



CHEMICAL AND TECHNOLOGICAL SYSTEMS

DOI: 10.15587/2312-8372.2020.198335

SELECTION OF CATALYSTS FOR THE PROCESS OF OXIDATIVE CONDENSATION OF METHANE USING THE INTELLIGENT DECISION SUPPORT SYSTEM

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Since most chemical processes are catalytic, the problem of the choice of catalysts is traditionally considered in many publications and is covered on many Internet sites. In this paper, the catalytic process of methane oxidative condensation and intelligent technologies for analysis and decision making for choosing the best catalyst option are considered as an object of research. The authors of the work consider many literature and Internet sources, which highlight the problems of the choice of catalysts in general, and indeed for the methane oxidative condensation. As a result of studying numerous sources, the authors determine that the tasks associated with choosing the best catalyst in each case are often very ambiguous and complex. Therefore, any informational support in solving problems related to the choice of catalysts will be useful. A large amount of information, the attraction of modern computer technology and the knowledge of qualified experts, all this makes the creation of an intelligent decision support system an important and real task.

This work is aimed at developing an intelligent decision support system to select the most effective catalyst for the methane oxidative condensation.

The methods chosen in the decision-making system are the hierarchy analysis method and data mining based on decision trees. The first of them requires the participation of a human expert, the second performs data mining without the participation of a specialist. It should be noted that the choice of the latter is also due to the fact that methods based on decision trees are among the top ten in terms of their effectiveness for data mining.

For computer implementation of the system, object-oriented programming based on Microsoft Visual Studio is used.

In the course of the study, in addition to the choice of catalysts using the developed decision-making system, a computer simulation of the methane oxidative condensation using the selected catalysts is carried out and the best version of the scheme is chosen. The obtained results can be useful at the design and implementation stages of the corresponding production, as well as used by process operators to analyze the production process.

Keywords: catalyst selectivity, environmental efficiency, data mining, hierarchy analysis method, decision trees, computer modeling.

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ECOLOGY AND ENVIRONMENTAL TECHNOLOGY

DOI: 10.15587/2312-8372.2020.196948

SUBSTANTIATION OF THE ENVIRONMENTAL AND ENERGY APPROACH OF IMPROVEMENT OF TECHNOLOGICAL REGULATIONS OF WATER TREATMENT SYSTEMS

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The object of research is the environmental safety of wastewater treatment plants while minimizing resource costs for the implementation of technological processes for the removal of pollutants from effluents. There are factors that comprehensively create the prerequisites for the inefficiency of activities to maintain the environmental safety of wastewater treatment systems, and, accordingly, the complexity of implementing their technical regulation. These factors include:

- lack of real – time information on a specific combined process of water treatment, the complexity of its adequate research, even in laboratory conditions;

- lack and/or low accuracy and speed of modern technical means of measuring the composition of aqueous solutions, especially in industrial conditions.

Elimination of the influence of negative factors is achieved by improving the scientific and theoretical foundations for the creation of technological regulations for wastewater treatment plants while improving the environmental safety of industrial facilities, taking into account the requirements for reducing resource costs according to the concept of synthesis of environmental management systems.

The environmental and energy criterion for assessing the functioning of wastewater treatment facilities is substantiated and analytically obtained. An analysis of the results of production implementa-

tion allows to state that the environmental and energy criterion, which shows the specific energy consumption for ensuring the environmental safety of water treatment, is acceptable to use when setting up industrial water treatment systems and creating their technological regulations. During the month of production research, the value of the environmental and energy criterion had deviations from the set by $\pm 3.4\%$, which is a technologically acceptable indicator.

An improved concept for setting integrated goals for achieving environmentally friendly sanitation in accordance with international systems for assessing the quality of enterprise management on the basis of environmental and energy criteria creates the prerequisites for obtaining an ISO 14001 certificate. Implementation of environmental management systems will provide:

- reduction of financial expenses due to saving of natural resources and reduction of penalties;

- profit growth due to potential implementation of reuse of water resources.

Keywords: wastewater treatment, removal of pollutants, environmentally friendly wastewater disposal, environmental management.

