"*Vesnik of Yanka Kupala State University of Grodno.*
Series 6. Engineering Science"

Том 12, № 1, 2022 ***ISSN 2223-5396***

Engineering Science

"Vesnik Hrodzenskaha Dziarzhaunaha Universiteta Imia Ianki Kupaly.
Seryia 6. Tekhnika"
"Vesnik of Yanka Kupala State University of Grodno.
Series 6. Engineering Science"
Vol. 12, No. 1, 2022 ISSN 2223-5396

UDC 631.311:621.182.56

Analysis of methods for hardening the working bodies of agricultural machines

[*Analiz metodov uprochneniia rabochikh organov sel'skokhoziaistvennykh mashin*]

A. I. Filippov [1],
Yu. K. Kalugin [2],
S. D. Leshchik [3]

[1] *Grodno State Agrarian University (Belarus)*
Tereshkovoi St., 28, 230008, Grodno, Belarus; e-mail: kafmehan@mail.ru
[2] *Yanka Kupala State University of Grodno (Belarus)*
Ozheshko St., 22, 230023, Grodno, Belarus; e-mail: kalugin_jk@grsu.by
[3] *Yanka Kupala State University of Grodno (Belarus)*
Ozheshko St., 22, 230023, Grodno, Belarus; e-mail: s.lesh@grsu.by

Abstract. The article provides an overview of the wear of the working bodies of agricultural machines operating in soil conditions. The factors affecting their wear are considered, as well as the search for methods of strengthening and durability of working bodies working on various soils, including soils clogged with stones. The intensity of destruction of the surface layer of a material depends on many factors that are interconnected: these are specific pressure, the amount and abrasiveness of solid particles participating in the wear process as the main agent of local destruction of the material and other factors. When processing the soil, the working bodies of tillage machines interact with it and undergo intense wear, that is, the process of destruction and separation of material from the surface of a solid body during friction, which manifests itself in a gradual change in the size and shape of the body, therefore, the search for modern methods of hardening based on innovative technologies is one of the important tasks of hardening. Among the numerous methods for increasing the wear resistance of working bodies operating under speed conditions in the presence of sources of contamination of the cutting surface, without changing the dimensions, it is possible to use, in addition to volume hardening, magnetic-pulse surface hardening and hardening by a laser beam. One of the common factors for these types of processing is structural changes in the surface layer caused by the influence of fields, heating and cooling of the material. Each of the processing methods has certain advantages and disadvantages. To consider the issue of increasing the wear resistance of parts and tools for processing and loosening the soil, it is necessary to analyze the characteristics of the most frequently used methods. As modern innovative technologies are created, it is possible to conduct research on strengthening the working bodies of agricultural machines that work with soil using modern methods. The development and application of modern hardening technologies for these working bodies will make it possible to evaluate and select the most optimal hardening methods.

Keywords: agricultural machines, working bodies, movement speed, soil hardness, soil stickiness, coefficient of friction, angle of friction, hardening, wear, aggregate, durability, volume hardening, magnetic-pulse processing, laser hardening, innovative technology.

Images – 4. Bibliography – 10 titles

"Vesnik Hrodzenskaha Dziarzhaunaha Universiteta Imia Ianki Kupaly.
Seryia 6. Tekhnika"
"Vesnik of Yanka Kupala State University of Grodno.
Series 6. Engineering Science"
Vol. 12, No. 1, 2022 ISSN 2223-5396

UDC 621.762.02

Technological bases and equipment for spheroidization of ammonium salt powders of perchloric acid by ultrasonic mechanical activation

[*Tekhnologicheskie osnovy i oborudovanie dlia sferoidizatsii poroshkov ammonievoi soli khlornoi kisloty metodom ul'trazvukovoi mekhanoaktivatsii*]

A. F. Iliyushchenko [1], O. K. Krivonos [2], E. E. Petiushik [3], V. V. Rubanik [4], V. V. Rubanik (Jr.) [5], V. S. Labetski [6], A. A. Krugleshov [7]

