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17. SIMPOZIJ „MATERIJALI I METALURGIJA“ dopuna „Zbornika sažetaka”

17th SYMPOSIUM „MATERIALS AND METALLURGY“ supplement of “Book of Abstracts”

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U Metalurgiji 63 (2024) 2,303-320 objavljen je Zbornik sažetaka (224). Rok za primitak sažetke je bio 30. studeni 2023. god. Mnogi autori zatražili novi rok do 25.03.2024. Organizacijski odbor Simpozija je prihvatio novi termin. Objavljuje se sada dodatnih još 160 sažetaka.

In Metalurgija 63 (2024) 2,303-320 published „ Book of Abstracts “ (224). Deadline for received of Abstracts was November, 30,2023 y. Many authors have request new deadline by March, 25, 2024 y. Organizing committee have accept new deadline. Now it published supplements of 103 Abstracts.

1. X. L. Wu, C. Zheng, M. Xu, A. J. Zheng, L. L. Zhu, P. X. Li, J. H. Yao, M. Wang, J. H. Wang, W. H. Xu

Research on the cyclic load life of automobile bellows. In this study, a Finite Element Computational (F E C) model for automotive bellows exhaust pipes is established, and the impact of displacement loads on their fatigue life is investigated. The relationships between various structural parameters of the exhaust pipes and stress, strain, and cycle counts are elucidated. Furthermore, the bellows' structure is optimized through an orthogonal experiment. A microscopic morphological analysis is conducted on 309S stainless steel automotive bellows exhaust pipes after fatigue failure. The findings indicate that as displacement loads increase, the fatigue life of the bellows exhaust pipes decreases. The error between finite element analysis and experimental results is found to be less than 8,8 %. During the water swell forming stage, partial martensite is produced due to cold deformation. Under alternating loads, with noticeable cracks at the wave peaks, indicating the presence of internal fatigue characteristics.

2. Zh. Romazanov, T. Niyazov, A. Akmaganbetova, M. Turabayeva, T. Karipov

The feasibility study for the organization of power flexible cables production. The article examines the issues of creating a power flexible cable production in the country (Republic of Kazakhstan). The research objective of the study is to assess the technical and economic feasibility for organization of such production. Production program, investment estimation (cost sheet) and model of financial and economic payback for this project were calculated in course of the article's research. The research confirms the effectiveness of the creation for cable production in Kazakhstan, also this project can be recommended for implementation.

3. Z. Yang

Reaserch on real-time detection of large-granularity green pellets based on YOLOV3 algorithm. In order to realize the real-time detection of abnormal green pellet particle size. First, image data of large-granularity green balls at different disk pelletizing machine material disk speeds and different camera angles are collected on site; then LabelImg software is used to label the image data of large-granularity green balls; and finally based on the YOLOv3 algorithm under the Pytorch deep learning framework train and detect large-grained ball image data. The experimental results show that: under the condition of high rotation speed of the material disk of the disc pelletizing machine, the detection accuracy can reach more than 90.58% for the image data of a single large-grained green ball, and the comprehensive detection rate can reach more than 85%.

4. X. Y. Zhang, T. X. Zhang, Y. Q. Cai

Design and analysis of automatic opening and closing manipulator for ore crushing ball mill cover. The automatic design of cap opening and closing of steel slag ball mill is the key to solve a series of problems caused by frequent cap opening and closing. In this paper, the automatic capping manipulator is designed for a steel slag ball mill in a factory, especially for the automatic tightening and loosening of the cap bolt, the grasping and transporting device of the cap, to ensure the safety and reliability of the design.

5. I.A. Mazur, V.I. Volokh, I. Mamuzić

Formation of slag inclusions in billets during casting on a continuous billet casting machine. For a long time at MNLZ (sorted continuous billet casting machine), billets with a defect classified as slag entrapment have been produced from various grades of steel. Metallographic studies of the billet defects revealed that the defect is caused not only by slag entrapment but also by cold drops and porosity. Based on the literature information and the thermodynamic model of the Fe-Si-Mn-O system, the mechanism and diagram of foam formation and entrapment of slag inclusions in the crystallizer were determined. The results of the metallographic study propose a mechanism for the formation and entrapment of cold drops, along with recommendations for reducing slag inclusions.

6. L.M. Deineko, L.S. Kryvchyk, V.L. Pinchuk, I. Mamuzić

The use of amorphous alloys to strengthen pipe tools. One of the means of strengthening the pipe tool is the use of powders of amorphous alloys, which are applied to the working surfaces of the pipe tool - matrix rings for pressing pipes, rollers, support bars of cold rolling mills. The technology of gas-thermal spraying is as follows: the material that is applied to the surface of the tool is plasticized by heating, dispersed by a gas stream and transported to the surface of the part. When hitting the rough surface of the tool, particles of the molten material are introduced into the surface layer, forming a coating.

7. O. Zhadanos, I. Derevyanko, V. Matsyshyn, I. Mamuzić

Research of heat engineering processes of secondary metallurgy. A regression models allows predicting the dynamics of the temperature of the melt during its processing depending on the amount of energy spent and the time the melt is in the ladle before processing. An analysis of the adequacy of the obtained regression model with experimental data was carried out. It was established that the coefficient of determination of the obtained regression model is 0.84, and the absolute error of forecasting is 9 degrees. To create a more accurate forecast model, additional factors must be taken into account the degree of shielding of electric arcs with slag, and the presence of an open surface of the melt, ets.

8. X. Li, Q. Z. Liu, H. H. Yu

Mechanochemical efficient recovery of cobalt from spent lithium-ion batteries (LiBs) by chloride solutions. Herein, a mechanochemical approach was developed for recover the cobalt and from spent lithium-ion batteries using a high-concentration chloride solution. Effect of parameters on the

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leaching efficiency of cobalt was studied. 97, 6% of Co was recovered under optimum conditions: rotation speed 500 r/min, S/L ratio: 1:150 g/ml, ball/material ratio 25:1 g/g, milling time 30 min, respectively. The dissolved cobalt was recovered by selective precipitation method to ensure that the recycled Co can be reused for lithium-ion battery production. This research presents a highly efficient and environmentally friendly approach for recovering cobalt from spent LiBs.

9. L. W. Zhang, C. Lei, N. N. Liu, J. P. Wang, C. J. Xu

Influence of process parameters on grain structure of round billet in vertical continuous casting. The Zhong Yuan Special Steel (ZYSS) installed a vertical caster for the production of special steel. This vertical caster differs from the vertically curved caster, exhibiting unique inclusion behavior, stress distribution, and solidification process. Based on ZYSS's continuous casting process parameters and CAFE nucleation parameters, the chip-moving boundary method was adopted to conduct a numerical simulation of the round billet. The superheat and cooling intensity are key process parameters of continuous casting. A gradual coarsening of the macrostructure can be observed with an increase in the superheat of the liquid steel. When the superheat increases from 30°C to 50°C, the center equiaxed crystal region decreases from 63,56 % to 42,25 %. A lower cooling intensity is beneficial for improving equiaxed crystallization.

10. J. Q. Zhang, Y. Gao, Y. H. Wang

Finite element analysis (FEA) of connecting shafts in cold rolling mills. Plate and strip production is an important part of the steel industry. Cold rolled plate and strip production technology, due to its characteristics of automation, high yield, and high efficiency, has led to a sharp increase in processing demand day by day. The connecting shaft is the connecting device of the steel rolling mill, which is used to transfer the power of the electric motor or gear seat to the rolling mill. This article conducts finite element analysis on the stress state of the connecting shaft of a certain type of cold rolling mill under actual working conditions. The analysis results show that the structural design of the connecting shaft is reasonable and has a good stress distribution state. The research results have certain reference value for the development of the connecting shaft of the cold rolling mill.

11. H. Y. Wang, Y. Y. Shao, Z. W. Jia, Q. Guo

Effect of acid-soluble aluminum content on precipitates and magnetic properties of grain oriented silicon steel. The effect of acid-soluble aluminum content on precipitates and magnetic properties of grain oriented silicon steel was researched by optical microscopy and zeiss ultra 55 Scanning Electron Microscope (SEM) technique respectively. The results show that the number of precipitates increases with the increase of acid-soluble aluminum content, and the size of precipitates is relatively large after hot rolling. Under the low hot rolling temperature, the number of precipitates in the samples is large and the size is small, moreover, the grain size of the primary recrystallized grain is small. The matching of process parameters under different production process lines is the key to obtain good magnetic performance. The effect of nitriding on magnetic properties of the samples is related to the acid-soluble aluminum content of the samples. Too much acid-soluble aluminum can deteriorate the magnetic properties.

12. K.O. Velichko, L.V. Kamkina, I. Mamuzić

Selection and priming of technological solutions for refining manganese-based alloys from phosphorus. One of the ways to reduce phosphorus in high-phosphorus manganese concentrates is by stagnation of electrometallurgical dephosphorization from the removal of processed manganese low-phosphorus slag and the accompanying phosphorus-containing manganese alloy with 2-3% P. After melting the alloy in an induction furnace, the gas-oxygen refining unit contains low-phosphorus slag and metal with high instead of phosphorus. During the oxidative processing of this metal in a gas-oxygen refining unit, phosphate slag is created instead of phosphorus oxide 18-20% (phosphate-free) and commercial metal with manganese up to 2% (commercial billet for steel production).

13. A.M. Hryshyn, L.V. Kamkina, I. Mamuzić

Oxidative conversion of methane on freshly reduced iron. Methane conversion can take place in the working space of the recovery unit, where methane is fed in a mixture with oxidants (CO2, H2O and O2). For solid-phase recovery, it is necessary to optimize the process of methane conversion with a complex oxidizer according to two parameters: the organization of the conversion process, which ensures a high level of CH4 conversion and a high regenerative potential of the gas phase; determining the ratio of CO2:H2O:O2 in the initial mixture, which ensures the necessary temperature regime in the reducing unit.

14. P. Huo, X. Li, W. Li

Constitutive model of high temperature plastic deformation of P91 alloy steel. The hot compression test of as-cast P91 alloy steel was carried out by Gleeble3500 multi-functional thermal simulation test machine under the deformation conditions of temperature of 900 ~ 1 100 °Cand strain rate of 0, 1~5 s^{-1}. The high temperature flow behavior of as-cast P91 alloy steel was studied. The effects of strain rate and deformation temperature on the two-phase relationship of as-cast P91 alloy steel were analyzed. The strain rate compensation factor Z was introduced, and the Arrhenius constitutive model equation was established. The results show that the theoretical value of the peak stress calculated by the constitutive model is in good agreement with the experimental results, and the correlation is 96, 8 %, which verifies the feasibility of the model.

15. K. Janiszewski

Steel filtration using multi-hole ceramic filters with an innovative design. The research results presented in the article constitute the next stage of a planned series of experiments on the process of refining steel from a dispersive non-metallic phase by its filtration method. The paper presents the results of experiments carried out using an innovative design of multi-hole ceramic filters, the filter holes of which have an elliptical shape. Analyses of the macro and microstructure and purity of the steel before and after the filtration process reflect the course of the research and confirm that this can be an effective and cheap method of its refining from non-metallic inclusions. The results presented are the first of their kind in the world and confirm that the shape of the filter holes of multi-hole ceramic filters may have a significant impact on the efficiency of the steel filtration process. The non-metallic phase identified at the ceramic filter-steel interface corresponds to the reaction products of the deoxidation of aluminum steel.

16. S. L. Liao, X. C. Meng, P. F. Shuai

Based on the constitutive model of high temperature plastic deformation of TC17 titanium alloy for underwater robot metal material. The hot compression tests of underwater vehicle metal material TC17 titanium alloy at deformation temperature of 800 ~ 950 °C and strain rate of 0,01 ~ 10 s^{-1} were carried out by Thermecmaster-Z thermal simulator. The hot deformation behavior of TC17 ferroalloy was studied. The effects of strain rate and deformation temperature on the high temperature forming of TC17 titanium alloy were analyzed. The multiple linear regression constitutive model of TC17 titanium alloy was established. The results show that the flow stress of TC17 alloy decreases with the increase of deformation temperature and increases with the increase of strain rate. The theoretical value of peak stress obtained by the multiple linear regression constitutive model of TC17 alloy is in good agreement with the experimental results, and the correlation is 97,25%. The model has high prediction accuracy.

17. X. F. Tang, Y. B. Long

Integration of gradient least mean squares in bidirectional long short-term (LSTM) memory networks for metallurgical bearing ball fault diagnosis. This paper introduces a novel diagnostic approach for bearing ball failures: a synergistic implementation of a bidirectional Long Short-Term Memory (LSTM) network, empowered by Gradient Minimum Mean Square. This method leverages deep analysis of operational data from bearings, enabling the precise identification of incipient bearing ball failures at early stages, thus markedly improving prediction accuracy. Our empirical results underscore the superior performance of this composite methodology in accurately detecting a spectrum of five mechanical bearing ball failure types, achieving a substantial enhancement in diagnostic precision.

18. K.Yu. Ostrovska, I. Mamuzić

Application of machine learning methods to optimize production processes in the metallurgical industry. In light of modern technologies and the development of artificial intelligence, machine learning methods have become widely used in various industries, including metallurgy. Machine learning methods allow you to automate production processes, improve product quality and reduce production costs. As a result of the application of machine learning

methods in metallurgy, it is possible to improve the quality of metal, reduce production time and reduce production costs. The application of machine learning methods to optimize production processes in the metallurgical industry has enormous potential for improving quality and increasing production efficiency.

19. H. Shportko, D. Dedyk, I. Mamuzić

Artificial Intelligence in Quality Support. Artificial Intelligence (AI) plays a crucial role in enhancing quality management systems. Its application opens up new possibilities for ensuring and optimizing the quality of products or services. AI systems can predict potential deviations in quality during the production or service delivery stages. This allows for prompt actions to prevent defects or non-compliance with quality standards, crucial for maintaining high levels of customer satisfaction. AI can automatically respond to changes in manufacturing or service processes, taking measures to immediately address anomalies in quality. This contributes to swift responses to deviations from standards and helps avoid negative impacts on the company's reputation.

