

**16. SIMPOZIJ „MATERIJALI I METALURGIJA“
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supplement „Book of Abstracts“**

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Review – Prikaz

U Metalurgiji 62 (2023) 2,309-328 objavljen je Zbornik sažetaka (259). Rok za primitak sažetke je bio 30. studeni 2022. god. Mnogi autori zatražili novi rok do 25.03.2023. Organizacijski odbor Simpozija je prihvatio novi termin. Objavljuje se sada dodatnih još 103 sažetaka.

In Metalurgija 62 (2023) 2,309-328 published „Book of Abstracts“ (259 Abstracts). Deadline for received of Abstracts was November, 30, 2022 y. Many authors have request new deadline by March, 25, 2023 y. Organizing committee have accept new deadline. Now it published supplements of 103 Abstracts.

Summaries**1. Y. Proydak, I. Mamuzić, G. Shvachyeh, G. Shlomchak**

Simulation of speed schedules for metal. The deals the features of the development and use of the multiprocessor computing system with mathematical and software of the latter for simulation of heat treatment of the steel billets. Objective of the work: developing the model of heat treatment of a long steel product, which can be used for recrystallization and spheroidizing annealing of calibrated steel. The use of the up-to-date multiprocessor computing technologies had been proposed for increasing speed and productivity of computations, what maintains the effective control of the technological process. Through the special software the multiprocessor system is able to set and control necessary temperature conditions on all plane of cross-sectional of standard at heating and self-control of metal, and if necessary maybe began to control the thermal mode of treatment in the interval of temperatures of annealing.

2. Y. Proydak, I. Mamuzić, G. Shvachyeh, T. Karpova

Heat treatment modes simulations of metal billets. Development features and application of multiprocessor computing system with its mathematical support and software for heat treatment modes simulation of metal billets are considered. Modern multiprocessor computing technologies application was suggested for increasing speed and efficiency of computation, which enables to effectively control technological processes. Multiprocessor system with special software is capable to set and control necessary temperature conditions along all the plane of cross-sectional of a billet at heating and self-control of metal, and with possible control of thermal mode of treatment in temperatures interval of annealing. The practical value of results obtained showed that the technological process by appropriate mathematical simulations was improved.

3. I. Mamuzić, G. Shvachyeh, D. Moroz, O. Zaporozhchenko

Specifics of the work model construction for the communication net of multiprocessor system. The deals is devoted to the questions of researching the construction specifics of net interface in the multiprocessor system with shared calculating zone. The system is intended for use in solving a wide range of applied problems in metallurgy. The four types of multiprocessor system topology are offered by authors for that: the “ruler”, the “ring”, the “star” and the “grid”. The specifics of tuning the net interface of the multiprocessor system for the pointed work modes of the communication system net are reported.

4. N.E.Pohrebna, O.A.Nosko, A.V., Hrebenieva, T.A.Aiupova, O.A. Aiupov

Structure, phase composition and alloying elements distribution in high chromium alloys. Cr and other alloying elements content in the Cr_7C_3 carbide forming in the High-Temperature Strength Ni-Cr Alloy Nikorim and 28Cr32Ni3V cast iron is determined. Cr_7C_3 carbide in the chrome-nickel alloy contains 94.5% Cr, and in 28Cr32Ni3V cast iron - 73% Cr; other alloying elements are present in small quantities. The Nikorim austenite matrix contains 68.7% Ni and 24.66% Cr, while the 28Cr32Ni3V high-chromium cast iron matrix contains 19.6% Cr and 2.9% Ni. By the X-ray 28Cr32Ni3V cast iron structural analysis the excess Cr_7C_3 carbide is revealed; also the matrix phase composition is determined: it contains 52% austenite and 48% ferrite phases.

5. S. O. Plitchenko, D. M. Bolotova, I. Alex. Vakulenko

The structure heterogeneity hot deformed austenite of the carbon steel. After hot deformation workpiece, the structural heterogeneity of austenite in various elements of the railway wheel is inherited by carbon steel after cooling. The size of austenite grains is determined by the mechanism development of secondary recrystallization from degree of the hot deformation. At deformations higher than 10%, development of secondary recrystallization occurs according to the mechanism movement of the grain boundaries with large angles of disorientation. At deformations of less than 10%, the density of dislocations in austenite becomes insufficient for the formation of a nucleus of secondary recrystallization by the mechanism movement of the grain boundaries. The mechanism of the development recrystallization determines dispersion and homogeneity of the austenite structure after hot deformation.

6. O. Gryshyn, A. Nadtochiy, I. Mamuzić

Joint recovery chrome and magnetic concentrates. The use of multi-component spongy ligatures, obtained by the technology of solid-phase recovery, allows to reduce energy costs and increase the efficiency of the use of alloying additives. The purpose of the work is to develop the physicochemical foundations of the processes of obtaining multicomponent ligatures based on chromium. Thermodynamic modeling of joint recovery of chromite and magnetite concentrates was carried out, data were obtained on the temperatures of the start of recovery, as well as the composition of the equilibrium gas phase of the analyzed system. Kinetic studies are represented by time dependences of the degree of recovery for various process conditions.

7. I.V. Derevyanko, O.V. Zhadanos, E.V. Zabolotskih

Research on the possibility of deoxidization of steelmaking slags with silicon carbide during the smelting of high-manganese steels. In order to determine the possibility of silicon carbide deoxidization of iron-carbon melts during steel smelting, a thermodynamic analysis of the interaction of components in the SiC-Fe-C system was carried out. In industry conditions, after the oxidation period, which ends with slag unloading, the bath was deoxidized with ferrosilicon (ferrosilicon-manganese), and then alloyed with ferromanganese. The slag of the reduction period was deoxidized with

silicon carbide. The obtained results showed that the complex physical and mechanical properties of metal castings from Gadfield steel are higher by 8-10%, compared to the quality of the metal obtained by traditional technologies.

8. I.V. Derevyanko, O.V. Zhadanos, A.V. Bezugly, Y.V. Yaroshenko

Investigation of the electrical condition of Acheson's resistance furnace. The feature of Acheson's furnaces for obtaining silicon carbide is that the resistance of the carbon material (core) serves to convert electrical energy into thermal energy. The first grate is located at a distance of 65 mm from the current-carrying unit. In relation to it, the potential of all other graters was measured. The first and last measurements were carried out in relation to the grids located at a distance of 65 mm from the current-carrying blocks. The conducted studies show the uneven distribution of power along the length of the core. To eliminate this phenomenon, it is necessary to optimize the technical parameters of the core and the transient contact zone of the current-carrying block core.

9. M.G. Malich, D.L. Vasiliev, D.V. Kress, I. Mamuzić

On the issue of reducing the energy of disintegration during the enrichment of ore mineral raw materials. An analysis of the existing classical theories of determining the amount of energy required for the disintegration of solid bodies is carried out. Each of them implements only a small part of the spectrum of conditions for crushing and crushing of mountain ore rocks. At the same time, they practically do not take into account the contact friction between the tool and the rock, as it happens in crushers and pipe mills. The authors proposed to use a new theory of local rock destruction taking into account internal and contact friction with symmetrical and asymmetrical distribution of contact tangential stresses. Studies show that the asymmetric distribution of contact tangential stresses theoretically provides a decrease in the specific energy of destruction of ore mineral raw materials up to 40 - 45 times.

10. V. Kyrychok, A. Nadtochiy, O. Gryshyn

Modeling the behavior of components in manganese slag systems. The search for schemes for the use of secondary raw materials and waste-free technologies that will allow returning manganese to the metallurgical redistribution is an urgent problem. Thermodynamic modeling of equilibrium in a complex system was carried out. The ratio of oxides in the system affects the viscosity and crystallization characteristics of this system. The degree of reduction of oxides is determined by the activity of the components of the slag phase, which depends on its chemical composition and temperature. The analysis of the data obtained in the work justifies the expediency of reprocessing metallurgical manganese slags.

11. G. Shvachych, I. Mamuzić, D. Shepilev, P. Ishchuk

Research of efficiency of a multiprocessor computing system. The article is devoted to the research of efficiency of a multiprocessor computing system in solving problems aimed at expanding the computing area. The basic regularities concerning the time of solving the problem are revealed, depending on the change in the multiprocessor system calculations area. The research is aimed at determining the deceleration factor associated with the increase of the computing area of a multiprocessor system when compared with the computer version with an unlimited computing area. The analytical ratios are derived for determining the calculations deceleration coefficient. The derived analytical relations were aimed at determining the optimal number of nodes of a multiprocessor system which allow the minimum delay of calculations.

12. I. Mamuzić, G. Shvachych, T. Doronina, O. Kholod

Parallel implementation of the combined algorithm of the branch and bound method. Parallel implementation of a combined branch-and-bound algorithm for the knapsack problem are considered. An approach combining parallel implementations of the branch-and-bound method and the heuristic search is proposed and implemented. Basic attention is focused on the questions of research of efficiency and acceleration for calculations due to the increase of the cluster system knots. As a result of the proposed approach, a organization scheme of the combined algorithm of distributed computing was obtained. The approach proposed in this studies saves the developers' efforts by reapplying common parts of the algorithm to solve various problems of optimization. In fact, one can implement a common solution scheme for different platforms once, and later use only problem-dependent modules for a specific class of problems.

