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JUSTIFICATION OF PHYTOREMEDIATION TECHNOLOGY OF DEGRADED LANDSCAPES ON THE BASIS OF ECOSYSTEM APPROACH

page 4–9

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The object of research is the development of natural and survival of artificial plant communities on the surface of the waste dump of the liquidated «Selydivska» coal mine of the State Enterprise «Selydivvugillya» (SE «Selydivvugillya», Selydove, Ukraine).

Phytoremediation of degraded mining lands, in particular rock dumps, aimed at creating a sustainable vegetation cover on the surface of technogenic rock masses. The biggest problem of the biological stage of landfill reclamation is the correct selection of the assortment of trees and shrubs and the creation of plant communities that are resistant to prolonged exposure to toxic substances of rock massifs. Self-breeding of waste dumps continues during their operation, and the dominant species are plants typical of the steppe and forest-steppe zones. The identification of dominant vegetation species on the surface of rock dumps is a source of important information for substantiating targeted phytoremediation of mining landscapes.

During 1996–2016 the plant diversity of the waste dump was investigated. It was established that plant groups are predominantly represented by the families of Cereals, Legumes, Asteraceae, and Cruciferous, and the largest number of species is observed along the lower base of the dump and at the top. The expediency of applying the method of phytoremediation of technogenic slopes of waste dumps with sod mats as an alternative environmental technology to restore the mining landscape to the state of the natural ecosystem is substantiated. According to the results of field studies, the survival rate of sod mats on the upper and lower tiers of the surface of the dump is the highest and makes up 53 % and 34 % of the total number of planted samples of plant communities.

The proposed method for phytoremediation of slopes of waste dumps with sod mats with vegetation typical of the selected area is a promising area for accelerated phytoremediation of mining lands.

Keywords: phytoremediation of degraded lands, waste dump, plant diversity, mining landscape, sod mat.

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OPTIMIZATION OF THE PROCESS OF OBTAINING EPOXIDIZED NATURAL RUBBER FOR THE DEVELOPMENT OF NEW COMPOSITE MATERIALS ON ITS BASIS

page 10–13

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The object of research is the process of epoxidation of natural rubber scrap. Epoxidized natural rubber (ENR) has a wide range of applications, for example, in treadmill coatings, special tires, belt drives, hoses, shoes, adhesives, sealants, floor coverings and other areas where only special synthetic rubbers are used. Natural rubber (NR) is modified by the epoxidation reaction to achieve higher oil resistance, increased adhesion, weather resistance and damping characteristics of materials with its use. Promising is the processing of secondary, non-standard, natural rubber (scrap) as a raw material for the ENR production. Thus, the task of scrap disposal and its return to the production cycle is solved. To accomplish the task of epoxidation of secondary rubber, the possibility of conducting combined physicochemical processes in a two-phase water-xylene medium in one reaction space was studied to reduce the total energy costs. The use of a combined reaction-separation process for the epoxidation of scrap of natural rubber allows to solve the problem of accumulation and disposal of rubber waste in the most efficient way. It is possible to obtain a product with a regulated functionalization degree without a significant amount of by-products. To find the optimal regime for conducting the combined reaction-separation process of epoxidation, the method of the planned experiment was used to obtain the regression equation with its subsequent analysis. The obtained regression equation makes it possible to optimize the conditions for conducting the process of epoxidation of nanocrystals with obtaining products with desired properties. As a result of the implementation of the planned experiment, it is found that epoxidation at a temperature of 93 °C of a diluted (10 % wt.) solution of natural rubber with peracetic acid formed «in situ» provides a higher epoxidation degree. The conditions and ratios of the components are selected under which NR retains aggregative stability during epoxidation in a water-xylene medium.

Keywords: natural rubber, epoxidation, combined process, reaction-separation process, scrap utilization.