20. I. S. Dmytriieva, I. Mamuzić

Optimizing the trajectory of automated machining of body parts in the Autodesk PowerMill environment. Machining of body parts on CNC machines has become widespread in various industries, so the task of optimizing machining parameters is relevant. This paper compares the effect of Autodesk PowerMill machining parameters, cutting modes, and cutting tool geometry on the efficiency of the drilling and milling process. As a result of the optimized machining path, the volume of GM code for a CNC machine has been significantly reduced, which affects the life of the machine and the stability of the cutting tool in general.

21. F. Yang, Q. F. Qin, Y. Li, Y. Y. Huang, S. P. Wang

Effect of MgO content in sintered ore on viscosity of blast furnace slag bearing high Al_2O_3. The effect of MgO content on the viscosity of blast furnace slag bearing high Al_2O_3 was studied under laboratory conditions. The viscosity of slag was determined by rotation method. The research results indicate that when the Al_2O_3 content in blast furnace slag is 17 % -18 %, the MgO content in blast furnace slag should be controlled at 10 %. When the Al_2O_3 content is 19 %, the MgO content should be controlled at 11 %, and the binary basicity of the slag should be controlled at around 1,10. This type of blast furnace slag has a lower melting point and better fluidity. The purpose of reducing the MgO content in the slag can be achieved by reducing the MgO content in sintered ore, that is, the MgO content in sintered ore should be controlled at 2,0 %-2,5 %.

22. F. D. Wang, Y. Zhao, L. Xue, G. L. Tan, X. K. Li

Kinetics analysis of quenching phase transformation of 1Cr13 steel by thermal analysis. Differential scanning calorimetry (DSC) was used to study the transformation process of 1Cr13 steel under quenching condition. The DSC curves were measured from 1 050 °C to room temperature at the cooling rate of 10, 20, 30, 50 °C /min, respectively. The Flynn-Wall-Ozawa method was used to obtain the activation energy of the transformation process of 1Cr13 steel under quenching condition. The kinetic mechanism functions of the transformation process of 1Cr13 steel under quenching condition were also investigated by Criado-Ortega methods. The results show that the activation energy is related to the phase transition fraction. It means the transformation process of 1Cr13 steel under quenching condition is not a simple one-step reaction but a complex multi-step reaction.

23. H. W. Wu, Y. Q. Cai, Z. H. Geng

Numerical simulation of intersecting line workpiece welded by arc robot welding. Taking the pipe-pipe intersecting structure workpiece as the target, the Finite Element simulation (FEM) of the workpiece is carried out by using the finite element analysis software ABAQUS and the DFLUX subroutine. The temperature field and stress field during and after welding were studied to verify the welding process parameters and welding quality reliability of the welding workstation. The results show that the equivalent residual stress distribution of the weldment is consistent with the actual situation. Robot welding of complex welds is not only efficient, but also the welding quality is stable and reliable. This study provides a reference for the research of robot welding other complex workpieces.

24. Y. Q. Cai, Z. H. Geng, H. W. Wu

Simulation of double robot cooperative sheet metal bending production line. Aiming at the problem that large sheet metal bending parts cannot be processed by single robot, and the manual assisted bending method has high labor intensity and low work efficiency; double robots work together to complete the handling of the plate; Firstly, according to the actual production requirements of sheet metal bending, the process planning and three-dimensional modeling of the production line are completed. Secondly, the kinematics analysis and base coordinate system calibration of the dual robot are completed. Then, by establishing the mathematical model of each unit, the end pose matrix in the local coordinate system of the robot is finally obtained, and the joint angles of the robot machine are obtained by inverse kinematics. Finally, the production line simulation is completed by Rapid offline programming. The research results show that the kinematics model is correct, and the production line can complete the sheet metal bending work without collision, which can provide reference for the research of large sheet metal bending.

25. B. W. Ning, Y. P. Zhao, X. H. Luo, L. C. Sun

Effect of annealing temperature on microstructure and mechanical properties of 5052 aluminum alloy pipe fittings alpine skiing sticks. The continuous annealing treatment of 5052 aluminum alloy pipe fittings for alpine skiing sticks was carried out in the temperature range of 300-500 °C by means of metallographic observation and mechanical property test. The results show that with the increase of annealing temperature, the strength and hardness of the samples decrease continuously, and the impact value, section shrinkage and elongation change significantly. The experimental results provide a technical reference for preventing the fracture of alpine skiing sticks during use.

26. A.V. Kramarenko, I.V. Semenkov, I. Mamuzić

Problems of modernizing the quality management system at industrial enterprises. Currently, there are several methodologies of quality management system. The most common are Lean Manufacturing and the 6 Sigma. The practice of implementing these concepts has shown that they easily adapt to various types of production, and through these changes, optimization of all production processes can be achieved. At the same time, there are substantial limitations. The most significant ones include insufficient resources for the modernization of the quality management system, as well as the necessity for organizational reform within the enterprise. Additionally, the improvement of product quality necessitates the development of a system of performance indicators and information support.

27. A.V. Kramarenko, I. Mamuzić

Quality Management Approaches in Metallurgical Production. The complex of modern problems associated with the production and realization of high-quality metal products requires new approaches. This necessitates the implementation of new management methods in production, including project management methods. The concept of quality management in project management is elucidated in the International Standard ISO 10006 and is based on the 8 principles of Total Quality Management (TQM). The active integration of Quality Management Systems (QMS) in accordance with global standards always demands substantial financial investments from enterprises. However, as practice demonstrates, these investments are always justified through the implementation of high-quality products in domestic and international markets.

28. A.V. Savych, I. Mamuzić

The role of the information field of society in the formation of the historical self-awareness of personality in the modern period. The most important indicator of the information society is that each of its members has equal rights and opportunities to freely produce and timely receive any information that interests him. The foundation of this process is the information culture of society. The anthropological dimension of culture comes to the fore. Culture should ensure the integrity of a person, their health and happiness in conditions when many factors of scientific, technical and social development destroy this integrity, negatively affect the health of a person, and prevent the achievement of their happiness.

29. Y. J. Zhang, J. Y. Pan, S. S. Wang, L. B. Wu, D. X. Gao

Fixed-time fuzzy adaptive output feedback control based on steel structure robotic arm. This paper proposes a fixed-time fuzzy adaptive output feedback control scheme for the robotic arm model (RAM) of steel structures. Firstly, the process of transforming RAM into a nonlinear system is elaborated. Secondly, a fuzzy observer is designed to approximate the nonlinear function and estimate the observed state of the system. Subsequently, a

fixed-time adaptive controller is constructed, ensuring the system's stability within a fixed time, with the convergence time unaffected by the initial state. Finally, the effectiveness of the strategy is verified through simulation examples.

30. X. F. Tang

Integrating empirical mode decomposition and convolutional neural network for efficient fault diagnosis in metallurgical machinery. The paper introduces an innovative framework for rotating machinery fault recognition by combining Empirical Mode Decomposition (EMD) and Convolutional Neural Network (CNN). This novel approach integrates feature extraction and selection, utilizing deep learning for precise classification of transmission components faults. Our method achieves an impressive accuracy of 98,97 %. This robust technology significantly enhances the detection and diagnosis of transmission faults in metallurgical plant, providing an efficient solution for intelligent manufacturing applications.

31. Sv. S. Kvon, A. Z. Issagulov, M. K. Ibatov, V. Yu. Kulikov, S. K. Arinova

Investigation of the properties of the CoCrFeMnNi alloy developed on the basis of the entropy approach. The paper presents the results of studying some properties and structure of a quasi high-entropy alloy (QHEA) of the CoCrFeMnNi system melted with the use of ferroalloys. The paper presents the results of a study of some properties and structure of a quasi-high-entropy alloy of the CoCrFeMnNi system, smelted using low-carbon ferromanganese and ferrochrome. Chemical composition, strength and microhardness have been studied. The structure contains a small number of inclusions of silicate nature. The experimental alloy demonstrated properties close to the level of properties of a similar alloy melted with the use of pure metals by 5-fold remelting. The results obtained showed the possibility of partial replacement of pure metals with ferroalloys when smelting of QHEAs, which will positively affect their cost.

32. Z. G. Li, T. Chen, X. Y. Qian, L. L. Jiang, D. Y. Wang

Effect of fly ASH (FA) on properties of magnesium sulphoaluminate cement (MSC) based fire retardant coatings for steel substrate. Magnesium sulphoaluminate (MSA) cement is a new type of inorganic coating for steel substrate with excellent fire retardant performance. In order to make full use of the advantages of MSA cement based coatings, the effect of fly ash on setting time, strength of MSA cement paste coating was studied. The phase compositions of MSA cement hydration products were analyzed by X - ray diffraction (XRD) and scanning electron microscopy (SEM). The results showed that the addition of fly ash prolongs setting time and increases the strength of MSA cement at 1 day (d) significantly. After adding fly ash, no new hydration products were generated, but it can significantly improve morphology of MSA cement with the compact structure of hydration products.

33. P. Huang, J. C. Dong, X. C. Han, Y. P. Qi, Y. M. Xiao, H. Y Leng

Prediction of mechanical properties of composite materials based on convolutional neural network- -long and short-term memory neural network. Convolutional neural networks (CNNs) have the advantage of processing complex images and extracting feature information from the images, while long and short term memory networks (LSTMs) are good at processing data with sequential features. In this paper, based on the deep material network, we propose to apply the CNN-LSTM neural network model to the prediction of mechanical properties of carbon fibre composites. Then the experimental results are compared with the model prediction results, and the results show that the CNN-LSTM prediction of the mechanical properties of carbon fibre composites is within 5% of the corresponding tensile mechanical experimental results, which proves the accuracy of the CNN-LSTM neural network model in the prediction of the mechanical properties of carbon fibre composites.

34. I. Mamuzić, M. O. Sobolenko, G.G. Shvachych, P.O. Shcherbyna

Analysis of promising directions for intensification of steel annealing. The expediency of using promising directions of intensification of electric contact or induction heating of metal is shown. The peculiarity of this approach is that the electrothermal treatment of steel allows technological processes to be implemented in automated flow lines. At the same time, the implementation of the spheroidal annealing mode of steel in the flow line is characterized by a reduction in the total duration of annealing, an increase in the heating rate, and an increase in the cooling rate at the corresponding stages of the product heat treatment mode. However, high-speed metal heat treatment processes will continue to require research, first of all, to control the main technological parameters in order to optimize them.

35. I. Mamuzić, M. O. Sobolenko, G.G. Shvachych, P.O. Shcherbyna

Research on the technique of intensification of spheroidizing annealing of low-carbon steels. Research and experimental data make it possible to note the directions of intensification of spheroidizing annealing of low-carbon steels. The stages of the methodology should include the following. First, preparation of the initial structural state of the steel billet, with requirements for the structure of the processed material based on the distribution of cementite globules in the ferrite matrix. Secondly, the application of temperature regimes in the process of its spheroidization, which are implemented by non-isothermal exposure, which compensates for the decrease in the thermodynamic factor by the increase in the kinetic factor during heating. Thirdly, to provide for the use of metal heating with an internal coolant at all stages of the spheroidization regime.

36. I. Mamuzić, M. O. Sobolenko, G.G. Shvachych, P.O. Shcherbyna

Development of the process of complex intensification of spheroidizing steel annealing. Complex intensification provides the possibility of technological implementation of intensive modes of steel annealing in current lines. The research is aimed at revealing the nature of the intensification of spheroidizing steel annealing due to the use of non-isothermal exposure and the use of an internal heat carrier for heating the metal, which allows to significantly reduce the duration of the spheroidization process with simultaneous improvement of technological properties. The metal acquires high dispersion and homogeneity of the structure on the entire plane of its section. The use of mathematical models, which are processed on a multiprocessor computer system, allows controlling the temperature field of the metal during its heating, aging and cooling.

37. I. Mamuzić, G.G. Shvachych, P.O. Shcherbyna

Improving the structure of the network interface of multiprocessor systems. Research reveals the problem of improving the network interface of a multiprocessor system and increasing its performance. The analysis of the main operating modes of the network interface revealed an influence on the parallelization efficiency estimates. Ways to increase the efficiency of a multiprocessor system by reorganizing the architecture of its network interface are shown. The proposed approach showed that by changing the architecture of the network interface of the multiprocessor system, the bandwidth of the switching bus is significantly expanded. The theoretical statements are consistent with the results of modeling the main performance characteristics of a multiprocessor system. The proposed approach made it possible to significantly increase the efficiency estimates of the multiprocessor system.

38. C. D. Wu, D. L. Guo, M. W. He, C. J. Wang, X. D. Meng, L. J. Zhang, K. Wang, H. C. Ji

Deformation analysis before and after hoisting and reinforcement of large flue. In the process of carrying out the installation of large flue, because the thickness of the flue is thin, it is easy to deform when hoisting with wire rope, and too much deformation will affect the subsequent use of the flue, resulting in waste, so in order to reduce the deformation of the flue, the existing conditions are utilized, and the bracket is added inside the flue to play the role of support, and the deformation of the flue is reduced. Using 3D modeling and numerical simulation software, the flue structure before and after adding supports was modeled and numerically analyzed, and the two simulation results were compared, and the deformation of the flue after adding supports was analyzed to be relatively obvious under the action of hoisting.

39. A. A. Akberdin, A. S. Kim, A. S. Orlov, R. B. Sultangaziyev.

Mathematical model of the phase composition diagram of the Fe – S - Cu system. The article presents the results of constructing a diagram of the phase composition of the Fe-S-Cu system and its mathematical model. Using the equations obtained in the work, a computer program was created and, using it, an analysis of phase formation in copper ores of various deposits was carried out. It was found that copper ore concentrates from the Berezovsk deposit in Kazakhstan contain Cu_5FeS_4 (20,22 %), CuS (14,21 %) and FeS_2 (65,57 %), and copper ores from the Zyryanovsk deposit contain $CuFeS_2$ (4,03 %), Cu_5FeS_4 (45,29 %) and FeS_2 (50,68 %). Such data allows you to choose the optimal methods for further processing of concentrates, and the mathematical approach itself is more productive than the often used geometric one according to the rule of segments.