13. I. Mamuzić, G. Shvachych, I. Laktionov, L. Kabak

Multiprocessor modeling technologies for the applied statistical tasks. The work considers the multiprocessors technologies of modeling for Monte Carlo tasks. It is shown that only application of the modern super productive systems permitted the new way to realize the mechanism of corresponding partitioned computations. The calculating schemes that supply to provide the increase of productivity and calculations' speed effectiveness are shown. In this article the modified algorithm of parallel calculations is offered based on the Monte Carlo method. It is shown that the parallel algorithms of the Monte Carlo method are stable to any input data and have the maximal parallel form and, thus, minimal possible time of realization using the parallel computing devices.

14. M. Kuzmenko, O. Egorov, I. Tarasevich

Method of adjusting rolling speed mode. The proposed method of adjusting the high-speed rolling mode significantly reduces the impact of instability tension on rolled products' transverse dimensions in the finishing train and stabilizes the rolling speed at the exit from the mill. Based on the results of computer simulation of billet rolling in the roughing and finishing trains, it is proved that influences in the control loop of the rolled loop have a high-frequency component caused by dynamic processes in the circuit and a low-frequency associated with changing the compression mode from the front of the rolled to the rear in the first finishing mill stand. This allowed improving an automatic adjustment of roll rotation speed and minimizing the instability of the cross-sectional area of rolled products at the entrance to the finishing train. Thus, using an active tension control of rolling stock in the last inter-mill space of the roughing train by implementing it into the existing tension regulator control system, rolled products tension is actively regulated and the rolled products' cross-sectional area is stabilized along the entire length.

15. I. I. Vishnevskiy, M. K. Vishnevskaya, I. Mamuzić

The quality management system as a key component of the overall management system of the organization. The presented study determined that the quality management system is one of the most important components of the overall enterprise management system. It must ensure the stability of the quality of products or services, as well as contribute to increasing consumer satisfaction. Modern management specialists consider this concept in four aspects, which reflect the evolution of the concept of quality with the development of not only production technologies, but also management science. It has been established – thanks to the improvement of the quality of management and products, there is a constant improvement of the system and processes in the organization. It has been proven, that the quality management system must be maintained in working condition and if necessary, it must be continuously improved in accordance with today's challenges and consumer requirements.

16. M.A. Myronenko, V.L. Galatska, O.A. Kolisnyk, M.S. Petrenko

Research of competitiveness management in the market of postal services in Ukraine. In modern conditions, there is an aggravation of competition in all sectors of the Ukrainian economy. In such conditions, only enterprises that systematically work on their own competitive advantages are able to control the situation on the market. This involves significant resources and requires sound direction and effective management. Therefore, the issues of formation of competitive advantages are the object of research both at the level of theory and at the level of practice. The purpose of the article is to consider theoretical and methodological approaches to managing the competitiveness of an enterprise on the example of the Joint Stock Company «Ukrposhta».

17. O. A. Savchuk, M. K. Vishnevskaya, I. Mamuzić

Benefits of implementing a quality management system into the organization's general management system. The presented work substantiates the key advantages of the introduction of the quality management system into the general management system of the organization. In particular, it is determined that: the company's resources are becoming more concentrated on meeting the needs and expectations of consumers; processes are being optimized in the management system; the development of documentation necessary for the release or sale of safe, complete and high-quality products is carried out, f. i. cost of internal resource. A direct relationship between the improvement of the quality of management and products and the improvement of the company's business process system has been established.

18. I. Mamuzić, I. Pobochii, O. Zaporozhchenko, V. Kozenkova

Efficient parallelization algorithms of the applied tasks in multiprocessor computing systems. The work is dedicated to the construction of numerical-analytical method of designing efficient algorithms for solution of problems in economics and engineering. Using a priori information about the smoothness of the solution, great attention is paid to the construction of high-accuracy solutions. The proposed approach eliminates recurrent structure calculations for desired vectors' decisions which leads to the accumulation of rounding errors. Parallel form of the algorithm is the maximum, and therefore demands the shortest possible time for implementation on parallel computing systems.

19. G. Shvachych, I. Mamuzić, M. Sazonova, A. Shyrin

Distributed algorithms for solving applied problems in an extreme setting. A proper class of the mathematical models had been deduced for investigating the thermophysical properties of materials by means of reverse methods. Procedure for treatment of the mathematical models is reduced to the extreme statement that allowed to develop the effective algorithms for solving the coefficient problems of the optional order of accuracy. A package of applied problems had been developed for solving the coefficient problems of the heat-conducting with the methods of mathematical simulation. Creation of package had been carried out considering the requirements of the object-oriented programming. The simulation procedure had been realized on the basis of application of multiprocessor computer system. The package of applied programs is intended for treatment of thermophysical experiments with reverse methods.

20. G. Shvachych, I. Mamuzić, D. Moroz, V. Kozenkova

Models of parallel computation of dynamic systems. The work is dedicated to the construction of numerical-analytical method of designing efficient algorithms for solution of problems in economics and engineering. Using a priori information about the smoothness of the solution, great attention is paid to the construction of high-accuracy solutions. At the same time, an important feature for the solution of given class problems is their high computational complexity. Therefore, the effective research of these tasks can be carried out only on the basis of multiprocessor systems. Higher acceleration of computations compared with the finite-difference approach is explained through the use of analytical solutions that allow to perform calculations simultaneously and in parallel on all temporary layers without the using combined memory.

21. T.I. Lysenko, M.A. Myronenko, I.V. Usichenko, S.M. Druzd.

The secret behind the efficiency of the operational activity of the MMZ company. A company needs stability in demand and availability of resources for its work. The manufacturing company MMZ (Mukachevo city) makes products which are 100% export oriented. In the last ten years the company has gotten a small place in the metal constructions sector of Western Europe. The company provides the main component of efficiency which is the quality of products, as well as the timeliness of delivery of products to the customer. It has achieved a balance between all production factors (material, financial, human), which ensured the growth in production volume at the lower cost.

22. I.V. Usichenko, T.I. Lysenko, K.S. Usichenko, O.S. Logvynenko

Investigation of the cost management system at PJSC «Dnipro Metallurgical Plant». One of the problems for the enterprise is the high cost of finished products. Reducing the cost of production is one of the main factors of increasing profits and increasing the profitability of production. To find ways to reduce the cost of production of the enterprise, an analysis of the composition of production costs was carried out. The analysis showed that raw materials, energy costs and fuel and lubricants costs have the largest share in the structure of production costs. Proposals were developed to reduce the cost of electricity consumption, reduce the consumption of natural gas, on the example of rolling mill "250". To improve cost management at the enterprise it is advisable to change the existing cost management system standard-cost to controlling.

23. I.V. Usichenko, K.S. Usichenko, V.V. Popov

Development of integrated management system of an enterprise. The prerequisites of an integrated management system based on the requirements of international standards ISO 9001 (quality), ISO 14001 (environmental protection), OHSAS 18001 (health care and ensuring occupational safety), SA 8000 (social responsibility) at a metallurgical plant are considered. The requirements to the integrated management system, its objectives and areas of impact are described. Proposed changes to the organizational structure of the enterprise management. The Integrated Management System Manual was developed. The emissions to the environment before and after the implementation of the integrated management system were analyzed. Method of calculation of economic efficiency and payback period of the proposed developments is shown.

24. O.S. Sobolevska, I. Mamuzić

Carbon footprint of the metallurgy. Demands to reduce the carbon footprint of metallurgy are being made by the public, environmentalists, regulators. Reducing the carbon footprint for the metallurgical industry means decarbonizing the steel production processes. According to the report of the non-profit think tank on climate change Sandbag, 41% of emissions can be avoided due to the optimized use of scrap. The technology will increase the use of annual fossil gas or hydrogen consumption to process primary iron ore into metals and replace integrated steel production with electric arc furnaces (EAF). However, EAFs can be virtually carbon-free. Optimization of the use of scrap - its better segregation and removal of impurities. Additional renewable electricity savings are achieved through reuse in the construction sector or through "direct recycling" of end-of-life steel structures without melting them in EAFs.

25. N. Karyachenko, I. Mamuzić

On the regularities of dynamic processes in cargo-transporting devices. In the presented work, the regularities of dynamic processes occurring in cargo-transporting devices with a moving distributed and concentrated inertial load are studied with full consideration of their characteristic features. Taking into account that the processes occurring in such systems have a two-wave character, one of the methods based on the choice of the solution of linear differential equations of motion in the form of a special two-wave solution representation was used to study them. Oscillations of such systems are carried out in the form of a superposition of two groups of standing waves with the same frequencies, but different waveforms and phases of oscillations. Based on the solution of the differential equation of transverse oscillations of flexible traction members, the influence of discretely located concentrated loads on the frequencies and forms of transverse oscillations of cargo-transporting devices, depending on the location of the moving loads, is studied.

26. D. O. Bannikov, I. V. Leontieva, I. Mamuzić

Steel as a modern alternative to reinforced concrete. At present, quite often, customers of design work and investors have a dilemma – which building material is better to give preference to – steel or reinforced concrete. Each of these materials has its own advantages and disadvantages, but often the decisive factor is the cost of the future structure. As shown by the analysis carried out by the authors on the example of the frame of a filter station building of medium dimensions in plan (66 × 36 m), steel allows not only to reduce the total mass of the structure by up to 5 times, but also to reduce construction costs by about 10–30 %. At the same time, it is possible to avoid such undesirable technological operations as wet work during the cold season. Thus, steel is currently a significant competitor to reinforced concrete, making it possible to increase the reliability and, if used correctly, the durability of structural solutions.