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DOI: 10.15587/2312-8372.2020.195946

DEVELOPMENT OF NATURAL UNDERGROUND ORE MINING TECHNOLOGIES IN ENERGY DISTRIBUTED MASSIFS

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The object of research is the technology and facilities for underground mining of ores in the disrupted massifs. One of the most problematic places is the formation of man-made voids, which influence the occurrence and redistribution of stress-strain state (SSS) of the rock massif. Their existence in the earth's crust provokes the influence of geomechanical and seismic phenomena, up to the level of earthquakes.

The study used:

- data from literature sources and patent documentation in the field of technologies and facilities for underground mining of ores in the energy-disrupted massifs of substantiation of technological parameters of operating units;
- laboratory and production experiments;
- physical modeling and selection of compositions of solidifying mixtures.

Analytical researches, comparative analysis of theoretical and practical results by standard and new methods with the participation of the authors were performed.

The questions of seismogeodynamic monitoring of the SSS of the rock massif during the safe development of rock-type ore deposits are considered. The interaction of natural and man-made systems providing geomechanical balance of ore-bearing massifs is shown. Possibilities of controlling the geomechanics of a massif with filling of man-made voids with various solid mixtures and tails of underground leaching of metals from substandard ores are investigated. The typification of processes is given and the distinctive features of underground block leaching of metals from rock ores are formulated in the aspect of controlling the geodynamics of the massif. The principle estimation of the combined technologies with rationalization of use of the SSS of the rock massif for regulation of the sign and magnitude of stresses in natural and artificial conditions is shown. The conclusions about the effectiveness of the controlled interaction of natural and man-made systems, ensuring the geomechanical balance of massifs and the earth's surface in the area of subsoil development over a long period of time. The research results can be used in the underground development of ore deposits of complex structure of Ukraine, the Russian Federation, the Republic of Kazakhstan and other developed mining countries of the world.

Keywords: stress-strain state, rock massif, underground development, environmental protection technology, geomechanical balance.

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DOI: 10.15587/2312-8372.2020.198785

APPLICATION OF SIMULATION MODELING FOR ASSESSMENT OF ENVIRONMENTAL SAFETY OF SOILS

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The object of research is the ecological safety of soil pollution by an industrial enterprise. The general geofiltration process could be considered as a complex of individual physical and physico-chemical processes. During the study, the individual components of the geofiltration process were considered and a reasonable choice of mathematical models for their description is made. One of the problems is the soil type influence assessment and the corresponding geofiltration scheme on the overall filtration processes results. The classification of soils according to the filtration processes that occur in them is considered. For different soils types, influence coefficients of individual processes constituting geofiltration are established. As an assessment of the results of geofiltration, the ratio of the current concentration of the pollutant to its background concentration is proposed. A technique is proposed for determining indicators of purification efficiency, based on a simulation experiment. An algorithm for conducting a simulation experiment on a complex of models was developed taking into account the established coefficients and 10,000 of its implementations were carried out. Based on the simulation experiment results, the values that allow assessing the geofiltration quality is determined:

- purification degree interval assessment;
- soil layer height, which provides the maximum possible purification degree and the complete purification probability when the pollutant passing through the soil layer for all the examined soils.

Considering the risk of contaminant entering groundwater through the soil layer is proposed and the assessing scale for this risk based on Harrington desirability scale is established. For all considered soils types, the risk of pollution penetration in cases when the initial concentration of the pollutant exceeds the background by three, five and ten times is assessed.

It makes possible to obtain values of geofiltration performance indicators depending on the pollutant initial concentration, taking into account the soil type. This indicators is recommended to take into account for designing locations for potentially hazardous facilities and industries.

Keywords: environmental safety, soil pollution, geofiltration, simulation experiment, purification degree.

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DOI: 10.15587/2312-8372.2020.197959

RESEARCH OF WINTER GARLIC STORAGE DEPENDING ON THE ELEMENTS OF THE POST-HARVEST REFINEMENT

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The object of research is the effect of post-harvest treatment with biological products on the safety of winter garlic. One of the most problematic places is to increase the shelf life of winter garlic for food and at the same time reduce disease damage. Processing of products with biological preparations before laying them in storage, the active strains of which are able to suppress the development of plant diseases, reduce production losses during storage.