40. C. F. Zhang, K. X. Cui, L. S. Yi, J. J. Wang

Effect of tempering temperature on microstructure and properties of 45 steel piano string. The effect of tempering temperature on microstructure and properties of 45 steel was studied. The string of 45 steel was tempered in the temperature range of 820°C-880 °C by means of metallographic observation and microstructure performance test. The results show that with the increase of tempering temperature, the hardness and yield strength of the sample increase first and then decrease, the tensile strength increases, the impact toughness jumps, and the elongation and reduction of area show an upward trend. The experimental results provide theoretical guidance for 45 steel in the process of making piano strings.

41. J. J. Bai, Y. Zhao, D. C. Liu, Y. N. Yan, X. B. Chen, Y. X. Sun

Research on data transmission and energy consumption optimization in steel plant terminal networks based on improved sep protocol. In steel plants with harsh conditions, numerous devices equipped with wireless sensors generate vast data and high energy consumption. Our study introduces the optimized PK-SEP algorithm, enhancing the Stable Election Protocol (SEP) and traditional K-means clustering with the elbow method and particle swarm optimization. This approach, tailored for large-scale WSNs in steel plants, effectively extends network lifespan, conserves energy, and improves data throughput, offering a viable solution for energy issues in WSNs and potentially boosting steel production efficiency and sustainability.

42. H. Ren, Y. J. Zhang, J. T. Chen, X. N. Wei, H. K. Chen, P. Liu

A method for detecting surface defects in hot-rolled strip steel based on deep learning. Hot-rolled strip steel is a material widely used in production activities and daily life. However, the appearance of surface defects during its production process is inevitable. To address this issue, we introduce a new detection method using Gold-Yolo to detect surface defects on hot-rolled strip steel. Our method effectively balances accuracy and real-time performance while detecting four common types of surface defects, achieving an average accuracy rate of 82,2 % for detecting individual types of surface defects. Experimental data prove that our method excels in classifying and locating surface defects on hot-rolled steel strip, demonstrating broad application prospects and promotional value.

43. I. Mamuzić, G.G. Shvachych, J.S. Proydak, G.G. Shlomchak, B.I. Moroz

Rational technology of heat treatment of severely deformed steel grades. Technologies that will allow fundamental change existing low-productivity energy-intensive processes can be attributed to to the production conditions of metal products and methods of rapid metal heating (wire, rods, etc.). Therefore, an alternative heat treatment method by furnace heating is electrothermal treatment, whose distinctive feature is high heating speed, which is provided due to the electromagnetic induction phenomena (induction heating) or electrical resistance (electrical contact heating). In electric contact heating installations, the processing is run continuously and sequentially (bunt rolled steel), allowing the mechanization and automation processes to switch to new heat treatment modes quickly. For the conditions of producing metal products (especially wire), this circumstance is decisive in the creation and new technological processes. For instance, the induction or electric contact heating, as shown by experimental studies, allows for cold or warm deformation of carbon or alloy steels in the technological flow of wire production.

44. I. Mamuzić, G.G. Shvachych, P.O. Shcherbyna, D.M. Moroz, T.P. Karpova

Mathematical simulation of multicycle technological processes of metalworking. The mathematical model must describe the modes that allow heating, holding, and cooling in the multicycle technological process of metalworking from billet to wire of the required size. Each of these processes has its functional source content. Since in multicycle mode, each process is assigned except own sources and moments of time and temperature amplitudes, such information allows problem formulation as inverted. Next, by the controlled structure of the thermal model, we will understand the differential model transformed in the space-time domain into a discrete one. The specific features of the thermal model will be such that for all modes, the inverse problem is the main means of obtaining the necessary information to solve thermal modeling problems by the flow line scheme.

45. I. Mamuzić, G.G. Shvachych, T.P. Karpova, P.O. Shcherbyna

Mathematical simulation of optimal modes of metal heat treatment. Research develops optimal modes of metal heat treatment by applying mathematical modeling methods. Simultaneously, low-temperature chamber furnaces with pulse heating are used. Mathematical support of thermal regulation systems is based on developing a combined model that includes the joint solution of problems of the non-stationary temperature field of the material (internal heat exchange) and external heat exchange problems. The internal heat exchange is described by the differential Fourier equation and the conditions of uniqueness (initial and boundary conditions and symmetry conditions). The pulsed coolant supply in low-temperature furnaces eliminates the main drawback of these furnaces - the uneven distribution of temperature across the cross-section of the billet, which improves the quality of heating the cage and reduces scale formation. The developed model's practical value of the heat exchange process in the furnace lies in its direct use for studies of heat treatment modes.

46. M. Walkowicz, M. Milczanowska

The effect of heat treatment on the structure and hardness of CuAl10Ni5Fe4 nickel aluminium bronze. The paper concerns the influence of heat treatment (annealing, quenching and aging) on the microstructure and hardness of flat bars samples from the CuAl10Ni5Fe4 alloy. The microstructures were observed in light and scanning electron microscopes. The appearance and area fractions of the martensite beta phase and their influence on the mechanical properties were examined. The annealing study at a temperature of 950 °C for 1 hour, followed by rapid quenching in water and subsequent tempering at a temperature of 350-500 °C for 15-120 minutes, demonstrated the potential for a significant increase in the hardness of aluminum bronze from approximately 200 HV3 up to 600 HV3. This suggests new possibilities for the material's applications.

47. J. Boryca, C. Kolmasiak, R. Wyczółkowski, V. Bagdasaryan, S. Aghbalyan

Calculation model of heating curves of a steel charge heated in a walking beam furnace before plastic working. The paper presents a universal computational model of heating curves for walking beam furnaces, which allows to determine the temperature distribution along the length of the furnace during heating of the steel charge. The model was made based on analytical dependencies regarding transient heat conduction, taking into account the temperature variability of all thermo-physical properties. The methodology of calculations and examples of heating curves for selected cases are presented.

48. G. Pačarek, T. Šolić, V. Štigler, M. Samardžić

Testing of mechanical properties of the VpCI-126 polyethylene inhibitor film. This paper describes results of experiment carried out on the VpCI-126 polyethylene inhibitor film with the aim to examine its mechanical properties. Test samples of the film were measured to determine the thickness, and then subjected to tear, fracture and puncture in order to examine mechanical properties that justify the wide application of this film in surface protection of materials. Volatile corrosion inhibitors, like the tested polyethylene inhibitor films, form a stable and reliable hydrophobic layer on the surface of the material, which prevents development of electrochemical corrosion mechanism. Results obtained in this experiment confirm very good mechanical properties of the tested film, thus justifying wide application of inhibitor films.

49. D. Yessengaliyev, B. Kelamanov, O. Sariev, Y. Kuanalin

Research of thermal analysis of nickel ore and mixture with carbon-containing reducing agents by non-isothermal method. The article presents the results of physicochemical studies of nickel ore and charges based on it for smelting nickel-containing ferroalloys. Using a derivatogram, the main phase transformations of nickel ore and mixtures with various carbon-containing reducing agents, such as coal and coke, are established. The activation energy of the processes occurring during the heat treatment of nickel ore and a mixture of nickel ore with various reducing agents by non-isothermal kinetics were determined.

50. I. Mamuzić, G.G. Shvachych, M.O. Aleksieiev, L.V. Kabak, V.V. Busygin

Parallel computations peculiarities for solving applied problems. Parallel computing allows for the distribution of computing tasks across multiple processors, resulting in faster and more efficient processing of complex problems that require more processing power than current computing equipment can provide. Such problems include numerical modeling of hydrodynamics and metallurgical thermophysics processes, pattern recognition, optimiza-

tion problems with many parameters, climate modeling, solving a wide range of multidimensional non-stationary problems, etc. As a rule, multiprocessing carries out the multiplication of the computations parallelism with the simultaneous performance of several data processing operations. In this case, it is possible to speed up the process of solving a computational problem and increase the computations' efficiency when dividing the applied algorithm into informationally independent parts and organizing each part of the computations on different processors. Studies have shown that multiprocessor systems are especially relevant for simulation of the latest technological processes.

51. I. Mamuzić, G.G. Shvachych, I.G. Hulina, A.A. Martynenko

Problems of using parallel computing for applied problems. Studies have shown that parallelism in solving applied problems has gained little popularity, as many researchers predicted. One of the possible reasons for this situation until recently was the high cost of high-performance systems. The modern trend of building parallel computing complexes from typical structural elements (microprocessors, memory chips, communication devices), the mass production of which has been mastered by industry, has reduced the influence of this factor, and now almost every consumer can have at own disposal a multiprocessor system of fairly high performance. Another, and probably the main reason for restraining the mass spread of parallelism, is that parallel computing requires a «parallel» generalization of the traditional sequential technology of solving problems on computing devices. Thus, numerical methods for multiprocessor systems should be designed as parallel and interactive processes that can be implemented on independent processors.

52. I. Mamuzić, G.G. Shvachych, O.M. Aleksieiev, A.L. Shyrin

Analysis of directions for improving the computer systems' productivity. Currently, the construction of the mentioned systems takes place by combining individual processors for parallel computation related to one large and complex task. So, to build supercomputers, one takes serial microprocessors with their local memory and connects them with a communication environment. The described architecture has many advantages, in particular: if necessary, it allows adding processors, thereby increasing the performance of the entire system, and it is enough to select a certain configuration of the computing complex given, saving financial resources or the existence of known computing power. In general, the very name of this type of system reflects its theoretically unlimited scalability. One of the most promising methods of constructing such systems is using "blade" technologies. At the same time, a network technology must be applicable, whose choice depends primarily on the class of tasks performed by users.

53. Y. F. Wang, J. W. Wang

Study on hot deformation behavior and constitutive model of TB6 titanium alloy. Thermecmaster-Z thermal simulator was used to carry out hot compression experiments on the metal material TB6 titanium alloy of exoskeleton robot at deformation temperature of 1 013 ~ 1 073 K and strain rate of 0,001 ~ 1 s^{-1}, and the influence of deformation conditions on the flow stress of TB6 titanium alloy was studied. The multivariate linear regression constitutive model of TB6 titanium alloy was established by Arrhenius hyperbolic sine equation. The results show that the flow stress is significantly affected by the strain rate, and the influence of deformation temperature on the flow stress is related to the strain rate. The theoretical value of the peak stress obtained by the multiple linear regression constitutive model of TB6 titanium alloy is well fitted with the actual value, and the correlation reaches 98,11 %, which proves that the model has high prediction accuracy.

54. L. Zhan, Q. Liu Issn

Research on thermal deformation constitutive model of 304 stainless steel based on travel insulation cup metal material. In order to improve the quality of people 's travel and improve the performance of travel insulation cup, the thermal deformation behavior of 304 stainless steel, the edible grade material of travel insulation cup, was studied by Gleeble-3800 thermal / mechanical simulation machine. The true stress-strain curve of 304 stainless steel was obtained by hot compression test with deformation temperature of 800~1 100 °C and strain rate range of 0,001 ~ 1 s^{-1}. According to the real stress-strain curve, the Arrhenius constitutive model of 304 stainless steel was constructed. The results show that the flow stress of 304 stainless steel increases with the increase of deformation temperature and strain rate. The theoretical stress value predicted by the constitutive model is fitted with the experimental results, and the correlation is 0.995, indicating that the model has high prediction accuracy.

55. G. Shvachych, I. Mamuzich, A. Selegej, B. Moroz, T. Kadylnykova, I. Pobochii, D. Moroz, Y. Friman

Load control operational correction of a blast furnace based on the correlation models. The paper uses regression analysis to research the movement dynamics of charge materials along the paths of a blast furnace coneless loader device. The research's main goal is to consider two main factors when optimizing the loading process of the blast furnace - the opening degree of the charge shutter of the loading device hopper and the inclination angle of the distribution tray. That approach allows the optimization of the loading impact, taking into account the current change in the granulometric parameters of the blast furnace charge. A model for determining the dynamic parameters of the charge flow in the case of its movement along the paths of the blast furnace coneless loading device has been developed.

56. A. E. Erzhan, Sv. S. Kvon, D. A. Issagulova, V. Yu. Kulikov, T. V. Kovaleva

The possibility of using iron ore concentrate as a binder when briquetting waste of ferroalloy production. The paper presents the results of studying the use of iron ore concentrate as a component of the charge for briquetting finely dispersed dust generated during the production of ferrosilicon. Experiments were carried out on introducing iron ore concentrate into the mixture in the amount of 3 to 10 %. Liquid glass and water were used as a binder. It was shown that the use of 5-7 % by weight of iron ore concentrate with the iron and silicon content of about 65 % and 26 %, respectively, led to increasing strength and density of the briquette by an average of 20 % compared to the same characteristics of briquettes obtained without adding iron ore concentrate. It should be expected that improving such briquette characteristics as strength and density will provide higher safety of the product during transportation and loading and better conditions during deoxidation and alloying, which ultimately ensures an improved steel quality.

57. I. Mamuzić, G.G. Shvachych, A.I. Kupin, A.M. Selegej, V.O. Petrenko

Forecasting and managing the blast furnace's current performance based on the blast furnace gas chemical composition data. A method of predicting blast furnace productivity has been developed to analyze the carbon oxide content in the gases leaving the furnace's cross-section. The study of the influence of the change in gas dynamics parameters of the blast furnace on the technical and economic indicators of smelting allowed the creation of the basis for forecasting an increase in furnace productivity and a decrease in coke consumption when rationalizing the distribution of ore load in the furnace. Correlations between the change in the ore load on the blast furnace throat and its operation's technical and economic indicators have been revealed. That allowed to evaluate the effect of introducing measures related to improving the gas-dynamic state of the "dry" zone of the blast furnace, provided by rationalizing the parameters of the lining materials loading mode.

58. I. Mamuzić, G.G. Shvachych, A.I. Kupin, A.M. Selegej, V.O. Petrenko

Management of blast furnace smelting based on gas load analysis along the throat radius. Scientific regulations have been developed that allow for the rational distribution of charge materials in the upper part of the blast furnace for maximum use of the regeneration potential of blast furnace gases. That increased the overall degree of use of carbon monoxide in the main working zones of the radius of the upper part of the furnace during the primary reduction of iron oxides. The theoretical studies conducted on the change in the velocity of the gas flow across the section in the upper part of the blast furnace allowed to determine the gas load for any radially annular zone of the throat. Based on experimental data, approaches have been developed to determine the change in the granulometric characteristics of the charge materials along the radius of the blast furnace throat. That allowed to reveal patterns of changes in the porosity of materials.