[1] *State Research and Production Powder Metallurgy Association (Belarus)*
Platonova St., 41, 220005, Minsk, Belarus; e-mail: alexil@mail.belpak.by
[2] *State Research and Production Powder Metallurgy Association (Belarus)*
Platonova St., 41, 220005, Minsk, Belarus; e-mail: krivonos_ok@tut.by
[3] *State Research and Production Powder Metallurgy Association (Belarus)*
Platonova St., 41, 220005, Minsk, Belarus; e-mail: pet65@bk.ru
[4] *Institute of Technical Acoustics of the National Academy of Sciences of Belarus (Belarus)*
Generala Ludnikova Ave., 13, 210009, Vitebsk, Belarus; e-mail: jr@tut.by
[5] *Institute of Technical Acoustics of the National Academy of Sciences of Belarus (Belarus)*
Generala Ludnikova Ave., 13, 210009, Vitebsk, Belarus; e-mail: v.v.rubanik@tut.by
[6] *Institute of Technical Acoustics of the National Academy of Sciences of Belarus (Belarus)*
Generala Ludnikova Ave., 13, 210009, Vitebsk, Belarus; e-mail: labetsky.V@yandex.by
[7] *Institute of Technical Acoustics of the National Academy of Sciences of Belarus (Belarus)*
Generala Ludnikova Ave., 13, 210009, Vitebsk, Belarus; e-mail: ikelmimi@gmail.com

Abstract. The article describes the mechanism for determining the technological modes of operation of equipment for the spheroidization of particles of powders of ammonium salt of perchloric acid by means of ultrasonic mechanical activation. In the introduction, the necessity of using spheroidization processes in the preparation of initial powder components technology in the production of energy-saturated composite materials is determined, and the object of research is also defined – the method of spheroidization of ammonium salt particles of perchloric acid by means of ultrasonic mechanical activation under various conditions. The purpose of the study is to establish the conditions for ultrasonic mechanical activation of the ammonium salt powder of perchloric acid and the modes of its implementation. In the main part, the components of technological equipment for ultrasonic treatment are considered and a diagram of an ultrasonic acoustic system and equipment is proposed, based on the use of an ultrasonic generator UZG 1-1 and a magnetostrictive transducer PMS-1-1. Based on the simulation of the geometry of the booster and the calculation of the waveguide, the designs of the transmitting elements are proposed, which ensure the implementation of the ultrasonic mechanical activation of the powder process. The set of studies of the ultrasonic mechanical activation of the powder of ammonium salt of perchloric acid "dry", in liquid and in liquid under excessive hydrostatic pressure for fixed periods of time at given oscillation frequencies and waveguide displacements amplitudes processes has been carried out. The qualitative aspect (taking into account the technological limitations expressed in the requirement to minimize additional technological operations to achieve acceptable parameters of the powder processing final result) of the ultrasonic mechanical activation of the powder of ammonium salt of perchloric acid and the quantitative parameters of its implementation method have been established. It is shown that ultrasonic action leads to a powder particles change in shape – they acquire a more rounded shape; it is advisable to carry out the process in an air environment at normal pressure "dry"; The optimal processing time is about 5 minutes at an amplitude of ultrasonic displacements of the

waveguide end face of 20–25 μm and an oscillation frequency of 20 kHz. The results obtained can be applied in the technological processes development for the mechanical activation of powders of ammonium salt of perchloric acid, as well as the choice of the necessary technological equipment and in production conditions tooling.

Keywords: spheroidization of powder components particles, ultrasonic mechanical activation, ultrasonic exposure modes, technological equipment for spheroidization.

Tables – 2. Images – 3. Bibliography – 10 titles

"Vesnik Hrodzenskaha Dziarzhaunaha Universiteta Imia Ianki Kupaly.
Seryia 6. Tekhnika"
"Vesnik of Yanka Kupala State University of Grodno.
Series 6. Engineering Science"
Vol. 12, No. 1, 2022 ISSN 2223-5396

UDC 537.525

Spectral and emission characteristics of XeCl-excilamps of high-frequency induction discharge for ultraviolet disinfection

[*Spektral'no-emissionnye kharakteristiki XeCl-eksilampy vysokochastotnogo induktsionnogo razriada dlia ul'trafioletovoi dezinfektsii*]

K. F. Znosko

Yanka Kupala State University of Grodno (Belarus)
Ozheshko St., 22, 230023, Grodno, Belarus; e-mail: znosko@rambler.ru