27. M.A. Myronenko, R.M. Korol, A.Yu. A.Yu. Myronenko, A.O. Taranenko

Features of manufacture technology of high-quality precision pipes from molybdenum alloy. The existing technology for manufacturing high-quality precision pipes is adjusted based on the actual quality indicators of the workpiece. The analysis of the parameters of a tubular billet made of an alloy based on molybdenum of foreign production was carried out, and the features of the parameters of the technology for the production of precision pipes from the material under study were established and experimentally confirmed. The application of these changes to the existing technology for the production of precision pipes from molybdenum-based alloys will reduce the consumption coefficient of the metal and increase the competitiveness of domestic pipe products.

28. O.A. Nosko, T.A. Aiupova, O.V. Bila, A.V. Hrebenieva, Yu.O. Kushnir

Na and W alloyed and Heat Treated Cz-Si Structure and Properties. Na, W and the complex (Na+W) and heat treatment influence on Cz-Si structure and electrophysical properties formation is studied. Heat treatment of Cz-Si (Na+W) causes a reduction in the number of defects; twins and etching pits are absent. The Cz-Si-Na, Cz-Si-W, and Cz-Si-(Na+W) X-ray patterns show additional maxima corresponding to silicon phases with a rhombic and BCC_{III} lattice, which indicates high-temperature silicon phase stabilization. The microhardness of all samples increases. The maximum microhard-

ness is typical for Cz-Si – (Na+W). The highest electrophysical properties values are inherent in unalloyed Cz-Si, as well as in Cz-Si –W and Cz-Si – (Na+W). Heat treatment leads to a decrease in specific electrical resistance and an increase in the minor charge carriers life time for all samples, the maximum effect is observed for Cz-Si – (Na+W).

29. I. S. Ostapenko, I. Mamuzić

Some aspects of the application of metal span structures made of welded wide-span I-beams. In the work, the technological aspects of the application of steel span structures of the inventory bridge property from welded wide-span I-beams are investigated. For the main beams of the span structures of the inventory bridge property, two factory marks corresponding to typical profiles are provided: MA, 12.35 m long and MB, 16.47 m long. One of the features of the researched object is that by cutting the factory marks, you can obtain assembly marks such length, which is necessary for the formation of span structures provided for by the bridge restoration scheme. Mastering the proposed technological process of improvement and application of steel span structures made of welded wide-span I-beams is recommended to be implemented during the temporary construction (restoration) of bridges.

30. V. Pinchuk, O. Tutova, S. Pinchuk

Research of mode and design parameters of roller cooler for dry cooling of liquid slag. The use of coal in metallurgy and energy industry is accompanied by the formation of a significant amount of waste, in particular slag. Promising methods of efficient use of liquid slag physical heat and environmental protection are dry cooling of liquid slag in roller coolers to obtain crushed slag. The influence of the design and operating parameters of roller coolers for dry granulation of ash melt with the utilization of its physical heat on the heat removal value has been theoretically and experimentally determined. It has been established that with a roll radius of 0.2 m and a molten bath height of 0.17 m, the roll rotation frequency of 1-1.5 rpm and the thickness of the slag ribbon of 1.5-2 mm are appropriate. With such design and technological parameters, the temperature of the slag ribbon after roller coolers is 950-1000°C, and the heat removal is up to 45%. With an increase in the rotational speed of the rolls, the average temperature of the slag ribbon increases, and the amount of heat removal does not exceed 30%.

31. S. V. Raksha, P. G. Anofriev, O. S. Kuropiatnyk, S. A. Volkova, V. M. Bohomaz

Dynamics of a centrifugal casting machine on a modified cardan suspension. Mathematical models of free and forced oscillations of a foundry machine on a pendulum cardan suspension are developed in the work. The machine has two natural frequencies. *Matlab* developed m-scenarios for calculating the natural frequencies of the foundry machine and its amplitude-frequency characteristics. The dependence of the natural frequencies of machine oscillations on the length of the suspension is almost linear. The influence of the length of the suspension of the form with an electric motor and a counterweight on the natural frequencies of oscillations of the module has a non-linear nature and extremes of the first and second oscillation frequencies.

32. O. K. Tsurban, M. K. Vishnevskaya

Stages of implementation of the quality management system. The main milestones of the implementation of the quality management system into the management system of the organization are investigated in the presented work. It is established that this should happen in stages. The first stage should consist in the analysis of the existing situation in the organization and training of personnel. The second stage – in the development of documentation and the implementation of necessary changes in the work of employees. At the final stage – the implementation of an internal audit of the quality system. It was determined that the implementation of these stages involves; development of a clear and transparent management system; involvement of all personnel of the organization; description and constant adjustment of processes.

33. N. Kalinina, T. Fenenko

Protected personal data categories in ensuring the quality of computer information systems. A definition of Personally identifiable information (PII), which is a collective term that can be defined differently in different documents, in particular in the standard. According to the Health Insurance Portability and Accountability Act (HIPAA) there are 18 identifiers that are considered PII. This information may be used to identify, contact, or locate an individual or may be used with other sources to identify an individual. Therefore, even at the early stages of IS design, it is necessary to study in detail all the data that will be operated by the computer IS, the quality assurance department must evaluate this data from the point of view of the legislation of the countries in which the distribution of the software is planned. Large companies forced to create departments responsible for quality control of research and development.

34. N. Kalinina

The issue of personal data protection in the design of personal health logs. With the growing use of smartphones and wearables, a variety of health tools have enabled users to generate their own private health logs and manage their health conditions, such as weight control, chronic disease treatment, and mental health management. The use data of these private health logs may attract various researchers: clinical researchers, marketers, demographers. In this case, the initial analysis is carried out by specialists in the field of computer science. Users themselves often underestimate the risk of disclosure of sensitive health data and deanonymization if personal information is disclosed. Formally, there are over 10 identifiers that are considered personally identifiable information (PII). A combination of even two PII can reveal an identity under HIPAA. Using the principles of designing information systems, taking into account PII protection, allows you to protect users and makes it possible to correctly using an array of anonymous data for research purposes.

35. B. Moroz, I. Mamuzić, T. Karpova, A. Martynenko

Intensification of spheroidizing annealing of low carbon steel. The paper considers complex intensification features of spheroidizing annealing of low-carbon steels and possible technological realizations of intensive annealing modes in current lines. The research aims to reveal the intensification nature of the steel's spheroidizing due to the non-isothermal holding and an internal coolant for the metal heating. That allows a significant reduction of the spheroidizing annealing process while improving the steel product's technological properties – providing a high dispersion and homogeneity of the structure across the entire plane of its section. The multiprocessor computing system with its mathematical and IT software for modeling the heat treatment modes of metal billets effectively controls the processes.

36. I. Mamuzić, B. Moroz, S. Shvachych, O. Kholod

Mathematical modeling of pipes production forecast. The studies analyzes some indicators of the production activity of Ukraine's metallurgical plants, which are under the auspices of Ukrtruboprom association for May-August 2022. Mathematical modeling of pipe production process forecast based on polynomial regression analysis was performed. The presented mathematical models provide adequate results for predicted indicators of economic activity of enterprises selected for analysis. The Russian military operations' negative impact on the hostilities' conduct in Ukraine is shown.

37. Y. Proydak, G. Shlomchak, I. Mamuzić, G. Shvachych

Research of contact stresses during rolling. The research provides a methodology and results of experimental research of contact stresses in the non-stationary process of strip rolling, i.e., the rolling with an increasing rear tension before it slips in the rolls. There is used a polarization-optical modeling method. The research aims at developing a method for the experimental determination of contact stresses during rolling with a linearly increasing back tension of the strip. It is shown that among the methods for studying the mechanics of a deformable solid, the most rigorously substantiated theoretically is the polarization-optical method of direct measurement of stresses.

38. G. Walczyk, W. Pakiela, M. Roszak

Effect of titanium powder addition and heat treatment on the grain size in the weld of ferritic stainless steel of the X2CrTiNb18 grade. Improving the strength properties of ferritic stainless steel welds is associated with reducing excessive grain growth. The article presents the research results on the effect of the titanium additive introduced to the weld material during the welding process of X2CrTiNb18 steel and using different temperature ranges of the heat treatment process for the welds obtained. The significant importance of the influence of titanium addition during welding and heat treatment operations on the change of weld morphology, including the reduction of ferrite grain growth and the evolution of selected mechanical properties of welds (strength, hardness, plasticity), was demonstrated.

39. S. Kordaszewski, G. Kiesiewicz, T. Knych, A. Mamala, P. Kwaśniewski, W. Ściężor, K. Franczak, M. Sadzikowski, P. Kowalewski

Research on mechanical and electrical properties of enamel winding wires connections made with the use of shark-al technology. The results of the research that have been presented in this article include the analysis of basic exploitative properties of connections made with the use of new family of

Shark-Al connectors, which are the first in the industry strictly dedicated for connecting the enamelled aluminium wires. In particular, the test results include the analysis of the contact resistance and tensile strength of connections prepared with the various types of connectors and various configurations of used enamelled wires. Results of this work enabled to verify the correctness of performed connecting process and also allowed to verify the connectors design.