59. I. Mamuzić, G.G. Shvachych, A.I. Kupin, A.M. Selegej, V.O. Petrenko

Mathematical simulation of the forecasting process of the charge materials distribution. In order to solve the problem of forecasting the distribution of charge materials on the blast furnace throat, the dependencies of the descent speed of the charge from the tray distributor of the coneless loading device are considered. Simultaneously, the conducted studies showed that the charge rise rate depends on several parameters, such as the metric parameters of the loading path elements, the size of the tray inclination angle, and the granulometric characteristics of the charge materials loaded on the furnace. Considering the mentioned factors, mathematical models of the dependence of charge descent rate from the tray were derived. It is shown that

the main parameter of the charge materials distribution is the descent rate of the charge flow from the distribution tray. That parameter allows for determining the flow trajectories of the charge materials in the blast furnace throat space. The study stage of the adequacy of the obtained mathematical models was carried out.

60. I. Mamuzić, G.G. Shvachych, A.I. Kupin, A.M. Selegej, V.O. Petrenko

Movement dynamics study of charge materials along the paths of a blast furnace device coneless loader. The research is devoted to the problem of the movement dynamics of charge materials along the paths of a coneless loader of the blast furnace device. Meanwhile, to optimize the loading process of the blast furnace, two main factors were considered - the degree of opening of the loading device hopper's charging shutter and the distribution tray's inclination angle. The experiments allowed for the collection of significant data on various conditions and options for loading the charge based on the specified approach. That allowed to develop a model for determining the dynamic parameters of the charge flow when moving along the paths of the coneless loading device of the blast furnace. The developed mathematical algorithms and statistical studies established the dependencies between different factors of charge loading. Corresponding graphic dependencies illustrated the studies.

61. W. Z. Teng, Y. J. Zhang, H. G. Zhang, D. X. Gao

Surface defect detection of steel based on improved YOLOv7 model. In response to the inevitable surface defects in the manufacturing process of hot-rolled steel, this paper proposes an improved steel surface defect detection model based on YOLOv7. In the Extended Efficient Large Aggregation Network (E-ELAN), the model replaces conventional convolution with Omni-Dimensional Dynamic Convolution (ODConv) to enhance the network's sensitivity to feature extraction using a combination of various attention mechanisms. Additionally, the detection head in the head section is replaced with an Efficient Decoupled Detection Head, enhancing the model's capability to classify and locate small defects. The proposed model is tested on the public dataset NEU-DET, achieving a high mAP of 76,5 %. This effectively enhances the model's ability to detect surface defects in steel while maintaining a fast detection speed.

62. D. O. Bannikov, L. I. Klochko, I. Mamuzić

Steels for nails for wooden structures. At present, wooden structures are becoming more and more popular and more widespread, from which sports halls, swimming pools, residential buildings and even fire stations are created. To ensure the necessary level of strength and reliability, nails are made of special steel, which has practically no yield area, but instead has high strength. The yield point and the strength limit of such steels practically coincide. Quantitatively, these values are equal to 710 and 760 MPa for nails with a diameter of 4 mm, respectively, and 570 MPa and 620 MPa for nails with a diameter of 5.5 mm. The elongation is, on average, 7.8 mm and 9.5 mm for diameters of 4 mm and 5.5 mm, respectively.

63. D. O. Bannikov, L. I. Klochko, I. Mamuzić

Steels for self-tapping screws for wooden structures. Self-tapping screws one of the most progressive types of connecting elements for nodal connections of wooden structures. They are used mainly for responsible elements, therefore they are made of high-quality steels. The laboratory tests made it possible to evaluate the strength characteristics of steels for self-tapping screws presented on the market of Ukraine. The diagram of work under tensile load turned out to be practically linear without a yield area. The strength limit is, on average, 800 MPa and 1030 MPa for self-tapping screws with a thread diameter of 4.2 mm and 6.0 mm, respectively, and the elongation is, on average, 7.7 mm and 10.8 mm for thread diameters of 4.2 mm and 6.0 mm.

64. A.M Kovzik, A.M. Holovachov, T.A. Aiupova, O.A. Nosko, Yu.O. Kushnir

Ni powder particles structure during electrolytic deposition. The electrolysis parameters influence on the synthesized Ni powder structure formation is studied. Circulation speed decrease provides a decrease in the Ni particles size, at the same time, at high cathodic current density, the Ni particles dispersion increases; despite the different nature of these factors influence on the response function, a synergistic effect is observed. Synergistic simultaneous temperature and electrolyte circulation speed effect on the particles size and morphology is observed. With their simultaneous increase, there is a more noticeable Ni particles thickening than with single factor increase. The synthesized mathematical model allows taking into account the electrolysis parameters synergistic effect on the electrolytic deposit characteristics and, adjusting these parameters, synthesizing Ni electrolytic powders with specified properties.

65. O.A. Nosko, T.A. Aiupova, V.Yu. Karpov, I.V. Holub, O.V. Bila

Heat treated titanium-based alloys corrosion resistance. Heat treatment improves corrosion resistance due to the stable structure formation. When testing for general corrosion in a marine atmosphere of the heat treated BT23 alloy corrosion resistance for 1 year and 20 cycles corresponds to 1-2 points, according to forecasts for 10 years and 100 cycles - it will reach 2-4 points, which corresponds to sustainable materials. Durability of heat-treated BT23 samples when tested for corrosion fatigue at 330 MPa high strain amplitudes is $140*10^3$ cycles; at 150 MPa - $20*10^6$ cycles. During the test of corrosion resistance under a static load of 0.9; 0.75 and 0.5 β_B during 60 days, corrosion cracking does not occur in heat-treated BT23 alloy.

66. O. Zhadanos, I. Derevyanko, E. Shepetyak, I. Mamuzić

Prediction of a thermal condition of a melt during VD process. During the vacuum steel degassing process in a VD installation, the temperature is one limiting factor. The monitoring of the metal temperature is complicated. Therefore, temperature prediction in the ladle during the VD process is important and useful for the billet quality. During research, the impact of argon blowing and input of the additives (alloys and other materials) on the temperature dynamics was considered. As a result of statistical data processing of industrial experiments is obtained the regression equation of the relation between decreasing melt temperature and time of vacuum degassing.

67. T. Selivorstova, V. Selivorstov, I. Mamuzić

Peculiarities of calculating the mode of gas-dynamic influence on the melt in the casting mold. The change in pressure in the «casting-gas injection device» system is determined by the dynamics of changes in the strength properties of the hardened metal layer. For the maximum possible level of gas pressure (MPa) the value of the deformation resistance of the casting material, is used as a parameter necessary for calculating the dynamics of pressure build-up in the specified system (σ) in the operating temperature range. The calculation of the dynamics of pressure changes should be based on the strength indicators of the thinnest wall of the formed shrinkage cavity in the overflow part of the casting throughout the entire solidification process.

68. V. Selivorstov, Y. Dotsenko, M. Adamchuk

Choosing a gas -forming substance to create overamospheric pressure in the closed overflow of big steel cast. The use of a mixture of CaCO3 + C is the most appropriate. Over ~ 25 minutes after pouring, the thickness of the layer of solidified metal on the surface of the casting will be 0.06 m, and the temperature of the inner surface of the container with a gas-forming substance 30 mm thick will be ~ 1000 0C. 207 g of the CaCO3+C mixture is needed to create a gas pressure casting at the level of 0.3 MPa in the cavity of the closed overflow.

69. L. Deineko, Yu. Shportko, I. Mamuzić

Quenching and Partitioning (Q&P) technology. The direction of finishing heat treatment, which is based on the principle of Quenching and Partitioning (Q&P), has been actively developing in recent years. Q&P technology (it can be considered a type of isothermal hardening) can be applied to a wide range of steels, including those with a wider range of carbon concentrations. The advantage of Q&P processing is the ability to regulate the microstructural state and properties of steels in a wide range by varying the temperature and time parameters of each processing stage. This makes it possible to obtain a high strength state and increased properties of plasticity, viscosity and a significantly lower level of ultimate stress (compared to the martensitic transformation) during hardening.

70. M. M. Boyko, D. O. Yakovyna, N. V. Polyakova, A. M. Kruhlov

Improving sinter quality by forming a rational layer structure. The main materials used in sintering are fine iron ore and its concentrate, fuel, flux, and in some cases, small metallurgical waste. To ensure a stable combustion process and high-quality sinter, the charge must be as homogeneous and gas-permeable as possible. The sinter charge prepared for sintering must meet the requirements for chemical composition, strength of its pelletized

particles, and its fractional composition. The quality of the charge preparation can be improved by intensifying mixing, controlling bulk density, achieving the most efficient pelletizing regimes, and influencing the transportation and loading of the charge into the sintering machine.

71. S. Zhuravlova, M. Boyko, R. Dutnii, O. Tanchev, A. Skrypnik
Patterns of out-of-furnace treatment of ultra-low sulphur steels. Steel quality requirements are constantly increasing, as is the need to reduce the energy and raw material costs of steel production. This has led to the development of new advanced processes carried out in the ladle or in special out-of-furnace metal treatment units. The development of modern technologies for the production of high-quality low sulphur BOF steel is mainly based on the use of sulphur-free charge materials. Many methods of out-of-furnace steel treatment have been investigated, but the advantages and disadvantages of individual technologies in the production of low-sulphur steel grades, particularly those with a sulphur content not exceeding 0.005%, have not yet been sufficiently studied.

72. O.G. Velychko, V.Yu. Kamkin, I. Mamuzić
Calculation determination of non-equilibrium of the decarburization reaction during vacuuming of iron melts in ladles. During vacuum processing of metal in ladles with simultaneous argon purging, such gas phases are CO bubbles, argon bubbles, and the surface of the metal exposed from slag. It was established that the decarburization reaction is shifted from equilibrium with the fraction of removed oxygen in CO bubbles, argon bubbles, and through the metal surface by 10-2000 times. The reaction of removing hydrogen from the metal deviates from equilibriu m by 2-8 times.

73. L. Kamkina, Yu. Projdak, Ya. Mianovska, R. Ankudinov, L.Isayeva
Resource-saving effect of using shungite in the production of manganese agglomerate. Shungites can be used as reducing agents in high-temperature metallurgical and chemical processes. During the sintering of manganese agglomerate, the effect of replacing coke carbon with carbon contained in shungite was modelled. When adding 11.5% shungite to the initial composition of the charge for obtaining manganese agglomerate, which corresponds to the replacement of 50% of coke carbon with shungite carbon, the conditions for obtaining the specified composition of the agglomerate with sufficient strength and specific productivity are ensured.

74. A. Vanyukov, L. Kamkina, D. Kovalev, I. Mamuzić
Technology of partial metallization of iron ore charge. The peculiarity of this technology for obtaining partially metallized raw materials is the presence of two zones along the height with different metallization products: spikes in the lower part of the sintering layer and pellets in the upper part of the layer. The degree of metallization for heats is 30-35% and 20-25% for pellets. The proposed technology of metallization makes it possible to obtain a product containing not only metallic iron, but also up to 40-50% oxide.

75. O.G. Velichko, Li Jie, Jiang Zhouhua
Features of the design and technology of melting in the AOD converter. The AOD converter (100 t) has a small specific volume, a deep bath and a small height from the bath level to the neck. During refining, it is prone to slag emissions. Intense vibrations of the bath cause vibration movements of the unit, which are approaching critical. It has been shown that the number and placement of side tuyeres limits the possibilities intensification of side blowing. It is proposed to supply process gases from the side-top or side-bottom during periods of blowing with a nitrogen-oxygen mixture.

76. L.E. Isaeva, V.Yu. Kamkin, N.I. Babenko, T.I. Zhadan, A.G. Bezshkurenko.
Influence of nitride-forming elements on the properties of 20 ATYu. The optimal amount of titanium in steel 20ATYu has been determined. For the most complete binding of nitrogen into AlN nitrides, the amount of aluminium in 20ATYu steel should be ≥40 10-3 wt. %. To obtain finely dispersed nitrides and maintain a sufficiently high fluidity of 20ATYu steel, the optimal aluminium content should be (40-60) 10-3 wt. %. It is recommended to subject ATU type steels to heat treatment under optimal temperature and time conditions to increase the amount of highly dispersed aluminium nitrides in the metal.

77. S. Zhuravlova, M. Boyko, V. Mameshyn, A. Marko, I. Mamuzić
The use of biomaterials in steelmaking. Carburizing is a technological process of adding carbon-containing components to steel to bring the carbon content to the required level. For regions with developed agriculture, such as Ukraine, the use of plant biomaterials, i.e. agricultural waste, is promising. This paper considers the use of sunflower husks, sunflower stalks, corn, and straw. All of these biomaterials require specific preparation technologies before being used for steel carburizing. Increasing the share of advanced high-strength steels in total steel production, which generally have a higher carbon content than conventional, low-carbon steels, will increase the use of carburizers and raise the requirements for their quality. The use of biomaterials will further reduce carbon dioxide emissions into the environment.

78. V. V. Bochka, M. V. Yaholnyk, K. V. Shmat, M. M. Oleksiienko
Analysis of agglomerate stabilization methods after sintering. Peculiarities of mechanical processing of agglomerate in various devices are considered. It has been proven that in order to stabilize the agglomerate in terms of size and strength in a drum-type device, it is necessary to distinguish three characteristic zones with different destruction mechanisms, by reducing the size and number of shelves in them. The optimal design and technological parameters of the stabilizer drum are proposed, which will allow providing the required level of initial loads on the agglomerate in the range of 60-100 J/kg.