Abstract. The object of study is a XeCl-excilamp with excitation by a high-frequency inductive discharge. The relevance of the work is due to the need to improve the spectral-emission characteristics of excilamps and methods for their excitation for wide practical application. The aim of the study is to optimize the spectral and emission characteristics of wide-aperture XeCl-exisilamp with electrode-free induction high-frequency discharge excitation for ultraviolet disinfection of municipal and industrial premises. The introduction briefly notes the positive effects of disinfection with ultraviolet radiation. Advantages and problems of excimer lamps and methods of their excitation as sources of ultraviolet radiation for disinfection are described. The main part presents the results of the development of a working model of an excilamp with induction high-frequency discharge excitation and the experimental study of its spectral-emission characteristics. The maximum output power of ~11 W on a mixture of HCl : Xe : He = 1 : 20 : 20 at its pressure of ~1 Torr is obtained. The maximum efficiency of the XeCl-excilamp from the high-frequency field energy invested in the discharge was ~8%, which is close to the typical values of the efficiency of excilamps with excitation by capacitive discharge. The spectral composition of the radiation was studied. It was shown that more than 90 % of the excimer lamp energy is concentrated in the ultraviolet region of the spectrum in the B-X band (maximum wavelength ~308 nm). A characteristic feature of the observed spectrum of the excimer lamp with induction high-frequency discharge excitation is the broadening of the radiation bands as compared to the spectra of the radiation of barrier or capacitive discharge excilamps. The obtained results make excitation of excilamps by high-frequency induction discharge attractive for further study and practical application. The main conclusions about the work done are formulated in the conclusion.

Keywords: disinfection, sanitization, ultraviolet radiation, excimer lamp, high-frequency generator, high-frequency induction discharge, spectral-emission characteristics.

Images – 8. Bibliography – 29 titles

"Vesnik Hrodzenskaha Dziarzhaunaha Universiteta Imia Ianki Kupaly.
Seryia 6. Tekhnika"
"Vesnik of Yanka Kupala State University of Grodno.
Vol. 12, No. 1, 2022 ISSN 2223-5396

UDC 504.3.054

Optical light microscopy in the determination of small fractions of suspended particles in the air of the urban environment

[*Svetovaia mikroskopiia*
v otsenke melkodispersnykh fraktsii vzveshennykh chastits
v atmosfernom vozdukhe gorodskoi sredy]

I. M. Kolesnik [1],
G. G. Yukhnevich [2],
E. A. Belova [3],
M. G. Lazovski [4]

[1] *Yanka Kupala State University of Grodno (Belarus)*
Dovatora Lane, 3/1, 230012, Grodno, Belarus; e-mail: kolesnik_irina@inbox.ru
[2] *Yanka Kupala State University of Grodno (Belarus)*
Dovatora Lane, 3/1, 230012, Grodno, Belarus; e-mail: guhnev@grsu.by
[3] *Yanka Kupala State University of Grodno (Belarus)*
Dovatora Lane, 3/1, 230012, Grodno, Belarus; e-mail: bielova@yahoo.com
[4] *Yanka Kupala State University of Grodno (Belarus)*
Dovatora Lane, 3/1, 230012, Grodno, Belarus; e-mail: mark1999.l@mail.ru

Abstract. Small fractions of particulate matter are a common air pollutant in the urban environment. To analyze the amount and size of solid particles, various modifications of optical microscopy and laser detection methods are used. The aim of the work is to evaluate the possibility of the usage of light microscopy to determine the quantitative and granulometric composition of particulate matter in the air of the urban environment. The article presents the results of gravimetric analysis of particulate matter, followed by examination by light microscopy of clarified filters. It is shown that using light microscopy makes it possible to estimate the number of particle size fractions of particulate matter larger than 0.3 μm in atmospheric air. It has been established that the number of particles in the atmospheric air in certain districts of Grodno varied by more than 15 times. The change in the mass concentrations of dust and the number of dispersed particles in the atmospheric air of individual points in the urban environment can be reversed, which indicates the difference in the sources of solid particles and their different chemical nature. The diameter of suspended particles in the atmospheric air of the urban environment is characterized by very high variability (80–157 %). The distribution of frequencies of occurrence of particles of different sizes in the air does not correspond to the normal law and right-sided asymmetry and positive kurtosis were observed in the variational histograms. A significant inverse connection was found between the particle size and their proportion in the samples. The most common fraction in the atmospheric air of Grodno was particles with a diameter of 0.5–1 μm (41.5–61.3 %). At the same time, a statistically significant association of points of the urban environment into clusters was determined primarily by the proportions of particles with a diameter of more than 5 microns.

Keywords: atmospheric air, particulate matter, concentration and fractional composition of suspended particles, gravimetric method, optical light microscopy.