40. G. Kiesiewicz, T. Knych, A. Mamala, P. Kwaśniewski, K. Korzeń, M. Zasadzińska, P. Kowalewski

Power cycling analysis of enameled aluminium winding wires connections prepared with the use of shark-al type connectors. The article presents the research results of current cyclic thermal tests performed on enamelled aluminium wires connections, made with the use of a new type of Shark-Al quick-connectors. In particular, the main purpose of the conducted research was to analyse the effect of cyclic heating on the contact resistance change during the tests which allows to test the stability of the connections in simulated working conditions under current flow. Tests included a total of 300 thermal cycles, of which the first 200 were carried out to the 65°C temperature measured in the connector at above the ambient temperature, and then additional 100 cycles were performed for the temperature of the connector at 140°C (tolerance +5°C). During the tests, the resistance of samples was monitored, which allowed to verify the correctness of performed connections.

41. G. Kiesiewicz, P. Kwaśniewski, W. Ścieżor, K. Franczak, M. Sazdikowski, S. Kordaszewski

Research on plastic deformation of Cu-Mg castings in cold drawing process and analysis of mechanical and electrical properties of obtained wires. The aim of the conducted research works which are presented in the article was to determine the mechanical and electrical properties of Cu-Mg wires obtained in cold drawing process with total deformation at the level of 95%. Base material for the research was obtained with the use of continuous casting process which allowed to produce CuMg0,05, CuMg0,5 and CuMg0,02 cylindrical rods with 9,5mm diameter which were next cold drawn up to 1,97 mm diameter. After the cold drawing process Vickers hardness measurements along with static tensile test and electrical conductivity analysis were performed in order to determine the evolution of castings properties as a result of the applied cold deformation.

42. K. Franczak, P. Kwaśniewski, G. Kiesiewicz, M. Sazdikowski, W. Ścieżor, S. Kordaszewski

Studies on magnesium addition to copper produced in the continuous casting process and analysis of mechanical, electrical and structural properties of obtained casts. Article presents the effect of magnesium addition to copper in the range of 0.02 - 0.5 wt. % on the mechanical, electrical and structural properties of obtained materials. All analysed alloys were produced by horizontal continuous casting set-up in the form of 9,5mm rods. Obtained Cu-Mg alloys were next tested for their as-cast properties via Vickers hardness analysis, electrical conductivity measurements and macrostructure observations in both cross and longitudinal section. The aim of the research was to verify the influence of the magnesium content on the properties of selected Cu-Mg alloys, which are dedicated to use in overhead railway system for contact wires and catenaries.

43. I. Mamuzić, G. Shvachych, L. Sushko

Application of petri nets for assessment of the technical condition of gear transmissions. The relevance of research aimed at determining estimates of the technical condition of gear transmission is beyond doubt. The research is aimed at using the Petri Net as a mathematical means of describing the studied discrete objects that reflect the logical sequence of events that occur during the functioning of the objects, which include gears. Time Petri Nets were used to realistically display processes and events that require a certain amount of time to complete. For example, in the case of the activation of gear elements. This approach was justified in the conditions when it is necessary to perform certain calculations of the working time of the simulated objects or to make a quantitative analysis of the functioning of the system.

44. I. Mamuzić, S. Alekseyenko, T. Kadylnykova, V. Dudnikov

Method of calculation of aerodynamic and acoustic characteristics of aerodynamic profiles. The paper considers the theory of explaining the physical mechanisms of the occurrence of the trailing edge aerodynamic tonal noise of the airfoils. An analysis of the possibilities of using the ANSYS FLUENT software package for direct calculation of the aerodynamic and acoustic characteristics of airfoils in the near field is carried out using the example of NACA0012 for the transitional flow regime. Characteristic features are reproduced, such as the formation of a "separation bubble" and the subsequent sequential appearance of descending vortices. The results let a more detailed study of the physical picture of the processes of vortex formation, and, accordingly, the process of generating sound vibrations. The considered technique allows carrying out further computational studies on the development of technology for reducing the aerodynamic noise of wind turbines.

45. L.I. Solonenko, I. Mamuzić, O.P. Bilyi, A.A. Taranov

A new way to make molds and cores. The method is intended for the manufacture of casting molds and cores from quartz sand, which is clad with dry liquid glass. The curing of such sand is carried out by microwave radiation in water vapor. The duration of the structuring of such a mixture depends on its mass and the size of the mold or core. The compressive strength of the structured mixture is 1.0...3.5 MPa.

46. I. Mamuzić, L.I. Solonenko, V.O. Zakharov, O.P. Bilyi

Heat-insulating mixture for the gating system of castings. The use of quartz sand conglomerates with liquid glass makes it possible to use the same mixture both for the working cavity of the casting mold and for the elements of the gating system that feed the casting. That is, conglomerates with dimensions of less than 0.315 mm can be used to make the working part of the mold (casting), and conglomerates with dimensions of more than 0.63 mm as a heat-insulating mixture of casting risers.

47. R.V. Usenko, I. Mamuzić, V.F. Mazorchuk

Shrinkage porosity in thin walls of steel castings. The reason for the occurrence of shrinkage porosity in the walls of steel castings with a thickness of 1 ... 5 mm is the uneven thickness of the layer of solidified steel melt on the mold surface. The uneven thickness of this layer is due to the variability of the melt flow rate in a thin wall during mold casting. To prevent the appearance of shrinkage porosity, the casting of the mold should be carried out at high speed and with increased overheating of the poured steel melt.

48. W. Ścieżor, R. Kowal, J. Grzebinoga, G. Kiesiewicz, P. Kwaśniewski, A. Mamala

Research on the influence of the proportion of nickel and silicon on the mechanical and electrical properties of CuNiSi alloys. CuNiSi alloys are widely used in applications that require both high mechanical strength and high electrical conductivity. Obtaining such set of properties is possible through the appropriate selection of mutual proportions of nickel and silicon in the alloy. The article presents research on the metallurgical synthesis of the CuNiSi alloy with a nickel content of 2.2 wt.% and silicon in the range of 0.8 - 1.3 wt.% and the process of casting ingots with a diameter of 40 mm. Each of the produced materials were subjected to the process of homogenization, solution heat treatment and artificial aging in order to improve the mechanical and electrical properties. Castings were directed to the chemical composition tests. Materials were also subjected to the Vickers hardness and electrical conductivity tests at each stage of the casting and heat treatment processes.

49. A. Dziubinska

Studies on the conditions of homogenization and properties in hot forming of ZK60 cast magnesium alloy. This paper presents a study of temperature conditions for homogenization of a cast high-strength ZK60 alloy belonging to the Mg-Zn-Zr group of magnesium alloys. On the basis of a literature review, two-stage homogenization conditions were selected to improve the forgeability of the ZK60 casting. The effectiveness of this treatment was evaluated experimentally on the basis of structure and hardness tests and was found to be satisfactory. Plastometric tests were carried out for the samples made from the ingots after homogenization. These tests were performed in a compression test in hot forming conditions at three temperatures (350 °C, 400 °C and 450 °C) and four strain rates (0,01; 0,1; 1,0 and 10 s⁻¹). The determined flow curves will be used to develop a material model of the cast magnesium alloy ZK60 for numerical simulations. The research leading to these results has received funding from the Norway Grants 2014-2021 via the National Centre for Research and Development

50. A. Dziubinska, E. Siemionek, B. Koczurkiewicz, W. Presz

Investigation of functions characterizing the flow curves of cast magnesium alloy MgAl9Zn1. The article presents the results of testing the flow curves of cast magnesium alloy MgAl9Zn1. Experimental tests were carried out on a deformation dilatometer in a compression test of cylindrical specimens heated to 380 °C, 400 °C, 420 °C at strain rates of 0,01 s⁻¹, 1 s⁻¹, 10 s⁻¹. The experimental curves were described by functions used in programs

for simulating metal forming processes based on the finite element method. The Generalized Reduced Gradient optimization method implemented in Microsoft Excel was used to determine the function coefficients. Based on the results obtained, the best functions characterizing the flow curves were selected for use in describing the material models used in numerical simulations of cast magnesium alloy MgAl9Zn1.

51. J. Pieprzyca, T. Merder, M. Saternus, M. Tkadlečková, J. Cupek, J. Walek

Modeling research on limitation of transition zone during continuous steel casting. The increase in market demand for small masses of special purpose steel forces its producers to use the technique of continuous casting with a transition zone. The article presents the results of model tests of limiting the range of the transition zone as a result of the use of an impact pad and changes in the volume of liquid steel in the tundish. A water physical model of a Continuous Steel Casting (CSC) device equipped with a two-outlets tundish was used for the research. The criterion for assessing the range of the transition zone was the value of the minimum time of complete mixing of the tracer in the modeling liquid, determined on the basis of the Residence Time Distribution (RTD) curves. Visualization techniques of the modeling liquid mixing process were used to identify hydrodynamic phenomena.

52. D. Gatner, K. Pietrucha, B. Dziergas, A. Nowak, D. Kowalcze, W. Łoński, M. Spilka, M. Kciuk

Comparison of the functional properties of selected multilayer systems. Electrodeposition of multilayers continues to grow and diversify. Research is still underway on the adaptation of multilayer systems to new applications in various industries. Both, Cu/Co and Cu/Ni multilayer systems are still very commonly used for practical purposes. In this work, the functional properties of selected multilayer systems with different layers quantity and thicknesses in nano scale were investigated. The Cu and Ni layers were electrolytically deposited on a low carbon steel substrate and obtained systems were subjected to structural (SEM, AFM and XRF) and anticorrosion properties study. The electrochemical parameters were determined by potentiodynamic method and the surface evaluation of the systems after corrosion tests was also carried out.

