



# CHEMICAL AND TECHNOLOGICAL SYSTEMS

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## PRODUCING OF NONWOVEN MATERIALS BY ELECTROSPINNING THE BIOCOMPATIBLE POLYMERS WITH CHITOSAN ADDITION

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The object of research is biocompatible composite nanofiber nonwoven materials with antiseptic properties, obtained by the electrospinning method. One of the most problematic places is the creation of a nonwoven biocompatible composite material with bactericidal properties; it has not previously been converted into fibers by electrospinning through high energy and financial costs.

The composition of biocompatible polymers is used: chitosan, polyvinyl acetate (PVAc) and polyvinyl alcohol (PVA). The electrospinning method on the capillary type laboratory installation with a «bottom-up» solution is proposed for the production of nonwoven polymeric materials.

Biocompatible composite nonwovens with antiseptic properties are obtained. This is due to the fact that the proposed method of electrospinning allows to obtain nonwoven materials with a certain statistical distribution of fibers, has several features when a solution of chitosan in lactic acid is introduced into the composition. In particular, for the composition based on PVA, the proportion of fibers with a diameter of 0.5–0.62  $\mu\text{m}$  increased by 9 %, while for compositions based on PVAc it decreased by 21 %. It is established that the optimal voltage of the electric field is 30 kV and the distance between the electrodes is 9–11 cm for the production of fibers from biocompatible PVA and PVAc with the addition of chitosan.

As a result of studies of the morphological features of the fibers obtained by optical polarization microscopy, it has been proved that with certain parameters of electrospinning, fibers with a diameter from 0.5 to 1.6  $\mu\text{m}$  are obtained. As a result of determining the statistical distribution of polymer fibers in nonwoven material in diameter, it has been found that 69–94 % of the fibers have a diameter of 0.5–0.72 microns.

A part of the fibers obtained in the laboratory installation of capillary electrospinning correspond to the area of nano-dimensions, which opens up prospects for obtaining biocompatible nanofibers with antiseptic and fungicidal properties. Therefore, the production of polymer biocompatible nonwovens by electrospinning can be used to create therapeutic systems.

**Keywords:** electrospinning method, polymeric biocompatible fibers, nonwoven materials, polymer fibers.

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# MEASURING METHODS IN CHEMICAL INDUSTRY

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## VISUALIZATION OF THE STATE OF RADIOLOGICAL CONTAMINATION OF FOOD PRODUCTS

page 8–14

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The object of research is the measurement, assessment, visualization and control of the effects of radiation exposure on life, public health, environmental protection and safety of national economic facilities, taking into account the risk of man-made disasters. One of the biggest problems is the need to develop scientific methods for the study of integrated assessments of the impact of man-made pressures on the environment and humans. And also in the creation of specialized systems for collecting, storing, processing and visualizing information using modern GIS (geographic information systems) technologies. This allows to analyze multidimensional data using their display while preserving the structural features of the information.

Comprehensive assessment of the impact of man-made pollution is used, which is a necessary condition for metrological support for in-depth study of the structure of the system, as the unity of components and connections.

As a result of this work, a specialized system for analyzing the data obtained when measuring samples of food products for compliance with the standards for a particular product has been formed. The basis of this system is the development of a database of food monitoring in the Cherkasy region (Ukraine), the structure of which includes a central bank and 5 specialized units. Examples are given of the calculation of comparative assessments of the state of areas of the region, including the radiation component.

Measurement and obtained control over a complex situation with simultaneous consideration of a large number of heterogeneous parameters are carried out. This is due to the fact that the proposed method complements the well-known methods of mathematical modeling of radiological contamination, directly affect the quality of life of the population, and has several features. In particular, the development of a software environment for the construction and visualization in the form of thematic maps of the correlation between radiological contamination and the incidence of the population of the region. This ensures the possibility of obtaining an assessment of the risk degree to public health and making informed decisions to minimize it.

**Keywords:** radiation contamination visualization, factor analysis, cluster analysis, radiological mapping.

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## DETERMINATION OF THE INFLUENCE OF THE TAPE TENSION AND THE DETACHMENT FORCE OF THE VELCRO FASTENER IN THE REHABILITATION FOOTWEAR

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The object of research is the constructive parameters of orthopedic postoperative footwear, which are based on complex theoretical and experimental studies of the effect of the upper outer surface of the foot on the top of the footwear during using. One of the most problematic places is the lack of knowledge of the conditions of interaction of the supporting belts with the Velcro fastener and the outer part of the freebie. It is needed to ensure the operational reliability of shoes.