79. V. Ruban, O. Stoianov, Y Synehin, V. Musiiko, T. Shashkin
Methodology for physical modelling of the process of metal cavity formation in the subelectrode zone. The geometric parameters of the cavity formed under the action of an electric arc without gas supply during out-of-furnace steel processing at a ladle-furnace unit (LF) were calculated. In order to determine the parameters of the cavity, it is necessary to calculate the depth of the cavity and its radius. It was assumed that the gas jet pulse on the model simulates the total pulse of the argon jet and electric arc under real conditions at the LF. The most significant parameters were selected, from which, using the modified π-theorem, similarity criteria were obtained.

80. I.V. Derevyanko, O.V. Zhadanos, Y.P. Damaskin, I. Mamuzić
Method of increasing Al2O3 content in bauxite agglomerate. The suitability of bauxite for obtaining electrocorundum is assessed by the content of alumina, and the presence of impurity oxides - by relative indicators - calcium and silicon modules. With an Al2O3 content in bauxite of at least 50%, the value of the modules should be $MCaO \geq 250$, and $MSiO2 \geq 12$. To reduce the cost and improve the quality of the agglomerate, during the composition of the agglomeration charge, a substandard fraction of electro-corundum and dust from gas cleaners is added to it. To level the content of harmful impurities, metallurgical alumina is added to the charge.

81. G.I. Perchun, A.O. Ivchenko, I. Mamuzić
Study of the influence of active cold deformation on the properties of reinforcement rolled rolls. Active cold deformation by the method of drawing round rolled products or by the method of stretching (stretching - process) of rolled products with a ready-made periodic profile, allows you to increase the strength of the reinforcement to a higher strength class. Active deformation by drawing of round rolled products with degrees of deformation from 20% to 45% allows to increase the strength of cold-deformed reinforcement to the level of 500 - 700 MPa.Therefore, in order to increase the plasticity of the finished products (armature) to the required level, additional technological operations in the form of cyclic deformations and heating of cold-deformed reinforcement are proposed.

82. M. M. Boyko, S.V. Zhuravlova, N.V. Polyakova, V.E. Treshchov
Biomass utilization in DRI production. Biomass is considered a valuable renewable energy source. Numerous studies have concluded that biomass utilization has good potential for the partial replacement of fossil fuels and reducing agents in metallurgical coke production, as carbonaceous fuel in iron ore sintering, in iron ore pellet production, pulverized injection into the blast furnace. Promising is used biomass in the reduction of iron. But raw biomass can have several disadvantages, such as high moisture content, low calorific value, hygroscopic nature, low bulk density, and high content of oxygenated volatile matters. Pre-treatment allows order to obtain bio-substitutes with required properties for metallurgical processes.

83. I.V. Usichenko, T.I. Lysenko, O.O. Kalinina
«Green» metallurgy in Ukraine. In 2021sectors metallurgy accounted nearly 10% of GDP, one third of export earnings, and employed about 600 thousand people. . At the same time, metallurgy accounted for 15% of the country's carbon emissions. The main requirement for the post-war recovery of the metallurgical industry of Ukraine should not be a return to the pre-war state, but full development and integration into the European community, based on sustainable development and taking into account the European "green" course. Renewal of ferrous metallurgy will allow Ukraine to become the cheapest supplier of environmentally friendly steel in the world and will provide serious support to European efforts to reduce harmful emissions into the atmosphere.

84. I.V. Usichenko, D.A. Obora, I. Mamuzić
MES - efficient production management in metallurgy. Manufacturing Execution System (MES) is a specialized system designed to solve the tasks of synchronization, coordination, analysis and optimization of production output. Functionality of MES-systems of metallurgical enterprises is directly related to the production cycle of fulfillment of volumetric shop plans. Two main functional blocks can be distinguished in MES-systems: operational production planning (calculation of optimal production schedules); management of production processes, control of production program execution and efficiency analysis. Implementation of MES at metallurgical enterprises will allow to achieve the maximum economic effect from production activities.

85. T. Lysenko, M.Myronenko, I.Usichenko, I.Paniotov, I. Mamuzić
Business strategy for foreign economic activities of machine-building enterprises. The machine-building company in Mukachevo produces high-quality welded parts and assemblies for world-renowned companies. Starting its activity ten years ago, the company chose to process foreign raw materials that are subject to the procedure established by law, without applying to them measures of non-tariff regulation of foreign economic activity, on the condition of further re-export of processing products on the European market. In a global sense, the company's strategy will consist in forming a positive image of domestic machine-building products and a friendly attitude of the world community towards Ukraine as a high-tech country.

86. V. V. Bilotserkivets, O. O. Zavhorodnia, K. O. Zavhorodnii, I. Mamuzić
Metallurgical complex as an industrial foundation of postindustrial society. At the beginning of the 21st century, the sphere of country's influence in the global economic system are determined by its international competitiveness, the foundations of which are laid by breakthrough technological innovations within powerful industrial and postindustrial clusters that combine all components of the product life cycle, its resource and infrastructural support. Within research the conditions for the innovative revival of the Ukrainian MC in the conditions of global competition are defined. The basic mechanisms of government support of the recovering of the in the framework of the national post-wartime development strategy are proposed. There are examined the possibilities of stimulating of domestic demand for steel products.

87. M.A. Myronenko, V.L. Galatska, V.V. Filipenko, B.P. Filipenko
The borrowings and internationalisms in the Ukrainian metallurgical vocabulary. In Ukrainian metallurgical terminology, there are both native and borrowed terms from many languages. If in the 19th and early 20th centuries the main sources of borrowing were the Latin , Greek and German languages, then at the beginning of the 21st century there is a dominance English borrowings .There are also many terms created with the help of affixes of Greek or Latin etymology. There are borrowings from Turkic languages French, Hungarian. Currently, there is a tendency to translate borrowed terms and internationalisms into native Ukrainian forms ets.

88. O. Zhadanos, Y. Proydak, I. Derevyanko, M. Petrenko
Mathematical modeling of the spread of dust and gas emissions from the sintering of manganese concentrates and smelting of ferroalloys. A model of the spreading of the dust and gas emissions from stationary sources of PLC "Nikopol Ferroalloy Plant" was performed. Revealed that the concentration of carbon monoxide in the zone of influence of the enterprise does not exceed the maximum permissible concentration (MPC) of 5 mg/m3. The maximum ground-level concentration of CO is achieved at a distance of 500 m from the emission sources and is 1.85 mg/m3 (0.37 MPC). Model allows to predict the spread of both carbon monoxide and other solid and gaseous components to adjust the process and avoid exceeding the maximum permissible concentration of substances released was developed.

89. O. Oleksenko, M. Vishnevska, I. Mamuzić
Application of the Pareto diagram in industrial production. The Pareto principle is applied to improve efficiency in all aspects, from time management to business strategy. In industrial production, the Pareto diagram, based on the outcomes of activities, allows for the identification of major issues and illustrates undesirable activity results related to quality (defects, breakdowns, errors, failures, claims, repairs, product returns); cost (amount of losses, expenses); delivery terms (lack of stocks, invoicing errors, disruption of delivery terms); safety (accidents, tragic mistakes, breakdowns), and so on. Therefore, it is an effective tool that helps allocate efforts to solve emerging production problems and, secondly, identifies the leading causes to address first.

90. V. Chubko, M. Vishnevska, I. Mamuzić
Using of ABC-analysis to interpreting the Pareto chart. The essence of ABC-analysis in this context is to identify 3 groups that have 3 levels of importance in quality management. Group A – a small number of objects with a high level of specific gravity according to the selected indicator – number of defects is usually 60-80%. Group B – the average number of objects with an average level of specific weight according to the selected indicator - 20%. Group C – a large number of objects with an insignificant value of the specific weight according to the selected indicator – (5%). The economic content of the research boils down to the fact that the maximum effect is achieved when solving tasks related to group A.

91. N. Karyachenko, I. Mamuzić
Determination of the main parameters of longitudinal vibrations in cargo-transporting devices. In the presented work, the main parameters of cargo-transporting devices with a moving distributed and concentrated inertial load are determined based on a study of longitudinal vibrations of ropes. The oscillations of such systems occur in the form of a superposition of two groups of standing waves with the same frequencies, but different oscillation forms and oscillation phases. Based on the solution of the differential equation of longitudinal vibrations of flexible traction members, the influence of discretely located concentrated loads on the frequencies and forms of longitudinal vibrations of cargo-transporting devices, depending on the location of moving loads, has been studied.

92. N. Karyachenko
System of nonlinear differential equilibrium equations of the plane bending of a rod. In the presented work, a system of nonlinear differential equilibrium equations for the plane bending of a rod is obtained. It is taken into account that a curved rod, the cross-sectional dimensions of which are very small compared to the length and radius of curvature of its axial line, under the influence of external forces takes on a shape that is significantly different from the original one. In this case, however, the material of the rod operates only in the elastic stage, and the length of its elastic line passing through the centers of gravity of the cross-sectional areas remains unchanged.

93. N. Karyachenko
Identification of nonlinear dependences of stresses on relative deformations during compression of the main types of rubber. When calculating the stress-strain state of rubber-cord traction elements, two features must be taken into account. Firstly – the physical nonlinearity of the rubber parameters and, secondly, the fact that the relative deformation of the rubber matrix under load does not change within 3-4%, as for metals and rocks, but reaches 75-80%. Under these conditions, the rigidity parameters of the rubber matrices of rubber cables undergo significant changes, which must be taken into account when studying their stress-strain state. Testing rubber samples used for the manufacture of rubber ropes and tapes for compression is necessary in the range of relative deformation of rubber matrices up to $\varepsilon \leq 0{,}7$.

94. A. Projdak
To the Question of Deoxidation of Copper and Copper Alloys. Phosphorus as a deoxidizer of copper is used in the form of phosphorus copper alloy, obtained by alloying copper with phosphorus. The method of production of such ligature is to melt copper with remelting it at 150-200^{0}C above the

liquidus temperature. The ratio of liquid copper to its melting slag in the furnace is maintained in the ratio of 1:(0.05-0.10). A method for producing alloys of the Cu-P system was also developed through the aluminothermal process using apatite concentrate. The charge consisted of apatite concentrate, copper, copper oxide and reducing agent (aluminum). The optimal parameters of the phosphorus reduction process by aluminum were determined as follows: process temperature, amount of aluminum, and the ratio of components.

95. Yu. Projdak, I. Mamuzić

The influence of chemical composition on the quality of wheel metal. In accordance with the requirements of various standards, chemical composition of elements of railway switches, such as rail frogs and switch diamonds, provides for a wide range of content of major elements. Thus, the content of manganese varies from 11.5 % to 16.5 %, silicon content ranges from 0.3 % to 0.9 %. However, the examination of a number of foreign standards on the chemical analysis reveals that the aluminum content is not regulated. It has been found out that the microheterogeneity of castings is formed during primary crystallization and is determined, mainly, by the chemical composition of metal and conditions of its crystallization. It has been shown that steel quality could be improved through a rational combination of a metal chemical composition within the requirements of regulatory documents.

96. V. Olshanskyi, O. Hohenko, Yu. Proidak, L. Kamkina, I. Mamuzić

Perspectives of Utilizing Technogenic Materials in Ukraine. Annual extraction of rock mass from active natural deposits amounts to 2 billion tons. Over 60...70% of the extracted raw materials accumulate in waste dumps, forming technogenic deposits. The volume of such waste exceeds 25 billion tons, covering an area of over 150 thousand hectares, which has been removed from agricultural use. The waste dumps and tailings ponds of Kryvyi Rih mining and processing plants contain up to 13 billion tons of overburden and up to 6 billion tons of waste from the beneficiation of poor iron ore. Decisions regarding their integration into the primary processes of metal and alloy production are based on the outcomes of thermodynamic modeling and investigations into the kinetic characteristics of physical and chemical processes.

97. V. V. Bochka, M. V. Yaholnyk, K. V. Shmat, M. M. Oleksiienko

Analysis of agglomerate stabilization methods after sintering. Peculiarities of mechanical processing of agglomerate in various devices are considered. It has been proven that in order to stabilize the agglomerate in terms of size and strength in a drum-type device, it is necessary to distinguish three characteristic zones with different destruction mechanisms, by reducing the size and number of shelves in them. The optimal design and technological parameters of the stabilizer drum are proposed, which will allow providing the required level of initial loads on the agglomerate in the range of 60-100 J/kg.

98. J. Mamuzic, Yu. Projdak, G. Shvachych, G. Shlomchak

Regulation of Non-Metallic Inclusions during Electric Remelting Processes of Wheel Steel. Deep refining of metal from non-metallic inclusions and gases during remelting, as well as reduction of dendritic and chemical heterogeneity enables to obtain an ingot with dense macrostructure, to increase the level of mechanical properties of steel, and to reduce the scatter thereof. Studies to determine the inhomogeneity of stresses around inclusions by measuring the micro-thermo-electromotive force at the metal-inclusion boundary and X-ray studies of stresses of the type II showed that the highest values of stresses were obtained around non-deformable inclusions of alumina and high alumina aluminosilicates of irregular shape. Experiments have established that due to the directed crystallization of metal in the process of electro-slag remelting and vacuum-arc remelting wheel steel for railway wheels, along with increased strength properties, has a significantly greater plasticity reserve.

99. A. Neskorodieva, E. Fedorov, T. Neskorodieva, A. Karapetyan

Intellectual Classification method of Gymnastic Elements. Shown, that the most effective is the use of hidden Markov models (generative approach) and neural networks (descriptive approach) for gymnastic elements classification. The created method has the following advantages: the input image is not square, which expands the application scope; the pairs number "convolutional layer – downsampling layer" is determined empirically, which increases the model classification accuracy; the layer quantity is determined automatically, which speeds up the model structure determination; the use of a neural network allows us to label frames of gymnastic elements, and the use of a generative approach allows the resulting sequence of labeled frames of gymnastic elements analyze effectively.

100. E. Fedorov, M. Leshchenko, T. Sahno, O. Smirnov and T.Utkina

The rating restoration method based on the neural network recommendation system. The using of neural networks with auto-associative memory allows to solve the problem of the recommendation system efficiency increasing. A neural network model for rating restoration based on self-organizing feature maps with a one-step learning method allows to increase the learning speed. A neural network rating restoration model based on an auto-associative generalized multilayer perceptron with a one-step learning method admits to improving training accuracy. A neural network rating restoration model based on a limited Cauchy machine with a stochastic learning method allows to deal with a large rating matrix. The experiments confirmed the developed software performance and allow to recommend it for practice use in recommendation system for restoring ratings.