53. I. Mamuzić, O. Dmitrieva, A. Misko, V. Huskova

Application of deep convolutional neural network for image scaling. This paper proposes a model of deep recursive neural network that takes into account the specific features of the input images, performs self-tuning with the definition of optimal scaling parameters and continues training. A unified deep learning neural network DJSR (Deep joint super resolution) was used to improve the quality of the output image. At the beginning the network is trained using an external image database, the tuning is done using the input image samples. The network can then be expanded into several specialized sub-networks, and sample learning is performed. The main idea is to exploit the surplus part-examples between different neighboring image scales. The proposed network contains a degradation model, a degradation discriminator, and a reconstruction model. The degradation model is used to produce realistic low-resolution images. The degradation discriminator ensures the similarity of the example parts of the obtained low-resolution image with the real images. The reconstruction model is used to directly create final high-resolution images by using the resulting images for training.

54. E. I. Malyi, M. S. Chemerinskiy

Obtaining electrode masses with improved performance characteristics. In presented work, electrode masses are considered with the participation of electrode pitch as a binder treated with a surface-active additive in order to improve their performance properties. In the studies carried out, a technological method was developed aimed at improving these properties by modifying the pitch with a surfactant. Treatment with a surfactant made it possible to establish the structural and chemical modification of the electrode masses, evaluating, by structural changes, the main characteristics and physicochemical properties that determine their behavior in the process of carbonization of the working end of the self-baking electrode. A feature of the proposed method is that the electrode mass with modified pitch binder has higher technological performance compared to the serial one, which will have a positive effect on performance.

55. K. Milewski, K. Piotrowska, M. Madej

Assessment of the properties of diamond-like carbon coatings used in the lime industry. The aim of the study was to analyze the properties of diamond-like carbon coatings - DLC in machines operating in the lime industry. DLC coatings were deposited by the Plasma-Enhanced Chemical Vapor Deposition PECVD method on 100Cr6 steel samples. Characterization of the geometric structure of samples was carried out on an optical profilometer. The friction junctions were tested in harsh conditions, i.e., corrosive environment and high temperature. The tribological tests were performed using a sliding ball-on-disc tribological tester. The static contact angle for selected lubricants was measured using an optical tensiometer. The summary presents the possibilities of using diamond-like coatings in selected friction junctions in the lime industry.

56. X. Y. Liu, H. Jin, Y. Y. Wang

Study on the mechanism of cobalt recovery from waste lithium cobaltate batteries in citric acid system. The lithium cobalt acid batteries was utilized as raw materials to separate out LiCoO₂ cathode material. Citric acid was used to leach cathode material, and LiCoO₂ leaching solution was electrodeposited to obtain cobalt plating, in the meantime the Li²⁺ ions were enriched. The optimized conditions of leaching process are 1,2 mol/L citric concentration and 0,35 mol/L sodium thiosulfate concentration, the leaching efficiency of cobalt and lithium is 97,5 % and 97,0 % respectively. At pH 4, the smooth cobalt coating with fine grains can be obtained on the stainless steel cathode.

57. K. Janiszewski

The influence of slenderness of ceramic filters on the efficiency of steel refining. The results presented in this paper are the next planned stage of research on the process of steel refining from dispersoid non-metallic phase by means of its filtration. The acquired results of macro and microstructure analyzes, as well as steel cleanliness before and after the filtration process, reflect the course of the research and attest that it can be an effective and cheap method of refining it from non-metallic inclusions. Presented results confirm that the slenderness of a filter has a significant impact on the effectiveness of the steel filtration process. Products of deoxidation have been identified on the filtration surface of ceramic filters.

58. I. Mamuzić, G. Shvachyeh, P. Shcherbyna

Decision of task global optimization through the multiprocessor computer systems. The paper considers one of the options for solving the global optimization problem using multiprocessor computing systems implemented on the basis of a personal computing cluster. The following results were obtained: a distributed combined algorithm for solving the global optimization problem was developed using the knapsack problem as an example. A series of computational experiments was carried out, the purpose of which was to study the effectiveness of a parallel algorithm, and the optimal variant of the combination "acceleration - efficiency" for a personal computing cluster was proposed. In addition, of undoubted interest would be special heuristic algorithms specially developed for a distributed multiprocessor system, the implementation of which would speed up and increase the efficiency of the parallel modeling procedure.

59. I. Mamuzić, G. Shvachyeh, P.O. Shcherbyna

Study of web resources adaptability technology. Researches are devoted to the categories of adaptability, as one of the main conditions put forward for the creation and use of modern Internet resources. It is shown that the Web resource must have certain capabilities for correct display on the screens of various devices, such as a computer, tablet, smartphone, e-book, etc. For this purpose, design adaptation technologies or specially developed versions of the resource. An analysis of the main principles of graphic interface adaptation was carried out. New web development strategies are proposed, including best practices regarding the concepts of "mobile first" and "progressive improvement". The effectiveness of the developed approach is illustrated against the background of solving metallurgical marketing problems.

60. G. Shvachyeh, I. Mamuzić, P. Shcherbyna

Modeling of the efficiency evaluation of information web-resources. When solving the problems of metallurgical marketing, special attention is paid to the problems of studying the evaluation of the effectiveness of information web resources. These studies are devoted to a comprehensive assessment of the effectiveness of web resources. A mathematical model for evaluating efficiency based on the use of regression multiple analysis is proposed. The selection of factors for the model is carried out in two stages. The first of them analyzes the use of certain variables that determine the patterns of development of the process under study. At the second stage, based on the selected factors, the mathematical model is refined, which is studied by the methods of statistical analysis. For research, the following factors were used: network congestion, data exchange speed, the number of visitors to the web resource, the number of new records on the resource under study. Studies have shown the adequacy of the proposed mathematical model.

61. I. Mamuzić, G. Shvachych, P. Shcherbyna

Research balancing system of interfaces for internet connections. Today, the problem of balancing network traffic in the global network is very relevant. This is explained by the fact that when choosing “high connection reliability”, network users usually work with several providers, with support for VPN technologies (both client and server), filtering services and protection against attacks, etc. In this case, the performance of network interface balancing plays an important role. MultiWAN-VPN gigabit routers were selected for balancing technology research. An important feature of such devices was the support of the balancing mode. Conducted experiments have shown that the use of several connections to providers with balancing modes gives the possibility of reserving connections and distributing traffic in accordance with the speeds specified in the WAN options. The effectiveness of the proposed approach is illustrated by a wide range of test studies.

62. I. Mamuzić, G. Shvachych, L. Sushko

Mathematical modeling of technical diagnostics of mechanisms. An algorithmic model of diagnostics, which gets complicated or simplified depending on the goals and operating conditions, is proposed to meet this purpose. The following characteristics of the signals were determined by means of a numerical experiment with the help of developed mathematical models: the dependence of the output signal of the measuring transducer on the operation of the gear teeth; informational signal about the breakage of one tooth; an information signal about the formation of a shell in a tooth; information signal about the formation of a crack; a signal that carries information about the beat of the gear shaft. The conducted experiments showed the effectiveness of the proposed approach.

63. S. Kordaszewski, M. Sadzikowski, G. Kiesiewicz, P. Kwaśniewski, P. Noga, W. Ściężor, K. Franczak, A. Kawecki

The influence of continuous casting and extrusion processes on the properties and structure of CuNi₂Si alloy and the morphology of the Ni-Si phase precipitates. CuNi₂Si alloys are widely used in various mechanical and electrical applications. These group of materials, due to the phenomena of precipitation hardening, are able to obtain high mechanical properties with also relatively high electrical properties. In the article authors compare two different types of products, made from the CW111C alloy i.e. rods which were continuously cast on the horizontal laboratory casting set-up (low degree of structure refinement) and rods commercially extruded with high degree of structure refinement. The presented results of experimental work characterize the tested materials in terms of their chemical composition, mechanical and electrical properties depending on the manufacturing process, as well as reveal their structures and the effect of heat treatment on the morphology of the Ni-Si precipitates.

64. I.O. Osypenko, I. Mamuzić, O.P. Bilyi

Refractory paints for molds and cores. Modern refractory paints for molds and cores, as a rule, contain a refractory material with a particle size of up to 50 microns. The presence of such materials in the paints prevents the occurrence of mechanical burn on the castings. At the same time, paints with refractory filler have many technological disadvantages. To avoid these shortcomings, refractory coatings without solid fillers are promising.

65. A.P. Bilyi, I. Mamuzić, T.V. Kimstach, S.I. Repyakh

Patterns of structural formation and properties of foundry bronze Cu-Al-Sn AND Cu-Al-Mn systems. Steady growth in world demand for bronze castings, in particular, for the automotive industry, will require new alloys with an unconventional combination of mechanical, tribomechanical, and corrosion properties in the near future. Therefore, the development of new bronzes, the improvement of existing ones and the development of new technological processes to produce castings are an urgent task of modern foundry production.