Tables – 5. Images – 9. Bibliography – 19 titles

"Vesnik Hrodzenskaha Dziarzhaunaha Universiteta Imia Ianki Kupaly.
Seryia 6. Tekhnika"
"Vesnik of Yanka Kupala State University of Grodno.
Series 6. Engineering Science"
Vol. 12, No. 1, 2022 ISSN 2223-5396

UDC 57.045

Stochastic modeling of meteorological elements for solving environmental monitoring problems

[*Stokhasticheskoe modelirovanie riadov meteorologicheskikh elementov dlia resheniia zadach ekologicheskogo monitoring*]

A. A. Butko [1],
O. I. Rodkin [2],
V. A. Pashinski [3]

[1] *International Sakharov Environmental Institute of Belarusian State University (Belarus)*
Botanicheskaya St., 15, 220070, Minsk, Belarus; e-mail: butko_andrei@mail.ru
[2] *Belarusian National Technical University (Belarus)*
Nezavisimosti Ave., 65, 220013, Minsk, Belarus; e-mail: aleh.rodzkin@rambler.ru

[3] *International Sakharov Environmental Institute of Belarusian State University (Belarus)*
Botanicheskaya St., 15, 220070, Minsk, Belarus; e-mail: Pashynski@mail.ru

Abstract. The purpose of the research presented in the publication is developing the stochastic model for simulating the series of meteorological elements used in predicting for transferring of biogenic elements into water bodies from the territory of agricultural land. The object of study is artificial series of meteorological elements with given statistical characteristics. As initial data, the meteorological data of the State Institution "Republican Hydrometeorological Center" for the Minsk object obtained for the period 2000–2020 were used. For development of the stochastic model, the following indicators were used: daily amount of total solar radiation, maximum and minimum air temperature, relative air humidity, amount of atmospheric precipitation, number of days with precipitation, maximum half-hour share of precipitation, wind speed at a height of 10 m above the earth's surface. Artificial meteorological series are obtained on the basis of a sample set of randomly generated daily values with using the Monte Carlo method. The stochastic component of precipitation generation is a Markov chain gamma model; total precipitation – inverse method of two-parameter gamma distribution; relative air humidity – Simpson distribution; wind speed – inverse Weibull distribution method; the minimum and maximum air temperatures and solar radiation are determined using the Matalas first-order recurrent filter. For each of the elements, a differentiated correspondence of the statistical parameters determined from the measured and calculated series of meteorological elements were proved. The results of investigation can be used for modeling and forecasting of weather in areas with limited meteorological observation data for solving applied problems in biological and ecological systems.

Keywords: modeling, random number generation, stochastic model, meteorological elements, weather, climate.

Tables – 8. Images – 8. Bibliography – 30 titles

"Vesnik Hrodzenskaha Dziarzhaunaha Universiteta Imia Ianki Kupaly.
Seryia 6. Tekhnika"
"Vesnik of Yanka Kupala State University of Grodno.
Series 6. Engineering Science"
Vol. 12, No. 1, 2022 ISSN 2223-5396

UDC 678.027:532.135

Comparative analysis of rheological properties indicators for thermoplastic melts

[*Sravnitel'nyi analiz pokazatelei reologicheskikh svoistv rasplavov termoplastov*]

V. G. Barsukov [1], T. S. Chikova [2]

[1] *Yanka Kupala State University of Grodno (Belarus)*
Ozheshko St., 22, 230023, Grodno, Belarus; e-mail: v.g.barsukov@grsu.by
[2] *International Sakharov Environmental Institute of Belarusian State University (Belarus)*
Botanicheskaya St., 15, 220037, Minsk, Belarus; e-mail: chikova.tamara@iseu.by

Abstract. The introduction analyzes the state of the issue and substantiates the research relevance. The aim of the work is to determine and comparatively analyze the values of physically normalized indicators of rheological properties of typical representatives of thermoplastic melts. In the methodological part of the work, to ensure the comparability of the results, the physically normalized form of the Ostwald-de-Waele power empirical rheological equation proposed by McKelvey is used. The calculation scheme is based on the transition from an approximating power function with rheologically non-deterministic parameters to two dimensionless rheologically determined complexes characterizing the stress-strain state of a nonlinear-viscous medium. The first dimensionless complex is presented in the form as the ratio of the actual shear rate to a unit normalization base value, and the second is in the form as the ratio of shear stresses acting on the deformable medium to the base (reduced) value of these stresses, which are necessary to overcome viscous resistance at a unit normalization shear rate. A technique is described for determining physically normalized indicators of rheological properties using the thermoplastic melts flow curves available in the scientific and technical literature (dependence of shear stresses on shear rate) based on the processing of these graphical dependencies plotted in double logarithmic coordinates. In the main part of the work, the values of physically normalized indicators of rheological parameters (the reduced index of viscous resistance and the indicator of the rheological nonlinearity of the melt) are determined and presented in the form of tables for widely used types of filled and unfilled thermoplastic polymers. A comparative analysis of these indicators has been carried out. Conclusions are given on the work and it is noted that the

results of the research can be used in engineering practice, as well as in the educational process when performing rheological calculations of the processes of processing thermoplastic polymeric materials.