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ANALYSIS OF FIRE AND HAZARDOUS SITES (ZONES) IN COAL MINES AND THE CAUSES OF COAL SELF-IGNITION

page 14–18

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Annually, dozens of endogenous fires are recorded in Ukrainian mines. To date, mining and geological factors have not been reliably established that contribute to the development of foci of spontaneous combustion of coal in characteristic places (zones) of the mine field. Thus, the object of research is the process of spontaneous combustion of coal from fire hazardous areas (zones) in coal mines. An analysis of the results of the investigation of endogenous fires shows that the areas of spontaneous combustion can be accumulation of losses of chipped coal in the working and developed space of exploited lavas, and the developed space of stopped faces, the edge parts of the array of the developed seam or protective solid blocks of coal. As well as close underworked and overworked seams, treatment and extended mine workings in and out of zones of influence of geological disturbances, accumulation of coal after its sudden release during a gas-dynamic phenomenon and the cavity of this discharge. Ceteris paribus, the factor of the presence of prolonged contact of mine air with the accumulation of chipped coal is a necessary condition for the occurrence of foci of spontaneous combustion. It is shown that with reciprocal schemes for ventilating excavation sections of gently sloping and inclined-fall formations, all fire sources occurred in zones adjacent to recoil or ventilation workings. At the same time, about 70 % of endogenous fires during the development of steeply falling seams occurred near the recoil mine due to the accumulation of large volumes of coal and the supply of a fresh air stream of air to the lava working space. The research results show that the thickness of the developed formation and the angle of its fall do not directly affect the accumulation of broken coal. They can't be the main factors determining the foci of endogenous fires, as is customary in normative documents.

The obtained results contribute to the improvement of the regulatory framework for the safe development of formations prone to spontaneous combustion, including gas-bearing ones.

Keywords: mine air, ventilation mode, geological disturbances, rock pressure, endogenous fire.

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RESEARCH OF STRUCTURE AND SORPTION PROPERTIES OF MONTMORILLONITE MODIFIED WITH HEXADECYLTHYMETHYLAMMONIUM BROMIDE

page 19–23

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The object of research is a natural layered silicate – montmorillonite of the Cherkasy deposit (Ukraine) with the general formula $(Ca,Na)(A1,Mg,Fe)_2(OH)_2[(Si,A1)_4O_{10}]\cdot nH_2O$. The chemical composition of the mineral: SiO_2 – 51.9 %, Al_2O_3 – 17.10 %, Fe_2O_3 – 7.92 %, MgO – 1.18 %, Na_2O, K_2O and CaO up to 2 % and H_2O – 8.78 %. Montmorillonite is characterized by a significant dispersion of particles and the presence of a large number of sorption centers on its surface is capable of cation exchange. One of the most problematic places is that montmorillonite is practically incapable of removing pollutants present in water as anions. In order to obtain sorbents capable of removing heavy metal anions, the surface of montmorillonite was modified with the cationic surfactant hexadecyltrimethylammonium bromide.

During the study, X-ray diffraction analysis, scanning electron microscopy, infrared spectroscopy, and thermal analysis were used to study the structure of the initial montmorillonite and its organo-modified forms. The spectrophotocolorimetric method is used to study the sorption properties of composites.

The work confirms that hexadecyltrimethylammonium bromide molecules are sorbed not only on the outer surface of the particles, but also migrate between the aluminosilicate packets of the layered structure of montmorillonite. Sorption studies have confirmed that the use of organomodified forms of montmorillonite has increased the degree of extraction of chromium (VI) ions from 32 % to 96 %. The resulting sorbents make it possible to purify contaminated water with a chromium (VI) concentration of 1 mg/dm^3 to the maximum permissible concentrations. This is due to the fact that the organomodification of the surface of montmorillonite has a number of features and allows to change the structure of the original mineral, as well as recharge the clay surface from negative to positive. This makes it possible to use organoclay to remove inorganic toxicants in anionic forms. Compared with similar known ones, the obtained composites provide the removal of even trace amounts of heavy metal anions from aqueous media.

Keywords: montmorillonite, organomontmorillonite, X-ray diffraction analysis, thermal analysis, sorption, chromium (VI).

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RESEARCH OF THE PROCESS OF SOLID COMBINED FUELS GASIFICATION

page 24–27

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The object of research is the combined 2-component solid fuel «coal-municipal solid waste» (MSW) in 5 parts with concentrations of 0–100 (wt. %) of each component. One of the most problematic places is the improvement of solid waste gasification processes, including the optimization of synthesis gas characteristics.

In the course of the study, laboratory thermogravity equipment is used, which is a physical model of a flow-type reactor with recirculation of intermediate reaction products. This installation includes a TGA (thermogravimetric analysis) installation unit, a chromatograph, a computer with a printer, and an automatic data-tracing system using computer methods, namely, thermogravimetric and chromatographic analysis.