66. H.Brui, I. Mamuzić, O.Yankin, O. Kuchin

Control of spatial displacements of the berth metal elements. During the construction of berths, special attention must be paid to ensuring their reliability and safety. In order to avoid possible accidents, it is important to carry out observations that must meet the regulatory requirements for stability, strength, durability and environmental safety. Control over the indicators of the state of the elements of the berths, natural and man-made impacts, namely: the implementation of systematic observations and periodic surveys should be carried out constantly. Systematic control allows obtaining relevant information and developing the most effective and cost-effective solutions for assessing the reliability of berth elements and, if necessary, performing repair work. Based on the results of observations, conclusions are drawn about the operability of structures, after which decisions are made on the timely elimination of inconsistencies.

67. I. Mamuzić, M.Trehub, Yu.Trehub, Yu.Zabolotna

Evaluation of the efficiency of terrestrial laser scanning for geodetic monitoring of metallurgical enterprises. Today, laser terrestrial scanning is a rapidly developing technology that expands the possibilities of its use to most industries. Rapid deformation detection is an urgent task for industrial regions and specific enterprises. In this area, both high measurement speed and accuracy of the results are important. The purpose of this study is to evaluate the accuracy and efficiency of geodetic monitoring of industrial enterprises with a laser terrestrial scanner. The accuracy assessment criteria are the dependence of the mean square error of point cloud registration on the root mean square error of the laser scanning station positioning. The criteria for geodetic monitoring include measurement accuracy, observation time at the station, and point cloud density.

68. I. Mamuzić, O. Dmitrieva, Y. Babenko, V. Huskova

Development of the model of recognition of textual data using neural networks. This research is devoted to the justification, development and software implementation of the model of textual data recognition, based on the application of neural networks with hybrid architecture ConvBiGRU. The tasks of the work were to investigate the problem of text recognition, to determine the criteria for evaluating the quality of recognition, to design the architecture of the model and software application. Also, we trained the software model for text recognition, tested the software application and performed a comparative analysis of the recognition quality on other neural networks. The quality of the developed model was evaluated using the known validity metric. To compensate for possible imbalances in the samples, accuracy and completeness metrics were introduced in addition to the chosen metric. As an integrated development environment, the free cross-platform interactive environment for scientific calculations Spyder was used, running on the Anaconda platform.

69. K. Korzeń, P. Kwaśniewski, G. Kiesiewicz, B. Jurkiewicz, Sz. Kordaszewski, B. Babiarczyk, E. Bożek

Research on the threaded connection system from AlMgSi alloy for electrical power cables under various clamping loads. This article presents strain gauge tests showing the force loads in the connection system of power cables, with AlMgSi shear bolts. Among others, the analysis of the influence of the tightening torque of the clamping unit on the distribution of forces and the evaluation of the strain in the entire system was carried out. The knowledge of the force conditions and loads in the threaded connection system allowed to develop, with the use of FEM modelling, the optimal geometry and material of elements for the power cable connection system.

70. L. Rudolf, M. T. Roszak

Design review as element of quality planning process to eliminate nonconformities in technical project documentation. Compliance with technical documentation is a factor affecting the effectiveness of each project. Therefore, a “Design Review” process has been developed to eliminate inconsistencies that arise during product development and industrialization. The process was developed and implemented based on research conducted at Tenneco Automotive Eastern Europe in Gliwice as one of the quality planning instruments. The process defines in a structured way who and in what phase of the project is reviewing the project documentation and for which documents compliance with the client’s requirements should be checked. The process output is a structured description of the identified non-conformities, which is used to develop and implement corrective actions as part of the continuous improvement process at the process and product planning.

71. J. Kessler, K. Draganová, K. Semrád, M. Fiľko

Modification of the 3D Printer for the Processing of the High-Performance Thermoplastic Polymers in the Production Process of Transport System Components. Nowadays, the ability to process the high-performance thermoplastic polymers has been still the domain of the industrial 3D printers. This article describes the possibilities of the commercial 3D printer modification to achieve the required boundary conditions for the processing of the high-performance thermoplastics with adequate mechanical properties. These materials have a very high melting point, and it is inevitable to ensure this increased temperature in the entire print volume. Therefore, it was necessary to perform the numerical simulations focused mainly on the

thermal load of the 3D printer construction. Consequently, the simulation results were experimentally verified, and the optimal material in terms of its density and mechanical properties was selected.

72. J. Kessler, K. Semrád, K. Draganová, P. Kašper

Application and Mechanical Properties of Thermoplastic Polymers for the Additive Manufacturing of Transportation Systems. The gradual integration of the additive manufacturing into the common practice involves more complex requirements for the used materials. Although the additive manufacturing was mainly used for the rapid-prototyping purposes, with the development of the high-performance thermoplastic materials, the produced components can be applied not only in the laboratory conditions, but also in the real operation. Therefore, it is necessary to consider also the environmental influences that can significantly shorten the component lifetime. This article presents the 3D printing process for the selected thermoplastic polymers and the experimental verification of the strength analysis of the universal sensor holder together with the quantitative and qualitative comparison of their mechanical properties.

73. M. S. Chemerinskiy, S. A. Sirovii, I. Mamuzić

Production of carbonaceous raw materials from renewable sources. Carbonaceous materials are mostly made from minerals. The search and development of ways to obtain them from renewable sources is relevant. Then the work is devoted to the production of carbonaceous material from natural, renewable raw materials (wood, fallen leaves, tree bark) for the production of carbonaceous masses for self-igniting electrodes. The dried and ground material was carbonized at a temperature of 1000 °C and its electrical properties were studied. Based on the obtained data, they came to the conclusion that the carbon material has worse performance compared to the base fillers. Therefore, further work will be conducted to find measures to improve these properties.

74. I. V. Holub, N. G. Chekmarova, I. Mamuzić

Formation of material properties. In the production of refractories, clinker technology is used, which results in the formation of various spinels of the type $MgCr_2O_4$, $MgAl_2O_4$ and $MgFe_2O_4$. An important role in the production of refractories belongs to two spinels - $MgCr_2O_4$, $MgAl_2O_4$. The main disadvantage is poor sintering. This property degrades the strength and compaction of refractory products. Magnesite spinels and their solid solutions are among the main phases of refractories, and phase transformations in refractories during heating strongly affect their properties. The result of the calculations using a software package that reveals the phase and component composition of the thermodynamic system is that spinels change their chemical activity at a temperature of about 800 °C. The results of dilatometric measurements help to explain the anomalous behavior of spinels, which simplifies the analysis of the influence of the third component.

75. T. V. Hulyk, A. YU. Chaykovskiy, I. Mamuzić

Planning of the environmental management system at the enterprise. One of the methods of increasing the efficiency of environmental protection management is the implementation of environmental management systems at enterprises. Their implementation allows the enterprise to reduce environmental disturbances, reduce the probability of emergency situations, reduce non-production costs, and strengthen the enterprise's position on the market. Analysis of the environmental management system can be considered as a reporting measure; managers should actively participate in the analysis of the effectiveness of the environmental management system and look for opportunities to improve it. Analysis by management should be accompanied by the development of corrective and preventive measures aimed at achieving compliance with the requirements of regulatory documentation and improving the environmental management system.

76. J. Xue, Y. Gao, L. Y. Huang, T. Q. He

Study on drum load of shearer. The shearer cutting drum plays an important role in improving the mining efficiency of the coal mine. Starting from the basic theoretical mechanics, this paper analyzes the force on the shearer cutting drum of a certain model, establishes the mathematical model of the force on the cutting drum, sets the shearer calculation parameters, and calculates the load of the cutting tooth on the shearer cutting drum. Through the analysis, it is concluded that the three-way instantaneous load of the drum cutting tooth is irregularly distributed, and the axial force has sudden changes in magnitude and direction. The research content of this paper has certain guiding significance for the layout design of shearer drum and cutting tooth.

77. D. Y. Yang, Q. C. Peng, H. J. Liu, P. H. Wu, D. J. Tan, C. Xie

Design and optimization of oxygen lance for 210 T converter. In order to satisfy the requirements of modern steelmaking for high oxygen supply intensity and high efficient smelting, the oxygen lance of 210 t converter with different structures are simulated by numerical simulation. The effects of the number of nozzles, Mach number and inclination angle on the velocity distribution, coalescence behavior and the impact area of the jet are discussed. The results demonstrate that compared with the five-hole oxygen lance, the increase of the number of nozzles accelerates the attenuation of jet and increases the coalescence of jet. At the same inclination angle, the change of Mach number has almost no influence on the jet. At the same Mach number, the increase of inclination angle causes the range of impact increases and the strength of impact decreases. Based on effective impact area, the optimal oxygen lance is scheme 9

78. C.Y. Cai, X. Deng, M.G. Shen, X.Y. Qiao

Study on structural optimization of submerged nozzle of continuous casting mold by water model experiment. In this paper, by changing the shape of the inner wall of the nozzle, a water model experiment was carried out on the slab with the section of 200 / mm × 1 200 / mm. The results show that under the same immersion depth and the same angle, the improved No.1 nozzle and the improved No.2 nozzle have swirling flow, which reduced the dead region and the internal longitudinal flow velocity, and the swirl ratio generated in improved No. 2 nozzle is more obvious than improved No. 1 nozzle. The impact depth of the velocity at the outlet of the improved No.2 nozzle is obviously lower than that of the original nozzle and the improved No.1 nozzle.