Keywords: power rheological equation, physical normalization, polymer melt, property indicators, viscous resistance.

Tables – 2. Images – 1. Bibliography – 18 titles

"Vesnik Hrodzenskaha Dziarzhaunaha Universiteta Imia Ianki Kupaly.
Seryia 6. Tekhnika"
"Vesnik of Yanka Kupala State University of Grodno.
Series 6. Engineering Science"
Vol. 12, No. 1, 2022 ISSN 2223-5396

UDC 628.477.6:658.567.1

Utilization of polymer packaging materials as a basis of environmental safety: biodegradable and edible materials

[*Utilizatsiia upakovochnykh materialov kak osnova ekologicheskoi bezopasnosti: biorazlagaemye i s"edobnye materialy*]

I. Yu. Ukhartseva [1], E. A. Tsvetkova [2], V. A. Goldade [3], V. M. Shapovalov [4]

[1] *P. O. Sukhoi Gomel State Technical University (Belarus)*
Oktiabria Ave., 48, 246029, Gomel, Belarus; e-mail: ukhartseva@yandex.ru
[2] *V. A. Belyi Metal-Polymer Research Institute of National Academy of Sciences of Belarus (Belarus)*
Kirova St., 32a, 246050, Gomel, Belarus; e-mail: tsvetkovaea21@mail.ru
[3] *V. A. Belyi Metal-Polymer Research Institute of National Academy of Sciences of Belarus (Belarus)*
Kirova St., 32a, 246050, Gomel, Belarus; e-mail: victor.goldade@gmail.com
[4] *V. A. Belyi Metal-Polymer Research Institute of National Academy of Sciences of Belarus (Belarus)*
Kirova St., 32a, 246050, Gomel, Belarus; e-mail: v.shapovalov@tut.by

Abstract. The introduction presents an analysis of waste disposal methods used in different countries, which indicates certain difficulties in the disposal of polymer waste due to their greatest environmental danger, since synthetic polymers decompose for a long time in natural conditions. Today, high requirements for environmental protection dictate the emergence of new types of processing of polymer waste through their self-destruction. An actual direction in the packaging industry is the production of environmentally friendly self-destructible packaging: biodegradable and edible. The basis for the production of such packages is raw materials of animal and vegetable origin. The purpose of the work is to substantiate the advantages of self-destructible packaging as an environmentally friendly material that does not harm the environment. The main part of the article provides information about the advantages of biodegradable and edible packaging materials. The advantage of biodegradable packaging is its ability to degrade into natural components that do not require separate collection, sorting, recycling or other disposal solutions. The disposal costs of such packaging are minimal, since the waste is decomposed under the influence of natural factors: water, various types of radiation or microorganisms. Edible packaging is the only type of biodegradable plastic packaging that does not require individual collection and special disposal conditions. Such packages have a high sorption capacity, which allows them to have a positive physiological effect on the human body, enriching food with minerals, vitamins, complexes of microelements, bioflavonoids, regulating the taste and aroma properties of the packaged food product and simplifying the nutrition process. In the conclusion, it is noted that the solution to the problems of recycling packaging materials indicates a global trend in the field of creating self-destructible materials – biodegradable and edible, the prospects of which are aimed at preserving the environment.

Keywords: packaging materials, biodegradation, hydradegradation, oxo-degradation, edible packaging, waste, utilization.

Tables – 3. Images – 2. Bibliography – 46 titles

"Vesnik Hrodzenskaha Dziarzhaunaha Universiteta Imia Ianki Kupaly.
Seryia 6. Tekhnika"
"Vesnik of Yanka Kupala State University of Grodno.
Series 6. Engineering Science"
Vol. 12, No. 1, 2022 ISSN 2223-5396

UDC 664.692.5

Methodology for calculating the pasta dough flow parameters in stepped cylindrical channels

[*Metodika raschetnoi otsenki parametrov techeniia makaronnogo testa v stupenchatykh tsilindricheskikh kanalakh*]

A. B. Torgan

Belarusian State Agrarian Technical University (Belarus)
Nezavisimosti Ave., 99, 220023, Minsk, Belarus; e-mail: anechkatorgan@mail.ru

