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ASSESSMENT OF THE RESISTANCE OF CONCRETE WITH RECYCLED AGGREGATE TO FREEZE-THAW CYCLES

pages 6–13

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The object of research is a concrete mix in which 50% of the natural coarse aggregate is replaced with recycled aggregate (RA) obtained by crushing demolished buildings and structures. This research was aimed at assessing the compressive strength and freeze-thaw resistance in a 5% NaCl solution of C30/37 concrete in which 50% of the natural coarse aggregate in the 4–8 and 8–16 mm fractions was replaced by RA from two regions of Ukraine.

The research problem concerns the recycling of construction and demolition waste into new building materials that can meet strength and durability requirements. This approach enables the broader use of RA without compromising the performance characteristics of concrete produced with its incorporation.

Two concrete mixes were prepared using RA from different regions: TN-218 (Kharkiv, Ukraine) and TN-249 (Mykolaiv, Ukraine). Both mixtures used CEM II/A-M (S-LL) 42.5 R cement and had the same water-cement ratio ($w/c \approx 0.43$). A superplasticizer and an air-entraining admixture were added to the mix.

The resulting concrete mixes demonstrated stable technological properties: the slump corresponded to class S5; the air content was 5.5–5.7%; and the density of compacted fresh concrete was 2444 kg/m^3. The 28-day compressive strength of both mixes exceeded 54 MPa, confirming that the regional origin of the RA did not significantly affect strength parameters.

Freeze-thaw resistance was evaluated using an accelerated method in a 5% NaCl solution. Both mixes achieved frost-resistance grade F200: the loss of compressive strength after freeze-thaw cycles was 4.04% for TN-218 and 4.35% for TN-249, while mass change remained minimal – 0.14% and 0.29%, respectively.

The results confirm the feasibility of using 50% RA in the production of C30/37 strength-class concrete intended for exterior exposure to freezing and chloride environments, provided that the aggregate grading, RA water absorption, and air-entrainment level are properly controlled. In practice, such mixes can be recommended for the manufacture of concrete and reinforced concrete products without prestressing, intended for use in environments subject to repeated freezing and thawing.

Keywords: concrete, durability, recycling, aggregates, freeze-thaw, chlorides, strength, circularity, debris, PSD.

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ASSESSMENT OF THE TECHNOLOGICAL EFFICIENCY AND POSSIBILITY OF IN-SITU REGENERATION OF A HETEROGENEOUS CATALYST IN THE COMPOSITION OF PROPPANT FOR HYDRAULIC FRACTURE OF OIL FORMATIONS

pages 14–20

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The object of this research is the process of in-situ catalytic upgrading of crude oil in a post-hydraulic fracturing environment using catalytically active proppant. The subject of research is the mechanism and conditions of in-situ catalysis of crude oil, as well as the efficiency and regeneration of the "zeolite + $CrCO_3$" heterogeneous catalyst introduced into a proppant mixture during hydraulic fracturing.

The research addressed the problem of improving the recovery of crude oils with high density, viscosity and a significant content of asphaltene-resin-paraffinic substances through in-situ catalysis using a heterogeneous catalyst injected into the formation together with proppant during hydraulic fracturing. The work aims to describe the technology for preparing catalytically active granules, justify the catalyst's operating cycle, investigate its regenerative capacity within the formation, and propose a regeneration technology.

The research analysed previous experiments aimed at determining the efficiency of the "zeolite + $CrCO_3$" heterogeneous catalyst and proposed a method for its preparation in the form of granules for subsequent addition to the proppant at a concentration of 20%. It was determined that one tonne of catalytically active granules provides catalytic treatment of approximately 7–8 thousand m^3 of crude oil until regeneration is required. Laboratory studies of catalyst regeneration on a filtration unit in dynamic mode were conducted, which showed that six cycles of washing with a solvent based on aviation kerosene with the addition of a surfactant are sufficient. The paper also describes a technology for washing the catalyst after a decline in well performance.

The obtained results can be effectively used in the design and implementation of hydraulic fracturing for oil extraction within a temperature range of 100–120°C. The proposed technology enables a significant increase in well production rates and the efficiency of field operations.

Keywords: hard-to-recover hydrocarbons, hydraulic fracturing, proppant, in-situ oil catalysis, zeolite, chromium carbonate, production enhancement.

