are obtained. Major influence factors of wastewater of milk processing enterprises, including pollutant concentrations, coagulant doses and flow rate in the mixing device are given.

Keywords: intensification, flotation plant, reactant mixing unit, diaphragm, physicochemical treatment, milk processing enterprise.

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CORRELATIONS AND SELECTION OF OPTIMUM CONDITIONS FOR CHROMATOGRAPHY OF ALKYLCYCLOHEXANECARBOXYLATE PRODUCTION PROCESS (p. 13-18)

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A number of esters of alkylcyclohexanecarboxylic acids are synthesized. The NMR spectral analysis of the synthesized esters is carried out, and their physicochemical characteristics are identified. Optimum parameters of the isothermal gas-liquid chromatography to analyze the reaction mixtures, the interaction of acrylates and 2,3-dimethyl-1,3-butadiene are determined.

The evaluation of the efficiency of the chromatography system and resolution settings is performed. The proposed chromatography conditions provide almost complete separation of the reaction mixture substances, and the analysis time does not exceed 15 min. The free energy linearity principle for the quantitative description of the relationship between the logarithms of the retention time of the substances, which are products of cycloaddition reaction of acrylates and 2,3-dimethyl-1,3-butadiene under gas chromatography and empirical parameters of substances: polarization, polarity, basicity, electrophilicity, molar volume and enthalpy of vaporization is applied. It is shown that in all cases the polarization ability of substances plays the greatest role in the correlations of the retention time logarithms, and the enthalpy of vaporization appeared a minor parameter. The developed method of chromatography analysis is used to determine the optimum conditions of the alkylcyclohexanecarboxylate production process.

The possibility of using correlations for predicting and determining the optimum conditions for chromatography analysis to monitor the processes of producing a number of esters of alkylcyclohexanecarboxylic acids is shown.

Keywords: alkylcyclohexanecarboxylates, gas-liquid chromatography, free energy linearity principle.

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TECHNOLOGY OF PRODUCING GRANULAR FERTILIZERS ON AN ORGANIC BASIS (p. 19-26)

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The possibility of producing granular fertilizers on an organic basis due to disposal of organic waste of poultry farms is proved. It is shown that such waste has a form of very liquid suspensions. Therefore, to minimize power consumption for their processing, granulation in the fluidized bed apparatus is the optimum technology of producing a granular product. Temperature conditions and operating parameters of organic suspension granulation process are experimentally determined. The existence of two operating modes of granulation, which allow producing both organic granules and mineral granules with an organic coating is shown.

Analytic dependences for determining the granules heating time and temperature by the value of the heat transfer coefficient included in the Biot number are obtained. They allow computing the temperature values of solids in a fluidized bed.

A flow diagram of the continuous installation to cover mineral fertilizer granules with organic matter is proposed. The resulting encapsulated product has a prolonged effect, i.e. nutrients, especially nitrogen enter the soil gradually over a long time.

Keywords: granulation, fluid bed apparatus, suspension, poultry manure, cavitator, temperature conditions.

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INVESTIGATION OF NICKEL CHEMICAL PRECIPITATION KINETICS (p. 26-31)

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The results of investigation of nickel hypophosphite reduction reaction kinetics in the bulk solution depending on the pH, temperature, oxidant content, nature and concentration of the activator, the presence of water-soluble polymer – polyvinylpyrrolidone are presented.

The main objective of the study was to investigate the kinetics and establish optimum conditions for nickel chemical precipitation in the bulk solution. It is found that the process of chemical precipitation of the metal in the alkalescent environment is characterized by the high rate and small induction period at a temperature of 60–70 °C. The presence of polyvinylpyrrolidone in the solution af-

fects the induction period duration and the reduction reaction rate. The nature of the polyvinylpyrrolidone effect depends strongly on the pH. It is proved that using preformed nickel hydrosols as the activator makes it possible to significantly shorten the induction period of the reduction reaction at low temperatures.

The results are used in the development of technology and substantiation of the process parameters of synthesis of composite metal-filled polyvinylpyrrolidone copolymers with (meth) acrylates and hydrogel materials on their basis by a combination of metal polymerization and reduction processes.

Keywords: metals, nickel, reduction, chemical precipitation, hydrosol, kinetics, reaction rate, polyvinylpyrrolidone, hydrogels, composite.

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A THEORETICAL ANALYSIS OF CHEMISORPTION OF SULFUR (IV) OXIDE. RATIONALE FOR THE CHOICE OF AN EFFICIENT MASS-EXCHANGE APPARATUS (p. 32-40)

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Since the European Union has tightened its environmental legislation requirements to the maximum allowable industrial emissions, there is a necessity to devise efficient treatment technologies for exhaust SO_2-containing gases. The study presents a critical analysis of industrial methods of disposal of sulfur (IV) oxide from exhaust gases. It is proved that the liquid-oxidative method using NaOH as an intermediate absorbent and air oxygen as an oxidant ensures optimal utilization of gases with low concentration of SO_2. The analysis of the related references and the performed calculations show that chemical adsorption of SO_2 requires high pH and low temperature, whereas oxidation of the chemisorbed SO_2 – low pH and high temperature.