In the course of the study, graphical dependencies of the change in the force of pressure on the upper part of postoperative orthopedic shoes were used when bending the sole as a function of the inclination angle between the tangent to the foot of the footwear and the support area. The forces of load R on the upper end of the postoperative orthopedic footwear are determined when the forces of friction between the lateral surfaces of the freebie and the external lateral sides of the foot are neglected. In this case, the problem is reduced to the construction of the equilibrium equations of the plane system of forces.

As the practice of using the Velcro fastener shows, with the increase of the tension of the supporting belt (with the loops), the force of detachment in the beginning increases to some maximum, and then, with increasing tension, the force of detachment decreases practically to zero. This circumstance may affect the reliability of the connection of the tops of orthopedic footwear. To ensure the strength of the fastener, it is necessary to choose the type of fastener, the width and the length of the active coupling area, the density of the hooks, which will ensure the reliability of the fastener in the shoes.

The optimal design features and the greatest value of the pressure force on the upper part of postoperative footwear at bending of the sole observed at an angle  $\gamma=25^\circ$  are obtained. This is due to the fact that the proposed material has a number of features, in particular the good density of hooks per  $\text{cm}^2$ .

**Keywords:** Velcro fastener, interaction of the supporting belts, position of the supporting tapes, position of hooks, bend of the sole.

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## ECOLOGY AND ENVIRONMENTAL TECHNOLOGY

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### ASSESSMENT OF THE ECOLOGICAL EFFICIENCY OF THE OPEN DEVELOPMENT OF NON-METALLIC DEPOSITS OF USEFUL MINERALS

page 21–27

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The object of research is the environmental safety of the functioning of mining enterprises. One of the most problematic places there are significant differences in the mining and geological condi-

tions and geometrical parameters of the quarries, the type and technical condition of the mining and transportation equipment used in mining enterprises, as well as the need to refine reserves in a reduced sanitary protection zone. Changes in the procedure for assessing the environmental impact of a planned activity by mining enterprises should include the development and implementation of additional technological solutions that will help reduce pollution in the adjacent territories. Therefore, there is a need to develop standardized approaches, the use of which will allow analyzing the technological processes of mining enterprises and be more dangerous from an environmental point of view, where significant amounts of pollutant emissions are generated.

In the course of the study, three typical technological schemes for the development of deposits of rocky building materials, differing in productivity and emissions of pollutants to adjacent territories, have been analyzed. It has been established that the use of belt conveyors allows reducing the zone of influence of an enterprise on the ecological state of adjacent territories and minimizing the environmental risks of the functioning of mining enterprises.

For the localization of emissions of pollutants in the mining enterprise, it is reasonable to place mobile and portable crushing and screening plants in a quarry directly in the faces or at work sites. This will reduce environmental pollution levels and increase the comfort of living in the mining regions.

Thanks to the use of modern research methods, methods of cartographic modeling and scientific forecasting and the use of com-



puter programs, optimal environmental-friendly field development technologies have been developed. Their use will reduce emissions of pollutants outside the sanitary protection zone and improve the environmental image of the mining enterprise. Such approaches will contribute to the successful passage of the environmental audit of mining enterprises, obtaining international environmental certificates and the development of new markets for products.

**Keywords:** non-metallic solid mineral deposits, environmental safety of mining enterprises, conveyor transport, crushing and screening complex.

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#### DEVELOPMENT OF REAGENTS FOR PROTECTION OF EQUIPMENT OF WATER SUPPLY SYSTEMS FROM SCALE AND CORROSION

page 27–32

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The object of research is environmentally friendly water exchange systems in industry and utilities. At existing enterprises, in the process of modernizing water use systems, they often switch to the use of corrosion inhibitors for metals and scale formation. After a long period of operation of these systems, equipment replacement is not performed. One of the most problematic places of reconstruction is the presence of scale formation and corrosion products on the inner surface of heat exchange equipment. These formations reduce

the efficiency of heat transfer and level the effectiveness of corrosion inhibitors and scale builders.

In this paper, the effectiveness of compositions proposed as etching solutions for cleaning metal surfaces from a sedimentary deposit, as well as stabilizers of scale formation, is evaluated. In the course of the study, compositions based on inorganic acids in the presence of urotropin, urotropin with thiocarbamide were used.

The research results indicate that the P-29 composition is characterized by the lowest corrosivity among the options considered. The deep corrosion rate is 0.118907 mm/year. The rate of destruction of chemically shrunk gypsum is at least 90 %.

For the purpose of effective and long-term use of heat exchange equipment, it is advisable to use corrosion and scale inhibitors. The paper presents a new P-33 composition, which at a concentration of 20 mg/dm<sup>3</sup> (water hardness 230–490 mg-eq/dm<sup>3</sup>,  $t=90\text{ }^{\circ}\text{C}$ ,  $\tau=5\text{ h}$ ) provides a stabilization effect of 56.0–93.3 %, and the anti-scale effect – 95.5–99.3 %. With an increase in the concentration of the reagent to 50 %, the stabilization and anti-scale effects reach 100 %.