During the study, varieties of Merefiansky white and Merefiansky pinkwinter garlic grown in the forest-steppe of Ukraine are used. The preparations Gliokladin and Phytosporin are used at a concentration of 2 % during the growing season and before being stored. Natural losses, the number of sprouted bulbs of garlic and affected by microbiological diseases, the total losses and the yield of standard products are determined.

Processing vegetable products with biological products of various actions helps to extend the shelf life and increase the yield of standard products at the end of storage. It was found that treatment with biological products reduces the incidence of garlic diseases. After 6 months of storage, the untreated bulbs defy themselves with diseases of 8.33–8.93 %. Treatment with Phytosporin reduces the damage to microorganisms to 6.28–6.88 %. The most effective is the treatment of bulbs with Glyocladiine. The number of affected bulbs decreases to 2.67–2.69 %. Biological treatment most suppresses the

development of fusarium and bacteriosis. The number of affected bulbs is 0.2–0.65 and 1.1–1.6 %, respectively.

The safety of winter garlic has a strong direct relationship with weight loss, the number of people affected by diseases and the amount of sprouted bulbs. The processing of garlic by biological preparations for storage does not ensure complete elimination of the harmful species, but only reduces the harmfulness of microorganisms to an acceptable level.

The proposed method for processing garlic bulbs with biological products before storage will reduce losses and extend the period of consumption. In the development of new, low-cost, environmentally friendly and affordable storage technologies, this is an important technique.

Keywords: biological treatment, Gliocladin, Phytosporin, microorganism affliction, weight loss, increase in shelf life.

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DOI: 10.15587/2312-8372.2020.198765

ANALYSIS OF THE INFLUENCE OF TECHNOLOGICAL PARAMETERS OF THE CHLOROGENIC ACID EXTRACTION PROCESS FROM SUNFLOWER MEAL ON THE DEGREE OF ITS EXTRACTION

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The object of research is the efficiency of extraction of chlorogenic acid – the natural antioxidant, depending on the conditions of its extraction from sunflower meal. The main problem of this issue is the fact that the extraction degree of the specified phenolic compound is influenced by many factors, such as the degree of grinding of the product, the type of raw material, the method of extraction, the nature of the solvent-extractant, the temperature and duration of the extraction process, the hydromodule in the system «raw – extractant» etc. The impact of each of these parameters requires careful consideration and appropriate research. This will determine the optimal values of the specified parameters of the extraction process and increase the efficiency of extraction of chlorogenic acid.

In this work, the raw material for the production of chlorogenic acid is a meal made from sunflower seeds – a cheap second raw material of oil and fat production. Previous studies have found that a high-efficiency extractant of the specified antioxidant is a solution of ethyl alcohol with a concentration of 60 %, and the optimum temperature of the process of extracting chlorogenic acid from sunflower meal is the boiling point of the extractant. As a result of this study, the regularity of the influence on the extraction degree of chlorogenic acid of such technological parameters as the hydromodule in the system «meal – ethyl alcohol solution 60 %» (hereinafter referred to as «meal – extractant») and the duration of the extraction process were studied. Experiments to determine the dependence of the extraction degree of chlorogenic acid on the hydromodule in the system «meal – extractant» and the duration of extraction were carried out in accordance with the plan of the full factor experiment. Mathematical methods using the Microsoft Office Excel 2003 (USA) and Stat Soft Statistica v6.0 (USA) software packages have been applied for experiment planning and data processing.

The dependence indicated in the paper is a quadratic function that predicts an increase in chlorogenic acid content during extraction, with an increase in the hydromodule in the «meal – extractant» system from 1:5 to 1:10 and a decrease in the extraction time from 60 minutes up to 30 minutes. It is established that for the maximum possible increase in the extraction degree of chlorogenic acid from the meal of sunflower seeds, the optimal value of the hydromodule extraction – 1:10, the duration of extraction – 30 minutes. The obtained results allow to increase the extraction degree of chlorogenic acid from sunflower meal from 2.46 % to 5.58 %. This indicates the possibility of increasing the efficiency of extraction of antioxidant more than 2 times.