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ECOLOGY AND ENVIRONMENTAL TECHNOLOGY

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SUBSTITUTION OF THE METHOD FOR ASSESSING GENERALIZED DYNAMIC INSTABILITY OF PARAMETERS OF THE GAS ENVIRONMENT OF PREMISES FOR EARLY FIRE WARNING

pages 21–27

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The object of research is the dynamics of the gas environment at the early stages of material combustion in premises. The problem to be solved is to develop a method of generalized dynamic instability of the gas environment, based on the local Kant function and its time derivative, to detect early unstable regimes of the gas environment preceding the development of a fire. A method for assessing the generalized dynamic instability of the gas environment of premises is proposed, focused on the parameters of early fire warning. Generalized dynamic instability is understood as a cumulative characteristic that expresses the level of local sensitivity of the dynamics of time series of gas environment parameters to excitation, as well as the rate of change of this sensitivity in time. The local in time variant of the Kantz method and its time derivative are used as the basis. The method is tested on experimental data of the current concentration of carbon monoxide, which are obtained under the conditions of modeling the ignition of materials. It is shown that the local Kantz function and its derivative demonstrate pronounced changes in the transient regimes of the gas environment in the absence of significant excesses of the permissible thresholds of the dangerous measured parameter. The results obtained allow to consider the proposed measure of generalized dynamic instability as an additional diagnostic feature in early fire warning systems. The dynamics of the proposed measure for the initial stages of ignition of alcohol, paper and textiles are studied. The relationship between the dynamic content of carbon monoxide and the change in the generalized measure is analyzed. The results obtained indicate the efficiency of the method and show that, despite the differences in the kinetics of gas release and the nature of combustion, the dynamic response of the generalized measure of dynamic instability is universal.

Keywords: generalized dynamic instability, local Kantz function, ignition of materials, gas environment, fire warning.

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DEVELOPING AN ENVIRONMENTAL KEY PERFORMANCE INDICATORS MONITORING AND CONTROL SYSTEM FOR EDUCATIONAL SMART LABORATORIES

pages 28–37

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The object of research is a set of processes for monitoring and intelligent control of energy consumption and the state of the SMART laboratory environment, aimed at improving its environmental safety.

The research problem is aimed at implementing integrated automated systems based on: monitoring, forecasting and adaptive control in real time of SMART laboratories. The research used methods for synthesis and analysis of energy consumption monitoring systems, microclimate control, CO_2 concentration forecasting and algorithms for adaptive control of educational environment resources.

Basic and extended key performance indicators (KPIs) have been formed for the SMART laboratory monitoring subsystem, which take into account the state of the microclimate and comfort, energy, environmental and operational indicators, and are the basis of modern eco-maps of the premises. The adaptive control subsystem uses adaptive control logic based on a predictive model. The developed open software and hardware architecture based on Node-RED integrates automation and environmental audit tools into a single analytical platform adapted to different types of educational locations. The adaptive automatic control system for SMART laboratories based on integrated predictive ML models contributes to a controlled reduction in energy consumption by more than 40%, in particular by reducing the average power from 4.1 kW to 2.4 kW. While traditional operating modes of laboratory equipment without adaptation are characterized by a high level of carbon intensity. According to the results of the LCA analysis, the total carbon footprint at the operational stage decreased from 1.85 to 0.47 kg CO_2/hour. The use of the proposed monitoring and control system for SMART laboratories forms a modern technical and software solution that meets the criteria of sustainable development.

Keywords: SMART laboratory, Eco-KPI, microclimate monitoring, adaptive control, CO_2 forecasting, LCA analysis.

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FOOD PRODUCTION TECHNOLOGY

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JUSTIFICATION OF THE USE OF A TECHNOLOGICAL FOOD ADDITIVE WITH TRANSGLUTAMINASE FOR STABILIZATION OF MINCE SYSTEMS OF COOKED SAUSAGE PRODUCTS

pages 38–43

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The object of the research is the technology for producing minced meat products using a functional additive. The need to form stable technological and structural indicators of emulsion sausages requires a comprehensive solution consisting in combining structure-forming raw materials of different origins.