Abstract. The introduction provides information about the state of the problem and substantiates the relevance of the research. The purpose of the work is to develop a methodology for calculating the relationship between pressure losses during the flow of pasta dough in channels with a stepped-variable cross section with the dimensions of the channel structural, as well as with the pasta dough rheological properties and the performance of device. In the methodological part of the work, the applied rheological model is described and a technique for mathematical modeling of power and kinematic parameters of pasta dough flow in stepped cylindrical channels is given. Due to the small contribution of the pasta dough shear strength to the total pressure loss, a rheological model of a non-linear-viscous medium is used, which is described by the power – law rheological Ostwald–de Waele equation. Neglecting the elastic deformations of the dough and the elastic change in volume, we assumed the condition of constancy of the volume and mass flow (productivity) for any cross section of the channel in each of its sections. In the main part of the work, analytical dependencies are presented that relate the magnitude of the pressure drop to overcome viscous resistance during the flow of pasta dough in channels with a stepped-variable cross section with the dimensions of the structural elements of the channel, as well as with the rheological properties of the pasta dough and the performance of the device. These dependences formed the theoretical basis for calculating method of the pasta dough flow parameters in stepped cylindrical channels. The technique was tested on the example of an industrial macaroni press matrix equipped with a system of stepped-variable channels in the pre-forming zone. The results of the research can be used in the design of new sizes of matrices for pasta dough molding as well as in the educational process in the training of food production process engineers.

Keywords: pasta dough, flow, stepped channel, calculation method, rheological model, mathematical modeling.

Tables – 4. Images – 4. Bibliography – 17 titles

"Vesnik Hrodzenskaha Dziarzhaunaha Universiteta Imia Ianki Kupaly.
Seryia 6. Tekhnika"
"Vesnik of Yanka Kupala State University of Grodno.
Series 6. Engineering Science"
Vol. 12, No. 1, 2022 ISSN 2223-5396
© Yanka Kupala State University of Grodno, 2022

UDC 678.02:547.995.12(043.3) + 678.02:577.11(043.3)

Analysis of existing applications of the biopolymer chitin and its derivatives

[*Analiz sushchestvuiushchikh sfer primeneniia biopolimera khitina i ego proizvodnykh*]

E. T. Klishanets

Yanka Kupala State University of Grodno (Belarus)
Dovatora Lane, 3/1, 230012, Grodno, Belarus; e-mail: alena-1989@yandex.ru

Abstract. The introduction presents scientific data on the structure, chemical composition and properties of chitin, chitosan and the chitin-glucan complex. In recent years, special attention has been paid to the biopolymer chitin and its derivatives. Due to their unique properties: biocompatibility, biodegradability, non-toxicity, they have found application in more than 70 areas: medicine, ecology, food industry, agriculture. Sources for the production of chitin can be the shell of commercial crustaceans, the biomass of fungi, and the cuticle of insects. The main part describes the modern fields of application of these biopolymers and raw materials for the production of chitin and its derivatives. At present, interest has increased in the problems of more rational use of renewable natural resources, both from an environmental and economic point of view. There are various biopolymers in the world, in particular, the biopolymer of the 21st century – chitin and its derivatives. The recommended daily intake of chitin is from 3 to 7 g. The consumption of such an amount of chitin or chitosan is used to remove toxins and harmful substances, radionuclides, and pathogenic microorganisms from the body. On the industrial scale of the Republic of Belarus, fungi, insect carrion, earthworms can serve to isolate chitin and its derivatives. Due to the fact that on the industrial scale of the Republic of Belarus, the use of crustaceans as a source of chitin for the Republic of Belarus is very costly. In addition, a negative factor is the increase in pollution of sinks with heavy metals and other toxic waste.

Keywords: chitin, chitosan, chitin-glucan complex, biocompatibility, biodegradability, demineralization, deproteinization.

Bibliography – 15 titles

"Vesnik Hrodzenskaha Dziarzhaunaha Universiteta Imia Ianki Kupaly.
Seryia 6. Tekhnika"
"Vesnik of Yanka Kupala State University of Grodno.
Series 6. Engineering Science"
Vol. 12, No. 1, 2022 ISSN 2223-5396

UDC 620.178.7

High-speed mode movement of solid particles in turbomachines with radial blades

[*Skorostnoi rezhim dvizheniia tverdykh chastits v turbomashinakh s radial'nymi lopastiami*]

V. G. Barsukov [1],
A. G. Lezhava [2],
M. A. Ilkevich [3]

[1] *Yanka Kupala State University of Grodno (Belarus)*
Ozheshko St., 22, 230023, Grodno, Belarus; e-mail: v.g.barsukov@grsu.by
[2] *Yanka Kupala State University of Grodno (Belarus)*
Ozheshko St., 22, 230023, Grodno, Belarus; e-mail: lataia@tut.by
[3] *Yanka Kupala State University of Grodno (Belarus)*
Ozheshko St., 22, 230023, Grodno, Belarus; e-mail: Ejsmont_MA@grsu.by