101. I. Nazarova, I. Mamuzić

Analysis of the scalability of parallel methods for solving high-dimensional dynamic problems. Research is devoted to evaluating the scalability of parallel methods for solving high-dimensional dynamic problems in combination with distributed architecture. The goal of using parallel computing in many cases is not to reduce execution time, but rather to provide the ability to solve more complex problems. The scalability analysis may be used to select the best algorithm-architecture combination for a problem under different constraints on the growth of the problem size and the number of processors. The article examines the scalability of parallel numerical methods for solving systems of high-dimensional SODE based on isoefficient analysis.

102. I. Nazarova, I. Yarosh

Efficiency of solving stiff initial problems based on implicit numerical schemes. A review of the authors' research on the parallel solution of high-dimensional stiff initial dynamic problems based on implicit numerical schemes is given. Block and multi-stage one-step implicit methods with built-in methods for estimating the local a posteriori error is considered. Control of the integration step in the methods is based on embedded forms, Runge's rule and local extrapolation technology. The speed-up and efficiency, overhead of parallelism as a function of the parameters of the method, task, machine-dependent constants and architecture are studied.

103. O. Liubymenko, E. Feldman, N. Maslova

Computer simulation of palladium sensor for hydrogen leak detection. The work is devoted to the solution of current scientific and technical problems, which consist in the substantiation, development and study of computer models using numerous methods for solving the system of equations for finding the space-time dependence of the concentration of atomic hydrogen in palladium with the corresponding initial and boundary conditions. The use of such models will make it possible to determine the moment of reaching the maximum bending of the membrane and calculate the speed of penetration through the border of the palladium membrane in real time. These results can be used to estimate the permeability of palladium membranes and coated in the process of creating membranes for hydrogen purification and the development of a solid all-metal hydrogen gas diffusion electrode for hydrogen-air fuel cells.

104. N. Maslova, O. Liubymenko

Research on the application of resource allocation algorithms in information protection systems of industrial enterprises. The development of information security measures during the construction of information protection systems requires optimization of the choice of protection means, available computing and material resources, and possible financial costs. Related tasks are risk management, coordination of enterprise activities taking into account plans in the field of information security, strategic planning. In order to choose the best algorithm for solving the problem, the use of intelligent agents with the functions of distribution and control of application, distribution and processing of resources is proposed. The work of the agents starts from the moment of designing the system and extends to the processes of selecting protection objects, processing threats and vulnerabilities that are fixed at the current stage of the functioning of the protection systems, the distribution of finances necessary for the implementation of security measures and the formation of a plan for the next period.

105. V. V. Sidanchenko, O.I. Nikolska, I. Mamuzić
Research of the stochastic properties of real data on the chemical composition of cast iron at the outlet of a blast furnace. At the moment, researchers have not come to a consensus on which distribution law describes data on the chemical composition of cast iron at the outlet. We put forward a hypothesis about the fractal properties of these data. Testing the time series data using the Kolmogorov-Smirnov test and analyzing the quantile plot rejected the hypothesis of normal distribution. At the same time, the fractal nature has been confirmed by research based on the Hurst exponent (R/S analysis), autocorrelation function with heavy "tails", deterministic chaos methods (phase trajectories of a strange attractor) and bifurcation analysis.

106. L.I. Solonenko, S.I. Repyakh, I.A. Kostenko
The ratio of the dimensions of the elements of pouring systems for frozen forms. For castings made of aluminum alloys, the regularities of the influence of the ratios of the dimensions of the elements of the pouring systems, the parameters of the casting and the pouring conditions on the maximum permissible mass of the melt. The duration of the existence of the primary foundry crust on the feeder fillet increases with a decrease in the flow rate of the melt in the feeder, as well as with an increase in the radius of the fillet and thickness of the feeder.

107. L.I. Solonenko, S.I. Repyakh, V.B. Chumachenko, I. Mamuzić
Kinetics of destruction of frozen sand-clay forms. The regularities of the kinetics of the destruction of frozen sand-clay molds pre-cooled to –15 °C at an ambient air temperature of +20±1°C and continuous dynamic impact on them have been established. The nature of clay and the content of gases dissolved in water are decisive parameters of frozen sand-clay forms from the point of view of its destruction under dynamic influence. From this point of view, the most technological are frozen sand-clay forms with 90 % quartz sand, 5 % boiled water and 5 % swollen bentonite clay.

108. L.I. Solonenko, S.I. Repyakh, O.I. Pohrebskyi, I. Mamuzić
Linear shrinkage of frozen sand-clay forms. The low pre-shrinkage expansion of castings in frozen sand-clay molds compared to castings made in raw sand-clay molds indicates a low probability of hot cracks in the castings. A decrease in the temperature of the mold with a humidity of 5...10 % from +20 to -20 °C leads to an increase in free linear shrinkage from 1.48...1.5 % to 1.54...1.88 %. At the same time, the difficult linear shrinkage decreases from 1.22...1.28 % to 1.14...1.22 %. That is, the main factors affecting the flow of processes of free and difficult linear shrinkage in frozen sand-clay forms are the rigidity of the form and its heat-accumulating capacity.

109. L.I. Solonenko, S.I. Repyakh, M.O. Reshetnyk
Fluidity of aluminum alloys and class of surface purity of castings when cast in frozen sand-clay molds. When casting in frozen sand-clay molds, the highest fluidity of aluminum alloys is observed at –20 °C. At the same time, with a decrease in the initial temperature of the frozen sand-clay mold, the surface roughness of AK5M2 alloy castings decreases, i.e., the class of their surface cleanliness increases from the 4th class at the initial temperature of the frozen sand-clay mold to –20 °C to the 5th class at the initial temperature frozen sand-clay form –40 °C.

110. K.I. Uzlov, S.I. Repiakh, T.V. Kimstach
Foundry tin-aluminum bronze BrO3A3 for tribotechnical purposes. In this work, ideas regarding regularities of single-phase structural state concentration interval existence shifting up to 3% (wt.) Sn in Cu-Sn-Al system copper corner with Al content up to 7.4% (wt.) and Sn 1...6% (wt.) have been further developed. It is devoted to copper-tin system's peritectic reaction chemical compound Cu_5Sn formation after α-Cu solid solution's primary crystallization according to Cu-Al eutectic system phase equilibria. New bronze's BrO3A3 manufacturing method and chemical composition have been protected by Patent UA 151379 dated July 13, 2022.

111. K.I. Uzlov, S.I. Repiakh, T.V. Kimstach
Tin-aluminum foundry bronze's BrO3A3 wear resistance investigation results. It has been established that bronze BrO3A3 has wear resistance during dry friction higher level (relative mass loss – 0.8%, diameter – 0.5% of initial values) compared to BrO5Tz5C5 (respectively – 7.0% and 6.3 %) and BrA9Zh3L (1.7% and 1.5%, respectively) bronzes. Bronze's BrO3A3 high wear resistance is due to solid phase β-Cu_5Sn presence in its structure. This chemical compound, during dry friction, due to bronze's soft (α-Cu) structural component's adhesive detachment and due to α-Cu plastic flowing under external tribotechnical loading influence not only accumulates β-Cu_5Sn on surface layer but also arranges it in rows along material flow direction. That is, new bronze's wear resistance tests demonstrate this characteristic preferential nature in comparison with materials BrO5Tz5C5 and BrA9Zh3L corresponding indicators, which are standardly used as bearing products friction elements.

112. L.I. Tsvirkun, I.O. Sobolevskyi, I. Mamuzić
Modern methods of distributed data collection and processing of computer network monitoring of foggy IT infrastructure as a means of improving production processes. The study investigated the peculiarities of data collection tasks distribution and processing methods in fog computing environments in order to expand the ability to monitor fog IT infrastructures in real time, optimize resource utilization, and increase system resilience. Analyzing these aspects, we identified problems with inefficient use of resources and insufficient resilience of monitoring systems. As a result of solving these problems, we developed plausible and practical solutions aimed at creating more efficient and reliable monitoring systems for fog IT infrastructures. This approach makes it possible to increase the efficiency of quality control at all stages of production processes in such environments.

113. M. Chemerynskyi, V. Pinchuk
Study of ash composition. Ash and slag residues are valuable raw materials. Residues formed after burning solid fuels, such as coal or forest and agricultural waste, in the process of electricity and heat production, contain various valuable components in different concentrations. These components include valuable metals (Ge, Mo, Zr, Ti, Li) and organomineral components (K, Na, Ca, Mg, Si). These substances are widely used as construction materials, fertilizers, thermal insulation materials, as well as valuable components in the production of batteries, semiconductors, and detectors. Additionally, the processing of ash and slag residues is an important aspect of sustainable and environmentally friendly production. Therefore, studies have been conducted to investigate the chemical composition of ash and methods of its processing.

114. V. Pererva, I. Maliga, I. Mamuzić
Energy saving in rolling industry. The blanks are heated in front of the rolling mill in methodical heating furnaces of various constructions. The choice of heating temperature depends on the brand of metal, the nuances of the rolling technology, the type of mill, the location of the processing units, the grade, etc. The main temperature determining the entire temperature regime of the process is the temperature of the end of rolling. It determines the quality and performance of finished products. Temperature control of rolling conditions will allow to adjust the temperature of process, taking into account changes in the structure of metal under deformation and grade of steel.

115. Y.S. Shyshko, Y.V. Shyshko
Increasing the energy efficiency of the process of welded pipes formation. Formation of a blank from sheet metal is an important stage of welded pipe manufacturing. To produce pipes with diameter of 310-1220 mm a hydraulic bending and forming machine JCO-2000 is used. During machine operation, oil overheating up to 75°C in the control line of the hydraulic system was detected, which lead to emergency stop of the machine. Usually external heat exchangers are commonly used to cool the oil, but this leads to the system complications and increased electricity consumption. The authors proposes the use of a built-in heat exchanger for control circuit cooling and simultaneous improvement of the system to optimize the machine's operation.

116. O. Dmitrieva, V. Huskova, I. Mamuzić
Construction of difference approximations with Legendre polynomials. When solving the Cauchy problem numerically for ordinary differential equations or their systems, increasing the accuracy requirements increases the computational load. A solution to the problem may be the use of highly parallel algorithms. The paper proposes an approach that allows one to increase the order of approximation of one-step block methods. To construct difference approximations, the use of orthogonal Legendre polynomials is proposed. Additional base points are introduced into the calculation block of the one-step method, which are the roots of an orthogonal polynomial of a given order. Thus, while maintaining the block dimension, a higher order of approximation of the difference scheme is ensured. The number of processors used remains constant.

117. O. Dmitrieva, V. Huskova, A. Khalyhov

Construction of operator transitions for neural network models with a continuous set of hidden states. The significant complexity of modern mathematical models of neural networks and machine learning models, which contain a super-powerful set of hidden states, requires an effective numerical implementation of differential equations and their systems. There is also a need to build numerical simulators using efficient parallel algorithms. To reduce resource costs, the work proposes to use operator transitions based on single- and multi-step block methods. Additionally, the computational schemes include procedures for controlling the integration step. The formation of operator transitions based on one-step block methods of maximum order of approximation was carried out using an integro-interpolation approach. It is also proposed to use fast matrix multiplication with recursive block partitioning to speed up calculations.

118. D. Khoma

GAN-based steganographic algorithms. Research on GAN-based steganographic algorithms explores novel approaches to embedding secret information within images without arousing suspicion. These algorithms leverage Generative Adversarial Networks (GANs) to enhance the secrecy and robustness of hidden data against detection. Integration of GAN aims to achieve imperceptible modifications in cover-image while preserving the quality and authenticity of the original content. These techniques often involve training GAN models to generate plausible cover images that encapsulate covert information, thus enabling secure communication or data hiding. “SteganoGAN” model represent significant advancements in this field, focusing on training GANs specifically for image steganographic purposes. This model aims to improve capacity, security, and resistance against adversarial attacks, promising enhanced privacy protection and covert communication in various applications.

119. A. Nikitenko, I. Mamuzić

Attention mechanisms as a method to improve the effectiveness of network intrusion detection system. This paper investigates the potential of attention mechanisms to enhance the effectiveness of a NIDS built upon a CNN and BiGRU architecture. A concise review of existing attention mechanisms is presented, highlighting their promising role in shaping the future of intrusion detection. Subsequently, a comparative study is conducted to evaluate the performance of the developed NIDS architecture when employing various attention mechanisms, including global attention, local attention, and self-attention. The effectiveness of each mechanism is assessed using standard metrics like accuracy, precision, recall, and F1-score. The findings demonstrate that incorporating attention mechanisms significantly improves the NIDS performance in terms of the aforementioned metrics, contributing valuable insights for further research in this domain.

120. S. O. Barsukova, H. P. Ivanova, Nikolska O.I

Modern approaches to modeling the stability of soil slopes using the finite element method. Among the numerical methods, the most effective are the finite element method, the boundary element method, the discrete element method. Currently, the finite element method (FEM) is the most widely used for solving geomechanical problems. The FEM is based on the division of the studied area into small sub-areas that can be considered as homogeneous and isotropic. The main concept of the method is that the movements of the internal points of each element are related to the movements of its nodes through the shape function. Therefore, it is relevant to continue research in the direction of studying the FEM in geomechanics and construction.

121. V. E. Olishevska, H. S. Olishevskiy

Research of static crack resistance of structural composite materials. For the first time, the use of layered metal compositions obtained by explosion welding as crack-resistant structural materials for the production of machine parts and mechanisms is substantiated. An automated calculation technique has been developed that allows investigating the condition of multilayer compositions and determining the criteria for destruction. An increase in crack resistance under static load by 86% when monometal is replaced by a bimetallic composition is substantiated. When replacing the monometal with a composition of three layers with an intermediate plastic layer, the increase in crack resistance under static load was 28%.