Cooked sausage "Olivier" minced systems were developed using a functional system consisting of transferase, hydrocolloids and a protein-containing additive. As a research result of minced meat systems, it was determined that the viscosity of the resulting minced meat increases with an increase in the content of the functional additive. This indicates an increase in intermolecular interaction and compaction of the protein matrix. A comprehensive assessment of active acidity before and after heat treatment indicates the possibility of stabilizing this indicator with enzymatic action on the raw materials. The textural characteristics of the finished product show a similar pattern, so the hardness of the sample without the use of the additive was 1575 g/cm^2, and when using 1% of the additive it increased by 32.9% and amounted to 2093 g/cm^2. Also heat treatment losses decreased from 22.00% to 15.11%.

The use of hydrocolloids and transglutaminase makes it possible to increase the protein and fat content in the products due to the formation of a strong matrix, which significantly reduces losses during heat treatment and prevents phase separation.

The obtained results made it possible to establish the relationship between the contraction of the technological additive with transglutaminase on the structural-mechanical indicators and chemical composition of minced systems. The practical value of the work lies in the possibility of using an ingredient complex to increase stability of minced systems, optimize the technological process and reduce losses.

Keywords: meat products, minced meat systems, transglutaminase, structure stabilization, hydrocolloids, emulsion sausages.

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IDENTIFICATION OF FACTORS INFLUENCING THE COMPOSITION AND ANTIOXIDANT ACTIVITY OF GRAPE POMACE AND ITS EXTRACTS

pages 44–52

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The object of research is the quality of grape berry components and the extracts obtained from them. The effect of grape variety and extraction method on the composition and antioxidant properties of berry components and their extracts has not been sufficiently studied.

It was found that, in terms of flavonoid content, the Madrasa and Merlot varieties are superior, while Merlot is also distinguished by higher tannin content. Among the white varieties, Rkatsiteli stands out with relatively higher indicators. In terms of antioxidant activity, the pomace of Rkatsiteli (79.2%) and Bayan Shirey (75.6%), as well as the seeds of Madrasa (87.1%) and Rkatsiteli (86.9%), showed the highest values. The CO_2 extract of grape skins demonstrated a higher radical scavenging capacity (128.1 mg/ml) and antioxidant activity (73.1%) compared to other samples.

This is explained by the biochemical characteristics of grape varieties, the fact that phenolic compounds are mainly concentrated in the skins and seeds, and the efficiency of extraction methods. Since CO_2 extraction is carried out at low temperatures in an inert gas environment, bioactive compounds are better preserved, resulting in higher antioxidant activity.

A comprehensive evaluation of the effect of grape variety and extraction method on the composition and antioxidant activity of berry components constitutes the features of this research.

The results can be applied in the food industry, winemaking, and pharmaceuticals. Their practical application ensures higher efficiency under optimal conditions – such as selecting suitable grape varieties, proper preparation of raw materials, and the use of more effective extraction methods like CO_2 technology.

Keywords: wine waste, grape skins, seed, pulp, grape pomace, antioxidant activity, radical scavenging activity phenolic compounds, anthocyanins.

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ASSESSMENT OF THE EFFECT OF ROSEHIP POWDER ON THE STRUCTURAL AND MECHANICAL PROPERTIES OF WHEAT DOUGH AND BREAD

pages 53–57

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The object of research is dough and bread made from wheat flour with the addition of rosehip powder. Its use in bread technology is considered as a promising direction for improving the quality of dough and finished products due to the natural content of biologically active substances in rosehip. The problem of insufficient knowledge of the effect of whole rosehip powder on the structural and mechanical properties of dough and bread is solved by conducting comprehensive studies using modern methods. According to the results of farinographic studies, it was found that the introduction of 2–8% rosehip powder contributes to an increase in the water absorption capacity of the dough and an extension of its formation time. At the same time, an increase in dough stability by 13.8–32.3% and a decrease in the degree of dilution by 6.6–18.0% compared to the control sample are observed, which indicates the strengthening of the structural and mechanical properties of the dough and its increased resistance to mechanical stress during kneading. Alveographic analysis also confirmed the strengthening of the dough structure: its tenacity increases, extensibility decreases, and the specific work of deformation increases by 5.3–21.1%. This is due to the strengthening of the gluten complex of wheat flour under the action of ascorbic acid, non-starch polysaccharides and polyphenolic compounds contained in rosehip powder.