Abstract. The introduction substantiates the relevance of research. The purpose of the work is to create and approbate a methodology for calculating the speed mode for movement of coarse solid particles along the radial blades of turbomachines. In the methodological part an analysis of the forces acting on a solid particle when sliding along the radial blades of turbomachines is carried out. A differential equation for motion of solid particles has been compiled and options for its solution have been considered. Analytical dependencies have been obtained that make it possible to determine the values of the relative and total velocities, as well as the angle between the corresponding vectors for the velocities of the particle as a function of time when it moves along the radius of the blade. A calculated estimate of the change in these parameters for a wide range variation of the friction coefficient of a particle on the rotor blade is carried out. It is shown that the total sliding velocity of the particle as well as its radial and transport components intensively increasing in the initial time range, asymptotically approach the linear functions of the particle coordinate, practically independent of its initial position, but linearly dependent on the angular velocity of the rotor rotation and nonlinearly – on the coefficient of friction of the particle on the blade. In this case, the exit angle of the particle does not depend on the radius and rotor angular velocity, but depends on the friction coefficient of the particle against the rotor blade. With an increase in the friction coefficient the relative and total velocities of particle motion decrease which leads to a decrease in the kinetic energy accumulated by the particles. Conclusions are drawn from the results of the study. It is noted that the results obtained can be used by design engineers when designing turbomachines with radial blades, as well as in the educational process when training mechanical engineers and process engineers.

Keywords: turbomachine, solid particle, speed, coefficient of friction, departure angle.

Tables – 3. Images – 2. Bibliography – 17 titles

"Vesnik Hrodzenskaha Dziarzhaunaha Universiteta Imia Ianki Kupaly.
Seryia 6. Tekhnika"
"Vesnik of Yanka Kupala State University of Grodno.
Series 6. Engineering Science"
Vol. 12, No. 1, 2022 ISSN 2223-5396

UDC 624.046.2

Experimental studies of reinforced concrete beams with external reinforcement of the tensioned face using composite fabrics

[*Eksperimental'nye issledovaniia zhelezobetonnykh balok s vneshnim armirovaniem rastianutoi grani kompozitnymi tkaniami*]

A. R. Volik [1], Ya. Ya. Novitski [2]

[1] *Yanka Kupala State University of Grodno (Belarus)*
Ozheshko St., 22, 230023, Grodno, Belarus; e-mail: a.volick@grsu.by
[2] *Yanka Kupala State University of Grodno (Belarus)*
Ozheshko St., 22, 230023, Grodno, Belarus; e-mail: novickij_yy@grsu.by

Abstract. The object of the study is reinforced concrete beams that are reinforced with technical polyamide (kapron) fabric produced by Branch "Khimvolokno Plant" JSC "Grodno Azot", and fiberglass, manufactured by JSC "Polotsk-Steklovolokno". The relevance of the stems from the need to obtain and study experimental data of the load-bearing capacity, fracture pattern, crack resistance and cracking of reinforced concrete beams reinforced with composite fabrics, since the topic of restoring the load-bearing capacity of reinforced concrete structures or their strengthening is currently very relevant. Reinforcement of bent reinforced concrete structures with composite fabrics allows using fabrics along the outer edges of the structure, as they are resistant to the external environment and are not subject to corrosion, and represent external composite reinforcement, which, together with metal reinforcement, perceive tensile forces. The most common system for the restoration of reinforced concrete structures is currently the system of external reinforcement of carbon tapes, but the use of this material is limited by high cost. The aim of the study is to experimentally confirm the possibility of effective use of technical polyamide (kapron) fabric, produced by Branch "Khimvolokno Plant" JSC "Grodno Azot", and glass fabric, produced by JSC "Polotsk-Steklovolokno", to strengthen the stretched face of reinforced concrete bent structures. Two reinforcement options are presented: gluing horizontal tapes along the entire length on the lower stretched face and the device of a U-shaped clip of fabrics in the stretched zone. Experimental studies have shown that the external reinforcement of the stretched zone with technical polyamide (kapron) fabric produced by Branch "Khimvolokno Plant" JSC "Grodno Azot", and fiberglass manufactured by JSC "Polotsk-Steklovolokno" change the nature of destruction, increase load-bearing capacity of reinforced concrete beams by 16–38 % in depending on the material and method of reinforcement, affect the crack resistance and crack formation. The results of experimental studies made it possible to solve an important applied problem of the effective use of these composite materials as external reinforcement of the tension face of bending reinforced concrete beams.