The developed compositions for cleaning the surfaces of heat exchange equipment based on affordable low-cost reagents, which are dominated by analogues in efficiency, are characterized by low corrosivity and ensure removal of poorly soluble chemically resistant substances (gypsum) from the metal surface. P-33 composition is superior to analogs in that it provides stabilization of the precipitated structure in gypsum solutions in the presence of calcium and magnesium carbonates at high temperatures.

**Keywords:** scale formation stabilizer, corrosion inhibitor, water circulation systems, surface restoration of metal equipment, corrosivity of aquatic environments.

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## FOOD PRODUCTION TECHNOLOGY

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### CORRECTION OF TECHNOLOGICAL CHARACTERISTICS OF PROTEIN-FAT MIXTURE BY EXPANDING THE COMPONENT COMPOSITION

page 33–36

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The object of research is the technological characteristics of the protein-fat mixture of increased nutritional value, depending on the addition of vegetable oil as a component. The protein-fat mixture is a mixture of dried, crushed flax seeds – 60.00±3.00 %, sesame seeds – 25.00±1.25 % and ground sunflower seeds – 15.00±0.75 % by weight of the seed mixture. One of the most problematic places in the production technology of this product is the fine grinding of raw materials, as well as the removal of the mixture from the chopper chamber due to the high viscosity of the mass. In the course of research, it is reasonable to expand the component composition of the protein-fat mixture of increased nutritional value by adding vegetable oil based on modeling and rationalizing the technological characteristics of the product.

The following technological indicators of the product are identified in this research, as the effective viscosity and the separation degree of the mixture, depending on the mass fraction of added vegetable oil. Rational amount of vegetable oil in the formulation of protein-fat mixture of high nutritional value is proved. Compared with the production of protein-fat mixture without the introduction of this component, the proposed technological solution provides the ability to overcome difficulties in fine grinding of seeds, as well as

the removal of the resulting paste from the chopper chamber. It is proved the necessary to use 15 % vegetable oil to obtain a protein-fat mixture with an effective viscosity and resistance to separation in accordance with the requirements of production. According to the content of flax seeds in the protein-fat mixture is  $51.00 \pm 2.50$  %, sesame seeds –  $21.25 \pm 1.00$  %, sunflower seeds –  $12.75 \pm 0.60$  %. The effective viscosity of the resulting protein-fat mixture is  $16.0 \pm 1.5$  Pa·s, and the degree of product separation is  $0.20 \pm 0.01$  %. Vegetable oil as a component of the protein-fat mixture improves its technological characteristics, which, in turn, simplifies the process of dosing and packaging the resulting product.

**Keywords:** oilseeds, vegetable oil, effective viscosity, degree of mixture separation.

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#### INVESTIGATION OF HYGROSCOPIC PROPERTIES OF THE SPELT GRAIN

page 37–41

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The object of research is the hygroscopic properties of the not collapsed (with flower films) and the collapsed (with the removed films) spelt grains. One of the problems is that during post-harvest processing and storage of spelt grain in different environmental conditions, its moisture can occur, which can lead to deterioration in the quality of the harvested crop. To prevent this, it is necessary to know the hygroscopic properties of spelt, in particular its equilibrium moisture, depending on the parameters of the air – its temperature and relative humidity. It is promising to predict the equilibrium moisture content of spelt according to the conditions of its processing or storage, which will avoid undesirable consequences. For the study of the hygroscopic properties of not collapsed and collapsed spelt, a common tensometric method for determining the equilibrium moisture is used. The experiments are carried out in the range of air temperatures of 5...25 °C and its relative humidity of 33...70 %, simulating the conditions of active ventilation and storage of grain at different times of the year. The numerical values of the equilibrium moisture content of spelt of variety Zorya Ukrainy of 2016 harvest are obtained for the indicated temperature ranges and relative air humidity. The equilibrium humidity of not collapsed spelt (in flower films) is within 9.35...13.78 %, collapsed (without films) – within 9.98...14.58 %. Compared with not collapsed spelt, the equilibrium moisture content of the collapsed is higher by 0.42...0.74 %, which must be taken into account when storing the latter. The nature of the dependence of the equilibrium humidity of not collapsed and collapsed spelt on the parameters of the ambient air – temperature and relative humidity is established. An empirical equation is proposed that allows predicting the values of the equilibrium moisture content of spelt depending on environmental parameters. This allows to justify the rational modes of post-harvest processing of spelt, especially active ventilation, predict safe storage periods depending on environmental conditions and prevent a decline in grain quality indicators.

**Keywords:** spelt grain storage, tensometric method, hygroscopic properties, equilibrium moisture, sorption isotherms.

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