It was established that the introduction of rosehip powder in an amount of 2–6% of the flour mass contributed to the improvement of the structure of the products, which is manifested in an increase in the specific volume of bread by 12.0–22.8% and a decrease in the hardness of its crumb by 14.1–28.2%. Increasing the additive content to 8% leads to a decrease in the improving effect, but the experimental indicators remain higher than the control ones.

The results obtained can be used in the practice of baking production during the development of bread technology with increased nutritional value and quality.

Keywords: bread, dough, rosehip powder, structural and mechanical properties, specific volume.

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DETERMINING THE PROSPECTS OF USING ARTIFICIAL INTELLIGENCE FOR GENERATING ENERGY BAR RECIPES

pages 58–67

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The objects of research are energy bars developed using mathematical modeling and various artificial intelligence (AI) models, including ChatGPT, Gemini, and Claude. The paper analyzes the quality and shelf-life indicators of these products. The AI application in recipe addresses the challenge of overcoming the complexity of traditional mathematical modeling for the rapid optimization of multi-component recipes. This ensures the creation of energy bars with an enhanced nutritional profile without compromising their sensory and structural-mechanical properties.

The "Horikhovo-fruktovyi" sample consisted of oat flakes, dried cranberries, and prunes with a nut mix of almonds and peanuts, and chaenomeles. The composition of the "Shypshyna" bar was generated by the Claude AI model and contained whey protein and oat flakes, as well as rosehip, honey, and nuts. The "Askorbinka" sample, generated by Gemini, contained soy components: protein isolate, milk powder, and oat flakes. The recipe for the "Smorodyna" bar, generated by the ChatGPT model, included protein isolate, oat flour, and berry powders.

The use of AI allowed for an improvement in the protein profile. The protein content in the "Askorbinka" and "Smorodyna" recipes is 2.3 times higher than the protein content in the "Horikhovo-fruktovyi" sample. These data may be explained by the fact that AI databases contain information indicating that energy bars should have high protein content.

The organoleptic evaluation of the energy bars was carried out using a 25-point scale developed by the authors. Among the fresh products, the highest score (24) was achieved by the "Smorodyna" sample, the recipe for which was generated by ChatGPT.

The samples were stored for 14 days in various packaging materials. The sample generated by Claude exhibited the best organoleptic characteristics. Regarding moisture content and acid value, the "Horikhovo-fruktovyi" sample performed best, showing moisture values from 19.9% to 25% and an acid value ranging from 1.75% to 1.83% at the end of the storage period. It was established that parchment paper and foil possess the best barrier properties for sample storage.

Keywords: energy bars, shelf-life, organoleptic properties, consumer properties, artificial intelligence, food quality.

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OPTIMIZATION OF FEED PROCUREMENT TECHNOLOGY TO MINIMIZE THE COST OF MILK FOR FARMS OF DIFFERENT PRODUCTION CAPACITIES

pages 68–75

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The object of research is the processes of harvesting, storage and feeding of stalk fodder in the feed supply system of Ukrainian dairy farms of various sizes and their impact on the economic indicators of milk production.

The research solves the problem of choosing the optimal and economically feasible method of fodder procurement for certain production conditions. A nonlinear model has been developed for choosing the method of procurement for silage-hay feed rations of dairy farms of various production capacities (from 100 to 1200 heads) has been developed.

The relevance of research is due to the need to create a scientifically based tool for optimizing the technology of fodder procurement, aimed at increasing the efficiency of fodder production, preserving the nutritional value of products and ensuring the competitiveness of dairy cattle breeding.

A model has been developed for optimizing production based on nonlinear programming, which takes into account technological, biochemical and economic losses of nutrients. The optimization criterion was chosen as the cost of 1 kg of milk, provided that the physiological needs of animals in dry matter, protein, and metabolizable energy are met. The theoretical model was built on the basis of nutrient balance ratios, production function of productivity, cost function and optimization of the production structure taking into account resource, technological and market constraints. The implementation was carried out using iterative methods. The results indicate an economically feasible production volume within 944–1150 cows for the productivity level, where the minimum specific costs are achieved. It is proven that a reduction in dry matter losses by 5% provides a reduction in the cost of milk by 3–6% depending on the size of the farm. Three-dimensional response surfaces were constructed, which can serve as a tool for planning dairy farms.

Keywords: roughage, diet, nutrients, dairy farm, model, optimization, cost price.

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