Keywords: sunflower meal extraction, chlorogenic acid, hydromodule, effective antioxidant, duration of extraction.

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REPORTS ON RESEARCH PROJECTS

DOI: 10.15587/2312-8372.2020.193074

STUDY OF THE TOXICOLOGICAL CHARACTERISTICS OF WATER-SOLUBLE SURFACE-ACTIVE SUBSTANCES OBTAINED BASED ON PHENOL, FORMALDEHYDE AND SODIUM SULPHITE

page 44–47

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The object of research is the products of the condensation reaction of phenol, formaldehyde and sodium sulfite in an aqueous medium, in order to obtain water-soluble non-toxic products based on it, which can be proposed for use as surfactants. In the course of the study, the effect of the reaction conditions (ratio of components, temperature and process time) on the quality of the products obtained and their toxicological characteristics are studied. The optimal ratio of the starting reagents phenol : formaldehyde : sodium sulfite : water is selected, which allows to obtain a product with

surface-active properties and which contains substances that can be harmful to health. It is recommended that the condensation process be carried out within 1 hour, the optimum reaction temperature is selected at 130 °C. The qualitative characteristics of the obtained product allow to recommend its use as an anionic surfactant. For this, the symptomatic and toxicological properties of the newly developed surfactant, the product of the condensation of phenol, formaldehyde and sodium sulfite in an aqueous medium, are studied. Based on the studies, it is found that with the introduction of such surfactants into the stomach of experimental white rats-females, their slightly irritating effect on the mucous membranes and skin is observed. According to the mortality criterion, with a single oral administration (LD₅₀), the harmful effects of the substance on rats are not noted. According to the research results, the product can be attributed to class IV hazard (low hazard substances) according to GOST 12.1.007.

According to toxicological findings, the resulting product can be recommended for use as a textile auxiliary substance, in the technological operations of bleaching, dyeing and printing of fabrics in contact with human skin, as well as additives to concrete mixtures used in the construction industry and other industries.

Keywords: condensation product of phenol, formaldehyde and sodium sulphite, surfactants, toxicology, lethal dose.

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DOI: 10.15587/2312-8372.2020.192599

THE INFLUENCE OF THE COMPOSITION OF BACTERIAL STARTER CULTURES ON THE MATURATION PROCESS AND THE QUALITY OF HARD RENNET CHEESE

page 48–52

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The object of research is the starter culture used in the production of solid rennet cheese.

One of the most problematic places is the selection of the number and composition of bacterial starter cultures for the production of hard cheeses with a low temperature of second heating.

During the study, analysis and synthesis methods were used – when studying the sources of scientific literature on the research topic; laboratory methods (biochemical and microbiological) studies – when determining the optimal composition of bacterial starter cultures; organoleptic methods – in determining the quality of the finished product; methods of mathematical statistics – for processing research results.

During the study, it was shown that in order to improve the coagulation of milk, which underwent high-temperature processing, it is necessary to add a double dose of calcium chloride and rennet and 0.1 % bacterial fermentation to the milk mixture. In addition, the mixture must be kept at 12 hours at 10–12 °C to improve the cheese ability of milk.

As a research result, it is found that with an increase in the total amount of bacterial starter culture, there is an increase in the acidity of milk before coagulation, a decrease in the duration of mixing of the grain after the second heating, and an increase in the acidity of whey at all stages of the technological process.

The most successful should be considered samples of cheeses made from sourdough, which included 1.5 % of the complex of mesophilic lactobacilli and 0.3 % of thermophilic lactobacilli *Lb. acidophilus*, the use of which ensures the formation of higher organoleptic characteristics of rennet cheese.

The use of highly effective bacterial starter cultures, the increased moisture content in the product and the maturation of the product at elevated temperatures make it possible to obtain cheese with a reduced ripening time of 25–30 days.

Thus, as a research result, optimal technological parameters are established that will allow to obtain rennet cheeses with a low temperature of the second heating of high quality.

Keywords: hard cheeses, bacterial starter cultures, starter cultures, lactic acid bacteria, milk-curdling enzymes.