122. I.H. Olishevskyi, O. Yu. Gusev, I. Mamuzić

Automated method of calculating parameters for a heating system based on heat pumps. The evaluation of previously developed technologies for the utilization of thermal energy in buildings was carried out. First time, attention is paid to the research of non-traditional ways of using heat pump heating for the purpose of heating, air conditioning and hot water supply of residential premises. An automated method of forming the control dependence of the mass flow of water in the system on the temperature of the outside air has been developed under the condition of constancy of the given comfortable temperature of the inside air. Conventional fuel savings of 13% to 18% compared to the technology using a heat accumulator are substantiated.

123. S. O. Barsukova, H. P. Ivanova

Modern approaches to modeling the stability of soil slopes using the finite element method. Among the numerical methods, the most effective are the finite element method, the boundary element method, the discrete element method. Currently, the finite element method (FEM) is the most widely used for solving geomechanical problems. The FEM is based on the division of the studied area into small sub-areas that can be considered as homogeneous and isotropic. The main concept of the method is that the movements of the internal points of each element are related to the movements of its nodes through the shape function. Therefore, it is relevant to continue research in the direction of studying the FEM in geomechanics and construction.

124. I. Mamuzić, G.G. Shvachych, P.O. Shcherbyna

Study of the multi-channel mode of operation of a multi-processor system. Research is aimed at increasing the efficiency of the cluster system by implementing a multi-channel mode of operation of its network interface. The operating conditions of the switching matrix of the switch in the cut-through mode are determined. This approach ensures the transfer of packets with the highest speed, which leads to an improvement in the overall efficiency of the cluster system. Analytical relations are derived for determining the optimal number of nodes of a multiprocessor cluster system, when the corresponding problem will be solved in the minimum possible time. The approach made it possible not only to increase the efficiency of parallelization, but also to significantly reduce the calculation time.

125. I. Mamuzić, G.G. Shvachych, P. O. Ishchuk

Analysis of Numerical Integration Methods for Pollution Transport Equations. In the modern world, where concern for the state of the environment is becoming increasingly relevant, studying the distribution of pollutants in natural environments requires the application of various methods, among which numerical integration of pollution transport equations plays an important role. Numerical solution methods include applying the application of the finite element method and the finite difference method. The finite element method allows for adapting the division of the study area to the characteristics of the environment, making it effective for complex geometries. On the other hand, the finite difference method is often used to solve simpler geometric configurations, providing fast and efficient calculations. Processing boundary conditions plays a key role in reproducing real conditions of pollutant spread. Therefore, it is necessary to consider various conditions, such as moving and stationary boundaries, to ensure the accuracy of numerical modeling.

126. I. Mamuzić, G.G. Shvachych, I.M. Udovyk, P. O. Ishchuk

Features of Numerical Integration of Pollution Transference Equations. The equation describing pollutant distribution in the working zone is investigated. Hence, there exists a partial differential equation of parabolic type, dependent on three spatial coordinates. Constructing an efficient algorithm to solve such a problem, characterized by minimal computational costs, is based on decomposing the given model over a certain time interval into a sequence of simpler equations. Thus, the pollutant transport process is divided into several stages, each of which uniquely determines the direction of convective transport of harmful impurities. The choice of such decomposition is driven by the fact that, in difference approximations of transport equations, the greatest complexity lies in approximating convective derivatives, which must necessarily account for the direction of convective transport. It is worth noting that if a second-order difference scheme is constructed for each equation, then the overall decomposition scheme will have second-order accuracy in the time coordinate.

127. I. Mamuzić, G.G. Shvachych, P. O. Ishchuk
Challenges of Parallel Numerical Integration of Pollution Transport Equations. Numerical integration of pollution transport equations is a key task in hydrodynamics and ecological sciences. Various numerical methods are applied to solve pollution transport equations, among which the finite element method and the finite difference method hold significance. One of the important features is the utilization of parallel computing for efficient numerical integration. Modern computing systems provide the capability to employ parallel algorithms, allowing for the distribution of computational tasks among different computing nodes and accelerating the integration process. The applying of parallel numerical integration enables the consideration of large amounts of data and resources, leading to increased computational speed. However, this also poses challenges in terms of effective task distribution and resource management.

128. G.G. Shvachych, M.O. Aleksieiev, R.O. Havrylov, I. Mamuzić
Development of a web platform for software installation. The research focuses on the process of developing a web-based platform for software installation and improving the performance of desktop and mobile devices. Unlike most websites that offer downloading only proprietary software, the proposed web platform provides the user with systematised software for popular desktop and mobile operating systems, the ability to select an individual licensed software package depending on the user's needs, and the ability to save selected individual software packages in their own profile in order to optimise work and time. The FrontEnd part of the web application has been developed using HTML (HyperText Markup Language), CSS (Cascading Style Sheets) and JavaScript technologies. The backend part of the web application has been developed using the PHP scripting language.

129. G.G. Shvachych, B.I. Moroz, R.O. Havrylov
Features of the development of a web platform for software installation. A web-based platform for software installation and performance improvement for desktop and mobile devices are being considered. The FrontEnd part of the web application has been developed using HTML, CSS, and JavaScript technologies. HTML technology has been used to structure the content on the application page. The use of CSS technology has been focused on styling HTML elements. The JavaScript programming language has been applied to add dynamic functionality to the page. The BackEnd part of the web application has been responsible for processing logic at the server level, managing the database and providing communication with the FrontEnd part. For this application, we have used PHP scripting language as one of the most popular languages for creating server logic.

130. G.G. Shvachych, O.M. Aleksieiev, I.I. Doroshevych
Development of an integrated cross-platform application for ordering, analyzing the status and control of electric vehicles. The research is aimed at developing an integrated cross-platform mobile application that provides the ability to order electric vehicles (electric scooters, electric bicycles, electric cars) from different provider companies. The presented development analyzes the real-time monitoring of the state of electric vehicles, such as battery charge, location, and speed. The control and management function is an important component of the efficient operation of electric vehicles. These aspects play a key role in ensuring the safety, reliability, and optimal functioning of transportation systems. Monitoring and control is an integral part of the development of modern electric transport systems aimed at creating efficient, safe, and sustainable transportation networks.

131. G.G. Shvachych, L.V. Kabak, I.I. Doroshevych
Features of the software development for ordering electric vehicles. The software of this project is focused on simplifying and speeding up the process of ordering electric vehicles, improving the safety and comfort of travel. To increase the manageability and scalability of the developed system, a modular structure was taken as the basis for the development of this project. Two frameworks from Google were used as tools for creating various applications and services: Firebase and Google Maps. These tools provide developers with opportunities to create a variety of applications and services. For example, Firebase is responsible for synchronizing data between users in real time. For this development, it is important that such a database allows using different methods of user authentication. Firebase also allows you to use cloud functions to automate tasks and process data.

132. I.G. Hulina, A.L. Shyrin, R.Y. Kudlay, I. Mamuzić
Development of a web application for automating food orders. The research is aimed at developing and creating a web application for automating food orders. The main goal is to create a flexible system for customer service and automate the order management process. The key difference of this application is that customers can not only view the full range of services but also order specific products, track their readiness, pick up, and pay independently without involving third parties. Additionally, the developed system provides a convenient tool for analyzing trends and demand among customers, enabling the company to make informed management decisions regarding order tracking and popular products. This approach focuses on developing new offers for users, aiming to develop and optimize the company's activities.

133. G.G. Shvachych, A.A. Martynenko, R.Y.Kudlay
Features of the software implementation of a web application for automating food orders. This project focuses on a web platform designed to automate food ordering. Microsoft SQL Server was selected for its development, offering flexibility in deployment based on project needs. SQL Server's multitasking and multi-user access capabilities enable concurrent execution of numerous queries and provide multiple users access to the database. It ensures transactions are executed consistently, coherently, and in isolation. Visual Studio Code was utilized to develop the FrontEnd, providing extensive customization options and high productivity. The FrontEnd was based on Visual Studio for creating multifunctional, attractive cross-platform applications. The project was developed using JavaScript with React framework support.

134. G.G. Shvachych, M.O. Aleksieiev, O.Y. Novokhatskyi
The development and implementation of game software to improve logical thinking and cognitive skills of users. This research aims to develop and implement game software to improve logical thinking and address cognitive challenges in both children and adults. One of the main goals of this research is to create game scenarios that actively promote critical and creative thinking. The software will be based on advanced learning and cognitive development methodologies, using game elements to stimulate the senses, logic and analytical thinking. The proposed study will explore the potential integration of game-based approaches into modern education systems, providing an effective and engaging method for learning and cognitive development.

135. G.G. Shvachych, B.I. Moroz, O.Y. Novokhatskyi
Features of software development for the development of logical thinking and decision making. The software for this project was developed using the cross-platform Unity development environment, renowned for its versatility and power in creating visually rich applications, particularly in the gaming sphere. Unity boasts a robust graphics engine supporting high-quality 2D and 3D effects, along with built-in tools for optimizing graphics and lighting. Leveraging the .NET platform, developers can efficiently utilize advanced features from Microsoft, ensuring the creation of high-quality, cross-platform applications. The application itself is built on the C# programming language, known for its rich toolset ideally suited for game development within the Unity environment.

136. G.G. Shvachych, I.M. Udovyk, A.T. Khar, V.R. Pashchenko
Development of a cross-platform application for organizing and conducting floristic business processes. The research is aimed at creating an innovative cross-platform application and simplifying the organization and management of floristic business processes. The convenient and attractive interface of the system allows to order flowers quickly and efficiently. Such an interface allows customers to easily search for the necessary flowers in the proposed database, add them to the basket and make payment. After receiving an order, florists have convenient tools to process it and prepare it for delivery. The developed system provides for the use of convenient payment options through integration with various payment systems. The use of the Telegram social network as the basis of this application allows for maximum compatibility with various platforms.
G.G. Shvachych, K.S. Rodna, G. Shikhaliyev
Development of a web application for the provision of project development services in the field of digital space. Nowadays, having a professional website has become essential for businesses. They can achieve success by using a web application. Therefore, it is crucial to create a user-friendly design with intuitive navigation, smooth animations, and a seamless user experience to attract customers effectively. This project's goal is to create a web in-

terface that will become the main tool for attracting customers for a wide range of users. The proposed website aims to solve problems by allowing users from different industries, including real estate, law, and healthcare to find clients quickly. Additionally, users can contact the studio to create their website and grow businesses.

137. G.G. Shvachych, L.I. Meshcheriakov, G. Shikhaliyev
Features of creating a web application for the provision of project development services. This web application is designed to offer top-notch project development services. To achieve it, should follow a process that involves several stages. Creating wireframes based on User Flow helps to understand user's behavior and how they move from one screen to another. It allows designers to provide users with a better experience. The user interface design is created to ensure effective interaction between the user and the product. Figma was used as a design tool with plugins: Autoflow, Product Planner, and Responsify. The coding of the interface, animations, and customization of forms was implemented. HTML5, CSS3, JavaScript with the jQuery library, and GSAP were used for creation.

138. I. Mamuzić, G.G. Shvachych, O.M. Aleksieiev, K.S. Rodna, I.A. Pobochii
Development of a stable multiplicative cryptographic algorithm. Any cryptographic algorithm's necessary and sufficient stability (the ability to resist hacking) is determined by the time of the information value (the period of its significance) and the costs of hacking it. Existing cryptographic algorithms are quite complex to implement; therefore, fairly simple algorithms such as $c = t \oplus k$ are used in most corporate asymmetric cryptographic systems. The proposed encryption and decryption algorithm is based on a reciprocal function that includes the text or cryptogram, the starting, and the multiplicative keys. A recurrent function quite easily implements the developed multiplicative cryptographic algorithm. The proposed algorithm implementation could be very effective when exchanging a pair of keys (startkey, multikey) with different public keys. A test program that implements the proposed cryptographic algorithm was given.

139. I. Mamuzić, G.G. Shvachych, J.S. Proydak, G.G. Shlomchak, B.I. Moroz
The effectiveness analysis of parallel computations of mathematical physics problems. Nowadays, mathematical simulation is developing progressively. Physical processes simulation of heat and mass transfer in the metallurgical industry boils down to the need to solve systems of linear algebraic equations. The following methods are traditionally used to create parallel solutions to the above systems of equations: the sweeping method, cyclic reduction, and decomposition. It is emphasized that the running method is economical but needs to scale better. The application of functional decomposition to the synthesis of parallel algorithms based on the counter sweeps method, "even-odd" reduction. In contrast, the method of straight lines leads to algorithms with high acceleration and efficiency. The conducted experimental computational experiments showed that the values of acceleration and efficiency were more acceptable in the straight-line method.

140. I. Mamuzić, G.G. Shvachych, J.S. Proydak, G.G. Shlomchak, D.M. Moroz
Multiprocessor systems in the problem of metal heat treatment. Improvement and creation of new technological processes related to metal heat treatment require significant costs for carrying out many full-scale experiments on laboratory, experimental, and industrial equipment and in industrial conditions. The reduction of experimental studies and the time required to conduct them to obtain the necessary information for the construction and implementation of technological developments can be done by multiprocessor computing systems. The problem of matching the processors' capabilities and the cluster system's network interface arises concerning the above. In solving the heat treatment problem of metal products, analytical relations are derived to determine the optimal number of nodes of a multiprocessor system per the selected processors. Thus, it is shown that the optimal number of blades of a cluster system, which gives the highest speed, decreases with an increase in the processors' computing power that combines the multiprocessor system.

141. I. Mamuzić, L.O. Kolysnyk, V.V. Busygin, I.L. Reshetnyak
Analysis of strategic directions for the pipe production development. In the economic analysis, the results of the required enterprise can be evaluated by indicators such as production volume, sales volume, profit, etc. However, when evaluating the efficiency of such an enterprise, it becomes obvious that more than the listed features are needed as they are absolute indicators of the enterprise's performance. The research aims to analyze indicators such as profit and profitability, which reflect the enterprise's economic efficiency, financial condition, and problems with its economic development. The company's priority activity areas are shown to improve equipment and technology based on modern scientific developments to reduce energy and material consumption and improve the quality of pipe products. The key ways of increasing profit and profitability are indicated. The increasing income factors that allow the enterprise to carry out its activities more successfully have been identified.