The study shows that the method of complex (TGA+gas) laboratory analysis can evaluate the calorific value of non-traditional, including combined, fuels. The determination of the dependence of the calorific value of gasification products of combined fuels on their composition and process parameters is in the range of 6–12 MJ/m^3. This is due to the fact that the method and installation proposed in the work has a number of features, the ability to support the calorific value of non-traditional, including combined fuels at a given level. Achievement of the effect is expected due to the choice of concentrations of components corresponding to a given value of Q_H^p. Thanks to this, it is possible to obtain constant values of Q_H^p upon receipt of various lots of solid waste for the production of synthesis gas without correction of technological parameters.

The technique presented in the work allows for an express assessment of various batches of solid waste and determine the optimal ratio of coal-solid waste. Compared with similar well-known methods, this provides the following advantages: stability of technological parameters, intensification of production and cheaper synthesis gas.

Keywords: combined 2-component solid fuel, municipal solid waste, gasification systems, heating value of synthesis gas.

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COMPARISON OF METHODS OF HEATING A ROTARY-FILM APPARATUS FOR THE PRODUCTION OF VEGETABLE CONCENTRATES

page 28–30

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The object of research is the temperature field of the working surface of the rotor-film apparatus (RFA) when heated by a nichrome spiral with a different coolant layer or using a flexible film resistive radiating type electric heater (FFREHRT). Since the concentration of vegetable purees using RFA is a promising solution, due to a significant reduction in processing time and high quality of the resulting products. Today, most RFAs use electric heating of nichromes with spirals with intermediate coolants, to process a uniform heat flow, which is determined empirically for the thickness of the coolant layer depending on the flow of raw materials, it is processed. Such methods make it possible to obtain qualitative indicators of the uniformity of the temperature field, but the problem is an increase in the metal consumption of the apparatus due to the presence of pumps for the movement of coolants, which generally complicates the operating conditions. Therefore, it is important to improve the RFA heating system using FFREHRT, which is also a thermally insulated surface with a uniform distribution of the temperature field over the entire radiation plane. In the course of the study, the uniformity of the temperature distribution in the RFA model sample is determined for various heating methods (nichrome wire with an intermediate coolant, PFMS-4 organosilicon liquid or FFREHRT).

The obtained comparison of heat removal methods made it possible to establish that heating with a nichrome spiral is optimal when the thickness of the coolant layer is 4 mm with a temperature difference of 1.2...2.4 °C. Under conditions of using FFREHRT, a temperature difference of 0.5...0.7 °C. This confirms the prospects of using FFREHRT in the RFA heating system in the conditions of a change in the feed rate of $0.5...1.5 \cdot 10^3$ kg/s.

Thanks to the use of FFREHRT for RFA heating, operational conditions will be improved by simplifying the structural properties, reducing resource costs compared to heating with a heating shell with a coolant and the optimal temperature difference on the working surface of the apparatus.

Keywords: production of vegetable semi-finished products, concentration of mashed potatoes, flexible film resistive heater of the radiating type, rotary film apparatus.

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RESEARCH OF OXIDATIVE STABILITY OF VEGETABLE OILS FOR USE IN SPORT NUTRITION

page 30–34

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The object of research is sunflower, high oleic sunflower and rapeseed oils, which are important in the production of food for people with increased physical activity. Such products should be balanced in component composition and enriched with biologically active substances, vitamins, antioxidants. Oils and fats are used as an important component of sport nutrition. Common oil is sunflower oil, which provides the diet with linoleic acid, as well as rapeseed oil, which enriches the products with linolenic acid. One of the most problematic places to use oils is oxidative damage, as this leads to the formation of hazardous compounds. During the study, the active oxygen method and the Oxitest device (Italy) were used. The first method allows to directly assess the content of oxidation products in the oil through the values of the peroxide value, the second method allows to measure oxygen consumption during oxidation processes in the oil.

The oxidative stability of sunflower oil is studied using the active oxygen method and the oxidation method using the Oxitest device at a temperature of 110 °C. It is found that the induction periods determined by the two methods are close (2 hours 40 minutes and 2 hours 43 minutes, respectively). The regularity of reducing the induction period of sunflower oil with increasing temperature by the oxidation method on an Oxitest device is established. The temperatures of 90, 100 and 110 °C are used. A comparative study of the oxidative stability of sunflower, high oleic sunflower and rapeseed oils is carried out. Based on the obtained data, a comparative characteristic of the stability of research oils to oxidation is given and recommendations for their use in sports nutrition are given. The obtained data will allow to evaluate the effect of each of the experimental oils on the shelf life of the oil-containing product.