79. M.F.A. Sabana, N. Muhayat, Triyono

Effect of the repair welding process on the microstructure and hardness of the t-joint S355J2+N steel. The purpose of this research is to determine effect of the repair welding process on the microstructure and hardness of the T-joint S355J2+N steel. This process was carried out by moving the welding position 10 mm from the initial position using Gas Metal Arc Welding (GMAW) with AWS ER-706S filler metal at a diameter of 1.2 mm. The result showed that the repair welding process causes changes in the microstructure due to repeated heating, thereby increasing the grain size of the microstructure with a decrease in hardness.

80. D. X. Gao, Y. J. Zhang, L. B. Wu, S. H. Liu

Adaptive neural command filtered fault-tolerant control for a twin roll inclined casting system. The essay studies the adaptive neural network fault tolerant control problem based on command filtering, which is aimed at twin-roll inclined casting system (TRICS). A command filter adaptive neural fault-tolerant control scheme for compensating actuator faults is come forward, and meanwhile, the compensating signal is designed to the error of the compensation filter due to the effect of virtual control. Furthermore, the application of Lyapunov stability theory have proved that all the signals in the closed loop system possessed the property of being bounded and stable. Finally, the effectiveness of the control scheme can be verified by means of simulation example.

81. I. Stepankin, D. Kuis, E. Pozdnyakov, A. Naizabekov, S. Lezhnev, E. Panin

Wear of 16MnCrS5 steel surface layers in the pulsing contact loads. Approaches to actualizing the use of modern alloy steels that are in demand in the Eurasian technological space are proposed. According to the criterion of resistance to contact fatigue, quantitative indicators of wear of the surface-hardened layers of steel 16MnCrS5 were revealed. With the contact stress amplitude up to 950 MPa, the composite material of carbonized and nitro-cemented layers is characterized by a period of high resistance with minimal manifestations of structural hardening by the mechanism of softening of the material. The obtained composite material with carbonized and nitro-cemented layers is characterized by a period of high resistance up to 15 000 cycles.

82. A.A. Ultarakova, A.M. Yessengazyev, N.G. Lokhova, Z.B. Karshyga, K.K. Kassymzhanov

Study of acid leaching of niobium from titanium production sludge. This article contains the results of acid leaching of titanium production sludge for the extraction of niobium into the solution. The material composition of sludge deposits from titanium-magnesium production was studied by methods of chemical, X-ray and electron-probe analysis. Studies of the sludge phase composition of the collector sludge showed that niobium was bonded mainly with aluminum and titanium. Electron-probe analysis showed that niobium in the form of fine grains is concentrated around the titanium particles. Agitation leaching was performed by two stages within a wide range of changing process parameters. The optimal leaching parameters were 4 %

hydrochloric acid (HCl), S:L = 1:10; $t=25\text{ }^{\circ}\text{C}$, agitation time 2 hours at the first stage. Optimal conditions for the second leaching stage were 20 % HCl, S:L = 1:5, $t=25\text{ }^{\circ}\text{C}$, agitation time of 2 hours.

83. A.Sh. Syzdykova, V.M. Yurov, A.D. Mekhtiyev, A.D. Alkina

Formation of the structure and properties of multi-element ion-plasma coatings. The article presents the results of the studies related to the development of hardening, antifriction, heat-resistant, corrosion-resistant coatings. There have been considered the models of concentration supercooling associated with the presence of a radial concentration gradient of metal nitride impurity; Benard cells, the occurrence of which is caused by the presence of a vertical temperature gradient; a cellular dislocation structure associated with the presence of plastic deformations in the coating; the emergence of auto-waves in the most diverse environments, including living beings. From the studies presented in the work, it follows that self-organization of forming coatings can occur only under conditions of a large value of the surface energy.

84. G. Pačarek, T. Šolić, I. Vidaković, M. Samardžić

Protective effects of vapour phase corrosion inhibitors tested in laboratory conditions. This research investigates protective effects of vapour phase corrosion inhibitors (VpCI) tested in laboratory conditions. Such tests are required to control the production quality and to provide for high-quality protection of products during exploitation. There are three different tests run to obtain results on effectiveness of protective effect of VpCIs (Razor Blade Test, Water Drop Test and VIA Test). Each test differs in its defined performance procedure, as well as in evaluation of the obtained results, yet all three tests confirmed that vapour phase corrosion inhibitors provide adequate protection of the material exposed to an aggressive atmosphere. Therefore, it is justified to use vapour corrosion inhibitors as a protection mechanism when designing surface protection technology.

85. R. Poloczek, B. Oleksiak

Modeling and simulating production processes with the use of the flexsim method. The steel industry is committed to integrating digital concepts into its production and organization to be more competitive in the context of globalization. Approaches to optimizing simulations have been developed in the steel sector. In this article, a model was built and a simulation was carried out using the FlexSim program. The simulation made it possible to identify weak points in the production process of galvanized profiles, which will enable the introduction of corrective actions that will eliminate emerging discrepancies in the future. Therefore, the proposed model can reliably simulate the behavior of multi-process operations in the steelmaking process.

86. M.T. Wang, Y.X. Chen, L. Gao

Study on laser surface micro-treatment of stainless steel. Laser surface micro-treatment refers to the use of appropriate laser energy to induce the surrounding gas and stainless steel reaction to produce a film or the use of large laser energy to manufacture micrometer grating. Using the principle of thin film interference or grating diffraction, the surface of stainless steel is marked with color, which can be used for information storage of metallurgical products. The relationship between laser line scanning and laser power is studied experimentally, the range of laser power density with color variation is obtained, and the optimal process parameters of uniform color are obtained.

87. V.M. Shevko, A.D. Badikova, R.A. Uteeva

Interaction of tricalcium phosphate with products of carbothermic reduction of silicon oxide. The article presents the research results on the interaction of tricalcium phosphate with the products of carbothermic reduction of silicon oxide (SiO_g , SiC, iron silicides). The research was carried out by computer thermodynamic modeling using the HSC-6.0 software package. It was established that SiO_g , Si, and SiC are highly reactive towards tricalcium phosphate at relatively low temperatures. It was found that, according to the formation degree of gaseous phosphorus from $\text{Ca}_3(\text{PO}_4)_2$, silicon-containing reducing agents form a decreasing series: $(\text{SiO}_g, \text{Si}) > \text{SiC} > \text{FeSi}_2 > \text{FeSi}$.

88. L. B. Li, J. B. Zheng, X. D. Shu, J. Zhang, W.W. Shen

Study on cold spinning deformation behavior and load mechanism of conical thin-walled aluminum alloy parts. Aiming at the problem that the wall thickness uniformity of conical thin-walled aluminum alloy parts formed by single-pass spinning is difficult to control, this paper systematically studies the influence of different spinning parameters on the material evolution law and load mechanism during the forming process of 1070 thin-walled aluminum alloy. The effects of slab thickness, roller gap and feed ratio on the macroscopic forming quality and mechanical load of 1070 thin-walled aluminum alloy conical parts were simulated by Simufact.forming software. Finally, the optimal spinning parameters of 1070 thin-walled aluminum alloy conical parts were obtained. The final results show that increasing the diameter-thickness ratio of the blank can prevent wrinkling, and reasonable spinning parameters can improve the uniformity of the wall thickness of the product.

89. A. Dziubinska

Numerical analysis of forging a connector for light vehicles from cast magnesium alloy preforms. The article presents the results of numerical analysis of the new forging process of the connector forging from cast preform on hydraulic press. The high strength ZK60 alloy (belonging to the Mg-Zn-Zr group of Mg alloys) was selected to numerical tests. Currently, this part in the industry is produced by multi-stage forging consisting of operations: bending, pre-forming, and finishing. The use of the cast preform would enable forging this component in one operation. However, obtaining specific mechanical properties requires inducing a certain level of strain within the forged part. Therefore, the design of the preform, its shape and volume, is of paramount importance. In the work presented in this article, preforms of different shapes were designed and assessed using Finite Element Method (FEM) analysis.

90. Suwarto, Merpatih, S. Petrus, Wajilan, A. Wahyudianto, A. Fernandes

Keruing (dipterocarpus grandiflorus) oleoresin as aluminum 1100 corrosion inhibitor in 3,5 % NaCl solution. Aluminum and its alloy corrosion inhibition have been important technological subjects due to the increasing application of the material. The corrosion inhibition of aluminum 1100 by Keruing (Dipterocarpus grandiflorus) oleoresin in 3,5 % NaCl solution was investigated using the galvanostatic polarization technique. Aluminum 1100, which had been dissolved in diesel fuel with a concentration of 0 %, 25 %, 50 %, 75 %, and 100 %, was immersed in Keruing oleoresin solution. The results showed that the efficiency of inhibition increases along with the increase of Keruing Oleoresin concentrations. Aluminum 1100 Keruing oleoresin coated with 50 % concentration in diesel fuel had 0,083 MPY corrosion rate, 99,74 % corrosion inhibitor efficiency. Keruing oleoresin can potentially be used as corrosion inhibitor that can be applied to aluminum in coastal areas.

91. Ye.P. Chsherbakova, A.M. Dostaeva, Kulikov V.Yu., Sv.S. Kvon, Alina A.A.

Studying the properties and structure of antifriction cast iron additionally alloyed with titanium. This article presents data on the study of the properties and structure of antifriction cast iron additionally alloyed with titanium. On the basis of experimental data favorable effect of titanium micro-alloying in an amount of 0,25 % on the performance properties of antifriction gray cast iron AChS-2 is shown: sliding factor increases almost 1,5 times, shape, and size of craters after shock-cycling impact are improved. This improvement in properties suggests an increase in structural strength and service life of parts made of the experimental alloy. The alloy was smelted in an industrial furnace.