142. I. Mamuzić, S.V. Shvachych, V.V. Busygin, A.T. Khar
Study of enterprise performance evaluations. The studies showed the necessity of applying profitability indicators to characterize enterprise efficiency in general and the profitability of various production areas. Profitability is the most generalized, qualitative indicator of the economic efficiency of a business entity, which allows comparing the profit amount with the size of how it was obtained. Therefore, profitability can be interpreted as a measure of revenue, yield, and business income. Profitability is measured by relative indicators that can be used to evaluate the enterprise's efficiency in general, its areas of activity (production, commercial, investment, etc.), the production profitability of certain types of products, and the provision of certain types of services. Studies have shown that profitability indicators are essential elements revealing the actual environment of profit formation. Therefore, they are mandatory when conducting a comparative analysis and assessing the enterprise's financial condition as a whole.

143. I. Mamuzić, G.G. Shvachych, M. O. Aleksieiev, B.I. Moroz
Study of multiprocessor system performance evaluations. This paper's main research goal is to develop an approach that analyzes the multiprocessor cluster modular computing system's performance evaluations further. Concurrently, the main attention is paid to the features that influence the network interface of such a system in assessing its efficiency. As a result of the research, the main operating modes of the network interface in multiprocessor cluster systems have been identified and established. In conjunction with this, an analysis of the main operating modes of the network interface in multiprocessor cluster systems was carried out, and their influence on parallelization efficiency evaluations was revealed. Ways to increase the multiprocessor cluster system's efficiency by organizing its network interface's architecture were also reported. For the convenience of determining the performance estimates of a multiprocessor computing system, the main analytical relationships through the parameters of the system's network interface were presented.

144. I. Mamuzić, G.G. Shvachych, P.O. Shcherbyna, P. O. Ishchuk
Improving the network interface structure of a multiprocessor system. The paper aims to improve the structure of the network interface of a multiprocessor system and increase its productivity by the multidimensional aggregation of network interface channels adapted to solving the problems of the studied class. Meanwhile, the main network interface modes of operation in multiprocessor computing systems are analyzed. Their influence on the estimates of parallelization efficiency is revealed, and ways to increase the efficiency of a multiprocessor system by reorganizing the architecture of its network interface are shown. Analytical ratios of multiprocessor computing system efficiency estimates based on network interface parameters are derived. The analysis of the detected modes of operation of the network interface in the modular multiprocessor cluster system was carried out. The operating conditions of the interconnect matrix of the switch in the end-to-end switching mode are defined. The practical value of the obtained results lies in applying the proposed multiprocessor system to create new technological processes.

145. I. Mamuzić, G.G. Shvachych, I.G. Hulina, A.A. Martynenko
Specialized software development for a modular multiprocessor system. The research aims to reveal the peculiarities of implementing and configuring the software system of a multiprocessor computing system, characterizing the software tools for communication (interaction) between its nodes, and describing the functioning specifics of these software tools. At the same time, it is considered that each of its nodes operates under the control of its copy of the standard OS. The composition and power of the system nodes can vary within the same module, but here, we consider each module homogeneous. Interaction between the modular system nodes is performed via the programming interface in the form of specialized libraries of functions. Since a mul-

tiprocessor computing system is built from ready-made hardware components, its operating system mainly includes ready-made general-purpose software products. However, the OS of the modular system includes a communication library and a basic means of launching specified parallel programs.

146. I. Mamuzić, G.G. Shvachych, L.V. Kabak, T.V. Chumak
The rationale for programming connections between processors of a multiprocessor system. The interaction process between nodes of the modular system occurs via the programming interface (specialized libraries). The communication system, in turn, includes the following components: software and hardware. The first includes two basic methods of information transfer, namely, through distributed memory, when the synchronization of access of branches to such memory occurs by so-called semaphores in the form of certain messages. The first of the above methods of programming interprocess connections is basic for *SMP technology* and single-processor computers. Functions related to work with *Shared memory* (*SHM*) are included directly in the composition of every multitasking OS. Directly for one computer, interprocess communication is implemented using the *SHM command*. The second of the named methods of programming interprocess connections is typical for networks of various types. Here, the communication between cluster nodes occurs using the *MPI* (*Message Passing Interface*) programming interface.

147. I. Mamuzić, M.V. Busygina
Research on the synthesis of new organic compounds. Opening the compounds cycle of 1a-c of thieno[2,3-d]pyrimidine derivatives under the excess hydrazine in dimethylformamide (DMF) is an essential reaction in the synthesis of organic compounds. The reaction scheme was as follows. Initial thieno[2,3-d]pyrimidine derivatives (1a-c) have a cyclic structure. Concurrently, the hydrazine action in DMF leads to breaking the cyclic structure and forming an intermediate product. Under such conditions of the noted reaction, DMF acted as a solvent and reaction catalyst. The reaction mechanism was as follows. Hydrazine interacts with the nitrogen atom (N) in the cyclic structure, breaking the nitrogen ring. Thanks to this, an intermediate amine product is formed. Direct opening of the cyclic structure leads to forming amines and other organic compounds with an open ring. Interim, opening the cycle of thieno[2,3-d]pyrimidine derivatives with hydrazine in DMF can be an essential step in synthesizing new organic compounds.

148. I. Mamuzić, M.V. Busygina
Study of multistage transformations in the synthesis of organic compounds. Nowadays, multistep transformations are a key aspect of modern organic chemistry and play a key role in the synthesis of organic compounds. That approach allows obtaining more complex molecules from simpler ones sequentially carrying out reactions at each stage. For the conducted studies, thieno[2,3-d]pyrimidine derivatives were taken as an object for studying that transformation kind due to several reaction centers. The reactivity of thieno[2,3-d]pyrimidine derivatives was studied based on interaction with hydrazine. As a result of boiling compounds 1a-c with an excess of hydrazine in dimethylformamide (DMF), amino derivatives of benzothienyl-1,2,6,7,9-pentazaspiro[4.5]deca-2,7-dien-ones 2a-c were obtained. Optimizing the reaction conditions at each stage to ensure maximum product yield and minimize side reactions is essential in multistage synthesis.

149. I. Mamuzić, Y. Friman, N. Molchanov
System development for evaluating the personnel performance at industrial enterprises. The research is devoted to developing a methodology for forming an effective system for evaluating personnel performance at industrial enterprises. The method of determining the integral evaluation of the success of the employee's work has been developed, based on which the rating evaluation of the company's employees is determined. Such an assessment determines the effectiveness of the actual results of the employees' activities. Moreover, on the one hand, it reflects the level of professionalism of each of them, and on the other hand, the degree of desire for effective performance of assigned tasks. The proposed approach motivates employees to participate in the implementation of the company's goals. It is proposed to use its decomposition to increase the evaluation efficiency level, considering the criteria specific to a certain center of responsibility. It is also shown that the success of the results of personnel activities is also influenced by employees' individual and psychological qualities, for each of which a certain definition was given.

150. I. Mamuzić, Y. Friman , H. Horobets
Evaluation analysis of the industrial enterprise efficiency. Modern trends of globalization and integration, penetrating all aspects of an industrial enterprise, demand a more careful study of personnel effectiveness as one of the key factors of its successful functioning. The studies illustrated that the evaluation of personnel activity must be carried out exclusively based on a set of quantitative and qualitative evaluation criteria. That, in turn, allows to constantly monitor the level of positive dynamics of the professional scale of each enterprise employee. For that purpose, the paper proposes to decompose the assessment of each enterprise employee. The direct connection between an effective system for evaluating the performance of employees and the possibility of increasing their income in the form of an increase in the remuneration level, which motivates employees to constantly improve their skills, as a factor in increasing the profitability level of an industrial enterprise, and its additional income, has been analyzed and proven.

151. I. Mamuzić, G.G. Shvachych, A.I. Kupin, A.M. Selegej, V.O. Petrenko
Study of the rational distribution problem of charge materials on the blast furnace throat. Computations based on the developed mathematical models showed that the displacement of the blast furnace charge's loading trajectories could occur significantly. Therefore, if the loading mode is left unchanged, the redistribution of charge materials inevitably causes a change in their trajectories. As a result, the recovery conditions of iron ore raw materials in the upper layers of the charge column are deteriorated. Considering the above, a study of the influence of furnace loading factors was conducted to achieve the best recovery conditions. The result of the conducted research was a solution to the problem of correcting the loading parameters of the blast furnace. That, in turn, allowed to justify a scientific approach to solving the problem of operational provision of rational distribution of charge materials on blast furnace throat by a given correction of the charge flow trajectories.

152. I. Mamuzić, G.G. Shvachych, Vol.V. Hnatushenko, V.R. Veres
Development and implementation of an interactive interface as a means of solving cognitive problems and making decisions. Research aims at creating an innovative tool for developing logical thinking, solving cognitive problems, and improving decision-making skills. The analysis of the requirements and the development of the concept allowed choosing the Python programming language due to its versatility and flexibility. The Ursina Engine framework was chosen to create the game engine. The library set contains ready-made shaders, geometric primitives, and animations. An essential part of the development was creating a user interface that was attractive and effective in perception. Graphics and soundtrack played an important role in creating a positive image of the interface and motivating users. The application helps improve the skills of solving puzzles and develops logical thinking and problem-solving, which positively affects users' personal and professional development. The application is used for education, entertainment, and the development of cognitive skills in different age groups of users.

153. I. Mamuzić, G.G. Shvachych, Vol.V. Hnatushenko, V.R. Veres
Features of using the python programming language and the ursina engine framework for modeling the development of logical thinking and solving cognitive problems. Python is a high-level language that allows developers to easily interact with many libraries and frameworks for scientific research, mathematical modeling, and data processing. This programming language is known for its simplicity and code readability. Concurrently, the Ursina Engine framework provides flexibility in working with graphics and animations, facilitating the creation of interactive visual effects and 2D and 3D graphical interfaces. Its simple API allows for a quick implementation of interactivity and visualizations, which is ideal for creating an interactive interface. The capabilities of the Ursina Engine framework in graphics and visualization allow the creation of attractive and motivating graphic effects that increase users' interest and stimulate them to solve complex problems. Overall, using the Python programming language and the Ursina Engine framework is a good choice, as those tools combine ease of learning, flexibility, and a user-friendly interface.

154. V.U. Grihorenko, D.V. Iskryzhitskyi
Development of the method of determining the rational kinematic mode in the process of cold rolling of pipes with rolls. Deformation of the metal occurs during the forward and reverse movement of the cage. Deformation, kinematics and force parameters are variables. Axial forces in reverse are greater than in forward. This affects the quality of the pipes and the stability of the tool. We calculate from the control sections: - the diameter (wall)

of the pipe and the mandrel; - previous value of forced rolling radius, - rolling force; - axial force. Changing the forced radius, we select one that provides a rational value and character of the axial force distribution.

155. O.P. Golovchenko, V.U. Grigorenko
The development of the method is based on the feeding mode and rotation during cold rolling to improve the accuracy of the pipes and ensure the regulated microstructure. The basis of the method is the experimental determination of the values of the accuracy parameters of pipes and microstructures under several modes of feed and rotation. The transverse difference, ovality and variation of the external diameter are 1.5-2.0 times smaller in the mode of feeding and turning the pipe of the workpiece before the straight line and before the turning strokes of the cage. For this mode, the grain on the outer surface is larger than the bottom on the inner surface by 1-2 points.

156. V. V. Ovsianykov, V.U. Grigorenko
Features of the selection of technical requirements for rolled plates to ensure regulated mechanical properties of welded pipes. Experience in the manufacture of large-diameter steel welded pipes with step-by-step bending on a press, seam welding and expansion has shown that for steel of strength category up to X70 and strength class up to K60, a decrease of 20-30 N/mm2 in the yield strength of rolled sheets is observed. The components of the technology have different effects on the reduction of the yield strength. When forming technical requirements for rolled plates, it is necessary to take into account the decrease in mechanical properties at the yield strength.

157. V.U. Grigorenko, S.V. Kutsevol, I. Mamuzić
To ensure the supply of natural rolling radius of Primus in cold pipe rolling mills. A round caliber has a variable fluidity at points on the surface of the rim along the width of the caliber. The natural rolling radius is unchanged over the course of the cage, and the added radius, which is similar to the partial radius of the drive gear, is unchanged. This involves greater forging of metal with a roller. To change the rolling of the required drive gear with a changeable pitch radius for the skin stepping tooth, the gear follows the law of changing the natural rolling radius.

158. V.U. Grigorenko. O.M. Zabolotny
Towards the development of methods for calculating the calibration of hot rolling rolls of shaped sections. The following methods are known for the production of channels: beam; selfish; bending straight real flanges; with an increased slope of the shelves and a curved wall; with unfolded shelves and a curved wall. Use a square blank. In rough gauges, intense uneven deformation of the metal occurs. Bullies, mustaches, captivity occur, and energy costs increase. It is proposed to use a rectangular blank. This will reduce the number of passes in calibers, reduce tool costs, gas consumption, and repair costs.

159. P. O. Kahanov, A. M. Miroshnik, I. Mamuzić
Formation of nonlinear trajectories of motion of moving objects with guaranteed accuracy in approximation areas. When implementing neuro-fuzzy models, the problem arises of determining the complexity of the model, the number of input and output fuzzy variables, the number of linguistic rules, the number of terms, the coordinates of modal values on the axes of input and output fuzzy variables, the number of neurons of artificial neural networks (ANN) or neuro-fuzzy systems, etc. , ensuring guaranteed accuracy of model implementation, modeling and control processes. An analytical method has been developed for determining the complexity of fuzzy and neural models depending on the specified accuracy of their implementation.

160. M. A. Miroshnyk, A. V. Shafranskiy, I. Mamuzić
Modeling of critical situations in pipeline networks. Modeling of pipeline networks allows predicting the behavior of a critical system in various operating conditions and making decisions in emergency situations. For modeling, pipeline networks are considered as multi-component systems represented by an interactive computer network (ICM) model on programmable functional modules (FPMs). A method and procedure for the synthesis of one-dimensional PCMs with reserve FMs has been developed. A diagnostic experiment procedure for PCM with observed outputs has been developed. The task of optimal placement of reserve FMs in the structure of the ICM has been solved. This allows simulating the process of eliminating emergency situations during the operation of pipeline networks.