Keywords: sport nutrition, sunflower oil, rapeseed oil, oxidative stability, induction period.

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RESEARCH OF HEAT TREATMENT INFLUENCE OF MILK ON QUALITY AND SAFETY OF HARD CHEESES

page 35–39

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The object of research is raw milk used for the production of hard cheeses by milk processing enterprises of Ukraine. The quality of raw milk is especially important, a key factor determining the effectiveness of the milk processing industry. Without milk, which meets certain requirements, it is impossible to organize the production of high-quality products. Special requirements are placed on the quality of raw milk intended for the cheese production. One of the most problematic places is improving the quality and cheese suitability of raw milk and improving the technological process for the production of natural hard cheeses

During the study, laboratory (biochemical and microbiological) research methods are used to determine the quality indicators of raw milk and finished products, as well as their microbial contamination. And for processing the results of the study, methods of mathematical statistics are used.

The work shows that bacterial contamination of raw milk, which exceeds the normative limit values, poses a threat to both the technological process of cheese making and the quality of the finished product. Methods are proposed for preventing a decrease in the yield of cheese and deterioration in its quality due to prolonged storage of milk at low temperatures. It is proved that the best results are obtained with ultra-high-temperature processing of milk with an exposure of 2–4 s. And also, that high-temperature and, especially, ultra-high-temperature (UHT treatment) is a very effective way to destroy bacterial microflora and improve the quality of raw milk by such an indicator as a «pollution tank». This allows to increase the cheese ability of raw milk. High temperatures of heat treatment of milk lead to changes in the salt and protein composition of milk. These changes should have both negative consequences – a deterioration in the rennet coagulation of milk and the synergistic properties of the clot, and a positive result consisting in an increase in the transfer of milk solids, primarily whey proteins, to clot and cheese.

Keywords: raw milk, cheese suitability of the milk, bacterial contamination, high-temperature treatment, ultra-high-temperature processing.

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RESEARCH OF DESTRUCTION OF STARCH CRYSTAL STRUCTURE IN CUPCAKES WITH IMPROVED RECIPE

page 40–44

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The research topics are the hardening process of flour confectionery during storage, accompanied by a complex of complex physical, chemical, colloidal and biochemical processes associated with starch and proteins. It is revealed that scientists use non-traditional herbal supplements in cupcakes, in particular, medicinal plants, seeds, fruits and leaves of nuts, vegetables, fruits, wild berries. In the work, the objects of research were developed according to the author's recipes: «Sesame», «Moriachok», «Mitsnyi Gorishok», «Osinnii Aromat», «Chornychnyi», «Medok», «Elitnyi» cupcakes, base samples for comparison – premium flour and «Stoluchnyi» cupcake. In the recipe for these cupcakes, part of the wheat flour is replaced with non-traditional raw materials:

– «Sesame» (rye flour, powders of blackberry leaves, blueberry, black currant, chamomile flowers, whey, sesame oil);

– «Moriachok» (oatmeal, powders of leaves of frangipani, raspberries, ordinary mother, thallus kelp, oil of pumpkin seeds);

– «Mitsnyi Gorishok» (buckwheat flour, peppermint, walnut leaf powder, whey, butter and walnut kernels);

– «Osinnii Aromat» (cornmeal, powders of St. John's wort, perforated, linden blossoms, Echinacea purpurea, skimmed milk powder, candied apple and cherry);

– «Osinnii Aromat» (buckwheat flour, chicory root powders, tricolor violet flowers, skimmed milk powder, dried blueberries);

– «Medok» (corn flour, powders of linden flowers, heart pollen, flower pollen, skimmed milk powder, pumpkin seed oil, natural honey with pollen);

– «Elitnyi» (oatmeal, peppermint leaves, beans, propolis, whey, natural honey with propolis).

In the course of the study, the X-ray phase analysis method was used on a DRON-UM-1 diffractometer (Russia), and it revealed the degree and types of deformation of the crystal structure of substances. The range of values is determined at reflection angles in the range of 10–30° – diffraction maxima of starch. The retrograde process based on the obtained diffractograms is analyzed and the ability of the used natural additives in cupcakes to extend their shelf life is confirmed. As a result of baking, the destruction of the crystalline structure of starch in the developed cupcake samples was much more intensive compared with the control sample of the «Stolychnyi» cupcake.

Keywords: flour confectionery, unconventional raw materials, diffraction angle, intensity of diffraction maximum, X-ray phase analysis, X-ray amorphous structure.

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