92. J. Cumin, D. Novoselović, M. Samardžić, Iva Samardžić

Statistical analysis of different mathematical models for stress-strain curves of AISI 321 stainless steel. This paper presents statistical analysis of data obtained by uniaxial tensile testing of AISI 321 stainless steel. This data is required as material input in numerical software, such as Abaqus, Ansys, MSC Marc, Nastran, etc. This data can be provided in the software as a set of points (piecewise linear model) that is cumbersome to enter, or it can be provided as a mathematical model, in the case of which the Finite Element Method (FEM) software calculates desired points directly from the mathematical model. Various mathematical models can be used to approximate tensile test data depending on the material loading state (linear, elasto-plastic, plastic). In this paper, the same uniaxial test data is analyzed, and curve fitting parameters are shown for each mathematical model.

93. D. Kolacz, W. Gluchowski, Z. Rdzawski, M. Łagoda, M. Maleta, K. Krukowski, M. Drajewicz

The effect of the rolling process on selected properties of magnesium copper with microadditives. The article presents the results of rolling magnesium copper castings with microadditives of P, Al, Ti, and Zr. The castings were made in the process of static casting into rods with a diameter of 20 mm. The obtained castings were shaped with a 3 % draft into bars of square cross-section and rolled on a shape mill with 20 % drafts on average. Mechanical properties were determined in a static tensile test at selected degrees of plastic deformation (57,2 %, 76,9 % and 91,3 %). At the final stage of

cold working of the wire rods with a total draft of 91,3 %, the microstructure and electrical conductivity were examined. The research indicates a strong influence of microadditives on the strengthening of castings in the rolling process and their electrical conductivity.

94. S.K. Arinova, Sv.S Kvon, D.R. Aubakirov, T.V. Kovaleva, D.A. Issagulova

Investigation of heat-resistant properties and microstructure of experimental steel based on the Cr-Ni-Ti-Nb system obtained under industrial conditions. The Nb effect on long-term strength of Cr18Ni10Ti steel is considered. There is substantiated selecting this steel for obtaining cast parts for metallurgical furnaces. It is shown that introduction of Nb in the amount of 1 % into steel of a given composition increases tensile strength and long-term strength by 15 %. Improving the properties is associated with the formation of NbC carbides.

95. A. Kawecki, E. Sieja-Smaga, A. Mamala, P. Kwaśniewski, G. Kiesiewicz, B. Smyrak, W. Ścieżor

Manufacturing and properties of cast Cu-Ag alloys designed for electrotechnical applications. The results of the current paper present the research concerning the obtaining of Cu-Ag alloys with wt. % of silver ranging between 5 and 20 % using continuous casting process. The process parameters have been introduced. Selected results regarding physical and mechanical properties of the casts have been discussed. Strength coefficients describing the plastic deformation range of the Cu-Ag alloys have been calculated using Hollomon's equation. Additionally, in order to determine the influence of the temperature with differential scanning calorimeter (DSC) on the electrical resistance, the values of temperature coefficients of resistance have been determined for all of the tested alloys.

96. D.R. Gizatullina, M.A. Akubaeva, A.M. Zhunussov, A.M. Makasheva

About the use of R-66 reagent in the technology of flotation enrichment of mixed copper. The paper presents laboratory and pilot flotation tests of the R-66 reagent on samples of mixed copper ore from the Konyrat deposit. The medium regulator reagent was supplied to the main flotation. Laboratory tests of the technology of flotation concentration on ore with a copper content of 0,31 % in a closed cycle in the optimal mode: R-66 - 100 g/t, sodium sulfide - 150 g/t, xanthate - 45 g/t, blowing agent - 60 g/t allows to extract copper into concentrate up to 85 %. At the same time, the copper content in the concentrate after two cleanings was reached at the level of 4,5 %, sulfur 42,3 %. At the same time, the R-66 reagent (100 g/t) makes it possible to completely eliminate the use of lime (1 000 g/t) in the ore dressing scheme.

97. M. Maleta, W. Gluchowski, Z. Rdzawski, M. Łagoda, J. Domagała-Dubiel

Influence of the speed of downward semi-continuous casting on the crystal size and mechanical properties of recycled copper. In this study, the influence of the speed of downward semi-continuous casting on the crystal size and mechanical properties of recycled copper after casting and cold deformation was investigated. It was shown that the increase in the casting speed from 0,09 m / min to 0,22 m / min resulted in refinement of the macrostructure and reduction of the crystal cross-sectional area from 3,221 mm² to 1,2 mm², which resulted in an increase in microhardness after casting by 8 %, while in the state after cold working, an increase in microhardness by 3 % and ultimate tensile strength by 2,5 %.

98. G. L. Tan, D. Tang, L. L. Guo, Q. Q. Zhang, F. D. Wang

Kinetics analysis of solidification process of 1035 steel at different cooling rates. It is of great theoretical significance to study the solidification kinetics of metal materials for improving the microstructure and properties. In this paper, the Differential Scanning Calorimetry (DSC) was used to measure the enthalpy change of solidification process of 1035 steel at different cooling rates. The activation energy of the solidification process was determined by the equal conversion method based on the data of enthalpy. The mechanism function of the solidification process was also determined. It is shown that the value of the activation energy of solidification process varied with the solidification fraction, and the mechanism functions of solidification process are different in different temperature ranges, which are $-\ln(1-\alpha)$ for 1 504-1 502 °C $-\ln(1-\alpha)^{1/2}$ for 1 500-1 942 °C and $-\ln(1-\alpha)^{2/5}$ for $\leq 1 490$ °C respectively.

99. J. Boryca, C. Kolmasiak, T. Wyleciał, D. Urbaniak

Effect of heating technology on scale adhesion in the steel charge heating process. The adhesion of scale to the steel substrate is an important parameter in the charge heating process before plastic processing. A low value of adhesion adversely affects the operation of heating furnaces, while too high value causes the scale to roll into a steel product and deteriorate its purity and quality. The paper presents the methodology of adhesion determination and the results obtained on the basis of the presented methodology. The influence of heating technology on adhesion for constant furnace efficiency and different values of excess air ratio is discussed. The furnace efficiency and the excess air ratio are the basic parameters of the process. It is extremely important in the context of the challenges of optimizing production processes, which in turn is an important element of the circular economy.

100. G. X. Liu, Z. S. Zhang, Y. Huang, Y. W. Bai, J. W. Zhang

Simulation study of cold steel feeding in steel die casting. To solve the problem of slow solidification of large ingots and the difficulty of eliminating internal shrinkage, a cold steel bar was fed into the molten steel during the solidification process after the completion of casting to affect the solidification process. Different cooling and solidification schemes for 60-ton 16-angle ingots were simulated by the finite element simulation software PROCAST. The simulation results show that the insertion of cold steel rods can shorten the full solidification time of the ingot. It is beneficial to improve the concentrated shrinkage in the central region under the conventional cooling scheme; in terms of the cold steel addition method, the decentralized addition of cold steel is more effective in improving the internal quality of the ingot.

101. C. D. Wu, D. L. Guo, C. J. Wang, Y. L. Wang, M. W. He, J. L. Zhang, H. C. Ji

Deformation analysis of running electric hoist. According to the practical engineering application, three-dimensional modeling of electric hoist and I-beam track is carried out, and the model is simplified to determine the electric hoist load, roller acceleration and speed, and the Abaqus software is used to simulate, analyze the simulation results, observe the actual maximum load under the track stress and strain to meet the requirements, calculate the allowable stress, Observe whether it exceeds the allowable stress and whether plastic deformation occurs. If the numerical simulation results of stress and strain are within the safety requirements, the project can be implemented.

102. J. Lulkiewicz, A. Kawalek, B. Pachutko, T. Bajor, S. Szkudelski

Microstructure and mechanical properties of forged and rolled rings made from X20Cr13 steel. The article describes the results of microstructure and mechanical properties tests (according to PN-EN ISO 6892-1:2016-09 and PN-EN ISO 6507-1:2007), which were obtained on specimens taken from a fragment of a ring rolled in the temperature range from 1 220 °C to 950 °C, with dimensions $\varnothing 965/803 \times 164$ mm, annealed and heat-treated: quenching at the temperature of $1 030 \pm 10$ °C in oil and tempering at a temperature of 650 °C. The starting material for rolling was a forging with an opening of $\varnothing 560/230 \times 180$ mm. Comparative hardness tests were also performed on specimens taken from the ring after rolling and softening annealing. The R_m , $R_{p0.2}$ and A indices of the ring fragment after heat treatment, as assumed, were respectively: 942 MPa, 763 MPa and 17 %.

103. L. Zhang, S. Cai, C. Han, S. P. Ji, B. Wu, H.C. Ji

Study on atmospheric corrosion behaviour and mechanism of Q235 steel after passivation. Q235 steel components have poor corrosion resistance and are susceptible to erosion by corrosive media, so they are generally passivated before being put into service. This paper investigates the corrosion behaviour and corrosion mechanism of passivated Q235 steel in atmospheric environments through macro and micro morphological characterisation and electrochemical simulation analysis.