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DOI: 10.15587/2312-8372.2020.195507

INFLUENCE OF RAW MATERIALS ON THE CHANGE OF CRYSTAL STRUCTURE OF GINGERBREAD IN THE STORAGE PROCESS

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The paper analyzes modern methods for studying the staling process of flour confectionery products, namely, X-ray diffraction analysis, X-ray diffraction, and differential scanning calorimetry. Since the crystalline structure of finished flour confectionery products is formed directly by starch, sugar and other carbohydrates, and the processes associated with the moisture content in them affect their storage. To conduct research on staling processes, the X-ray phase analysis method is used on a DRON-UM-1 diffractometer (Russia), and it revealed the degree and types of deformation of the crystal structure of substances. Diffraction maxima of starch are studied at reflection angles in the range of 10–30°. The objects of research are the «Bdzhilka» and «Imbyrni Pikantni» author's gingerbreads, and the «Pivnichni» gingerbreads are chosen as the base sample for comparison.

The gingerbread recipes contain the following raw materials:

– «Bdzhilka» – peeled rye flour, fermented rye malt, artificial honey, sunflower oil, skimmed milk powder, apple butter, bee pollen, creeping thyme inflorescence powder;

– «Imbyrni Pikantni» – peeled rye flour, rye malt extract, invert syrup, dried cheese whey, ginger root powder, elderberry inflorescence powder.

As a result of X-ray phase analysis, the destruction degree of the starch crystal lattice in the pulp structure of the developed gingerbread is studied. The interaction of starch with other carbohydrates and their influence on the formation of the final crystalline structure of finished products and changes in the crystal structure during storage are analyzed. The processes of staling up of fresh gingerbread, after 2 and 4 months of storage, which are affected by the processes of self-association, hydrotreatment of mono- and disaccharides, degradation and retrograde of starch, are studied.

The features of the staling process after 2 and 4 months of storage using the analysis of diffraction peak peaks are revealed. The retrogradation process of starch in finished products based on

the obtained diffractograms is analyzed and the ability of the used natural additives in gingerbreads to extend their shelf life is proved. The results of these studies can be implemented in the confectionery industry in order to produce products with a long shelf life.

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

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DOI: 10.15587/2312-8372.2020.192603

RESEARCH OF THE PHYTOESTROGENS CONTENT IN SOYBEAN AND CHICKPEA FLOUR

page 58–60

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The object of the research is the Krasnokutsky 195 chickpea variety, the Almaz soybean variety, and the 2018 harvest from the Agrotek collection nursery (Kyiv, Ukraine). One of the most problematic places is the ambiguous attitude of many scientists regarding the qualitative and quantitative content of phytoestrogens in leguminous grains. During the study, the method of differential spectrophotometry is used. It is established that native soybean and chickpea grains are carriers of 36.8 and 22.3 % phytoestrogens. During germination, drying and grinding of legumes, the content of phytoestrogens decreases to 15.6 % in soybean flour and to 13.3 % in chickpea flour. The use of KI as a medium for germinating soybean grains, and NaHSeO₃ as a medium for germinating chickpea grains, reduces the content of phytoestrogens by 2.7 and 1.6 %, respectively. It is determined that all experimental samples have an absorption peak at $\lambda=400$ nm, which corresponds to the content of isoflavonoids daidzein in them. Samples of flour from germinated soybean and chickpea grains in solutions of mineral salts have an absorption peak at $\lambda=225$ nm, which corresponds to the content of isoflavonoids in daidzin. It is established that the germination of legumes in solutions of mineral salts does not affect the content of biochanin and formononetin. In samples with chickpea flour sprouted in a NaHSeO₃ solution, an increase in genistein content by 60 % relative to the control is observed. The carried out complex of studies allows to state that there is a need to study the effect of soybean and chickpea flour germinated in KI and NaHSeO₃ solutions, respectively, on biological objects.

The results obtained in the study are the scientific basis for the correction of the diets of people with endocrine disorders and require special dietary nutrition.

Keywords: diets, special dietary nutrition, phytoestrogens content, soybean flour, chickpea flour.

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