The study justifies economic efficiency of combining the operations of dust collection, chemisorption and oxidation of the chemisorbed SO_2 in a single unit. A thorough analysis of the existing mass-exchange equipment and the made calculations allow implementing the process. We have suggested new technical solutions and an efficient main unit of a horizontal apparatus with scoop-shaped dispersants that fully meets the physical and chemical characteristics of the above processes. The proposed device facilitates an upstream phase movement, thereby providing the required modes for dust collection, chemisorptions, and SO_2 oxidation. The unit has low resistance to mass transfer from the gas and the fluid films. Due to the direct supply of energy to the fluid and the non-stationary mode of dispersion, the apparatus has little hydraulic resistance and low energy costs. The theoretical studies minimize the number of experimental research and scientifically justify the choice of a technologically appropriate mode of purifying exhaust gases from SO_2.

Keywords: sulfur (IV) oxide, purification of gas emissions, mass-exchange apparatus, chemical adsorption/chemisorption, dust collection, absorbent.

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APPLICABILITY OF ALKALI-ACTIVATED CEMENT FOR IMMOBILIZATION OF LOW-LEVEL RADIOACTIVE WASTE IN ION-EXCHANGE RESINS (p. 40-45)

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All generated and collected low-level radioactive wastes (LRW) should be processed into final products for a long-term disposal without loss of their properties. Worldwide, cementation is the most widely used technology for immobilization of nuclear wastes. Due to many existing varieties of LRW some of these wastes are incompatible with the process of hydration and hardening of a cement matrix and require optimization of cement immobilization technologies. The paper presents the results of devising new formulations of multi-component alkali-activated cement, which is aimed at complex processing of low-level radioactive waste with ion-exchange resins. The radioactive wastes to be immobilized included two types of ion-exchange resins: cation- and anion-exchange resins mixed as 2:1 with pH=12 and anion-exchange resin with pH=5. Analysis of the obtained results from the developed optimal recipes proved that the

properties of the final products are in compliance and in some cases even exceed those set in standards GB 7023 and GB 14569 of the P. R. China. High efficiency of the alkali-activated cement matrices for immobilization of radioactive wastes is attributed to their ability to bind radionuclides not only mechanically and adsorptionally, as it happens in case of traditional cement matrices, but also chemically – within the composition of zeolite-like hydration products of the $R_2O{\cdot}MeO{\cdot}Al_2O_3{\cdot}nSiO_2mH_2O$ or $R_2O{\cdot}Al_2O_3{\cdot}nSiO_2mH_2O$ types, where: R=Na, K, and Cs; Me=Ca, Mg, and Sr.

Keywords: alkali-activated cements, geopolymers, immobilization, low-level radioactive waste.

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THE EFFECT OF NITROGEN-CONTAINING ORGANIC ADMIXTURES ON THE CHEMICAL PROCESSES OF CEMENT HARDENING (p. 46-54)

Anna Fleisher, Volodymyr Tokarchuk, Valentin Sviderskyi

Improved crystallization conditions for new hydrate formations can secure a dense, strong and minimally hard structure of cement stone and improve its building and technical properties as well as durability. This can be achieved by limiting oversaturation of the liquid phase of hardening cement while maintaining high concentrations of mineral-forming ions. Construction industry uses organic and inorganic additives for this purpose.

Since many studies are aimed at the search, purposeful synthesis or chemical recycling of industrial waste to obtain additives for cements, mortars and concretes, the topical problem is to study the mechanism of influence of the obtained compounds on cement hardening, which would provide a more selective approach to the methods of synthesis or chemical recycling.

We have studied the effect of additives on the chemical processes of cement hardening. The additive is a product of processing a polymer fraction of solid waste that consists of amides and ammonium salts of terephthalic acid. The use of additives intensifies milling, provides plasticizing effect, accelerates the setting and hardening time and increases the brand strength of cement in normal and low temperatures.

It is determined that the action of additives consists in the following: in a strongly alkaline environment of hardening cement, components of the additives are hydrolyzed to form insoluble calcium terephthalate, which reduces both the concentration of calcium ions in a pore solution and oversaturation with calcium hydroxide. This phenomenon accelerates the reaction of hydrolytic dissociation of clinker minerals to restore equilibrium concentration of calcium ions.

It is proved that such mechanism of action facilitates hydration of silicate and aluminate minerals of clinker, which accelerates the gel and crystalline phases, crystallization of hydro-silicates, and their conversion from high-base into low-base ones.

Keywords: chemical additive, amide of terephthalic acid, cement hardening, alkaline environment, oversaturation of a pore solution, insoluble calcium terephthalate, crystallization.

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STUDY OF THE NANOCATALYSIS EFFECT ON THE STRENGTH FORMATION OF REACTIVE POWDER CONCRETE (p. 55-60)

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Changes in the rate of cement hydration affect not only the technological characteristics of concrete mixes, but also cause changes in the rate of concrete compressive strength formation.

The paper examines the effect of micellar solutions, consisting of micelle-forming surfactants or a mixture of micelle-forming surfactants and conventional molecular surfactant. The study found that the micellar solutions change the nature and the ratio of hydration products in the cement stone, but do not change the type of cement hydration products that is act as micellar catalysts. This significantly increases the rate of strength formation of reactive powder concretes, both at initial and later hardening stages.

It is proved that the micellar catalysis can be used to control hardening and strength formation of cement, thereby reducing the time to achieve the design strength of concrete. Thus, concrete gains the strength of 50 MPa for 4 days with the use of the micellar catalysis and the same strength for 28 days without additives.

Keywords: concrete, strength, surfactants, micellar catalysis, cement, powder, filler, rate.

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