Keywords: reinforcement, beam, composite material, fiberglass, polyamide fabric load-bearing capacity, crack resistance.

Images – 6. Bibliography – 16 titles

"Vesnik Hrodzenskaha Dziarzhaunaha Universiteta Imia Ianki Kupaly.
Seryia 6. Tekhnika"
"Vesnik of Yanka Kupala State University of Grodno.
Series 6. Engineering Science"
Vol. 12, No. 1, 2022 ISSN 2223-5396

UDC 691.175.3

Structural and mechanical modeling

of density and stiffness of hybrid composite reinforcement

[*Strukturno-mekhanicheskoe modelirovanie plotnosti i zhestkosti gibridnoi kompozitnoi armatury*]

S. A. Sazon

Yanka Kupala State University of Grodno (Belarus)
Ozheshko St., 22, 230023, Grodno, Belarus; e-mail: ssazon@grsu.by

Abstract. A structural-mechanical analysis of the influence of high-modulus fibers on the physical and mechanical properties of hybrid composite reinforcement has been performed. In the introduction, the need for a detailed physical and mechanical analysis of the properties of combined composite reinforcement is updated due to the insufficient study of many issues. Despite the progress made in the field of modeling structural composite reinforcement and the development of its production technology, many issues related to its strength are not well understood, which is the main constraint in the adoption of scientifically based standards for assigning mechanical characteristics, control and testing methods. The aim of the study is to develop methods and use them to carry out a structural-mechanical analysis of the influence of the type and content of high-modulus fibers on the density and elastic moduli of hybrid composite reinforcement. In the main part of the article, mathematical modeling of the possible mechanism of destruction of combined rods with different content of high-modulus reinforcing fibers and base fibers was carried out. At the first stage, a structural-mechanical analysis of the factors contributing to the increase in the moduli of longitudinal elasticity described by the "rule of mixtures" was carried out. In this case, the influence of the mass and volume content of high-modulus fibers on the density of the hybrid composite, as well as its moduli of longitudinal and transverse elasticity, was modeled. The results obtained make it possible to modernize the method of predictive assessment of the density and elasticity moduli of composite building reinforcement and can be used by engineering and technical workers of manufacturers and consumers of such reinforcement, as well as in the educational process in the training of engineering personnel of the construction profile.

Keywords: combined reinforcement, strength properties, rule of mixtures, high-modulus fibers, metal cord.

Tables – 6. Images – 2. Bibliography – 27 titles

"Vesnik Hrodzenskaha Dziarzhaunaha Universiteta Imia Ianki Kupaly.
Seryia 6. Tekhnika"
"Vesnik of Yanka Kupala State University of Grodno.
Series 6. Engineering Science"
Vol. 12, No. 1, 2022 ISSN 2223-5396

UDC 381.1+53(092)

Science, industry and defense need highly educated specialist

[*Nauke, promyshlennosti i oborone nuzhny vysokoobrazovannye spetsialisty*]

A. I. Sviridenok

e-mail: svarad@yandex.ru

Abstract. The introduction provides a brief analysis of the problem and substantiates its relevance. It is noted that the progress of modern and future generations of human society is unthinkable without the development and improvement of the quality of science, education and culture. The issue of training or attracting talented researchers and engineers from outside is becoming one of the most important tasks both for universities and for the competitiveness of firms manufacturing science-intensive products. The purpose of the work is to carry out a comprehensive analysis of the problem and the main directions of the development of education in order to train creatively thinking specialists for scientific and innovation sphere. The main part of the article notes that among a large array of problems, the solution of which determines the success of scientific and innovative development, the most important is the preparation, search and stimulation of innovatively active, creative people. The historical aspects of scientific creativity are analyzed on the example of outstanding scientists of the past centuries from different fields of science. The psychological features of this problem and examples of its solution in the USA and the Russian Federation are considered. An assessment of the subconscious and "random" factors for the emergence of new ideas and scientific concepts was made. The advantages and some negative consequences of modern Internet technologies for the educational process and cultural development are shown. Using examples from the history of science and technology, the contribution of young researchers to the

development of breakthrough areas of science is analyzed. In conclusion, it is noted that the events taking place in the world and in our country clearly show the need for a flexible and purposeful transformation of the education system in order to adapt to modern and future needs of training creatively thinking personnel for the scientific and innovative sphere.

Keywords: science, technology, young scientists, specialists, modern education.

Bibliography – 6 titles