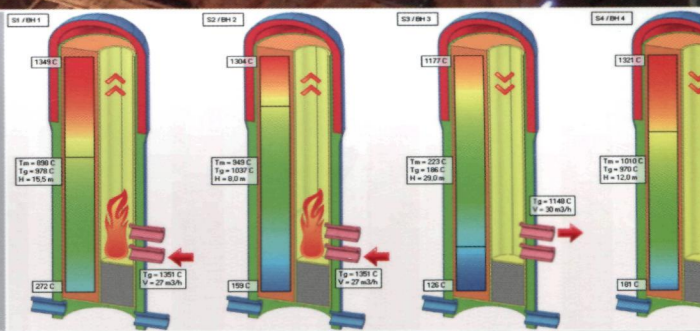
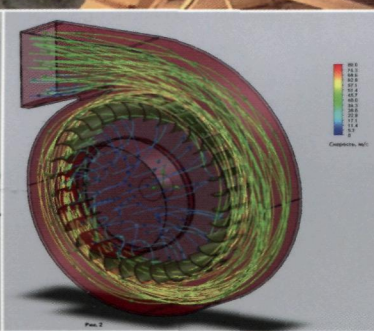
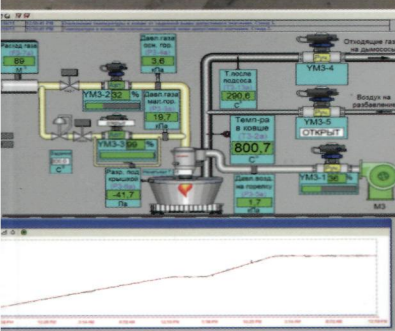


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# СТАЛЬ



**НИИ металлургической теплотехники**  
**ОАО «ВНИИМТ» – 85 лет!**  
 Импортозамещение, энергоэффективные технологии для металлургии и машиностроения

系2x4150m 高炉圆盖法冶金熔渣粒化项目



РЕКЛАМА

## 3/2015

Москва • ООО «Интермет Инжиниринг»



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## ABSTRACTS

UDC 621.783:061.6

**The Research Institute of Metallurgical Thermotechnics (OJSC «VNIIMT») Celebrates Its 85th Anniversary**

Zainullin L. A., Druzhinin Gh. M. // *Stal'*. 2015. No. 3. P. 2 – 6.  
Summarizes the development of the research institute of metallurgical heat engineering «JSC VNIIMT», which celebrates its 85th anniversary. The basic directions of activity of the institute at the present stage.

**Key words:** design, modernization, thermal processes, gas dynamics, combustion, granulation, heating and thermal furnaces, burners.

UDC 622.7:669.1

**Peculiarities of Piro-, Hydrometallurgical Techniques of Dephosphorizing Brown Iron Ore of the Lisakovsky Deposit**

Karelin V. Gh., Zainullin L. A., Epishin A. Yu., Artov D. A. // *Stal'*. 2015. No. 3. P. 8 – 11.

The work package has been performed on investigation of peculiarities of roasting and subsequent leaching of phosphorus from Lisakovsky concentrate with weak sulphuric acid. It is determined that the phosphorus from Lisakovsky concentrate is in the form of hydrated phosphorus-containing component which is decomposed when being roasted and free phosphorus oxide is formed. The efficiency of phosphorus leaching from the roasted concentrate depends on several conditions: sulphuric acid concentration, solid/liquid ratio, pulp temperature and the speed of pulp mixing. As a result the described technique allows obtaining of the content of residual phosphorus in the leached Lisakovsky concentrate at the level of 0,15 – 0,18 %.

**Key words:** phosphorus, concentrate, roasting, leaching.

UDC 622.788

**Optimization of Performance of the Exhauster Tract of the Roasting Machine OK-108 of the JSC Sokolovsko-Sarbaisky Producing Association for Increasing Pellets Output**

Butkarev A. A., Butkarev A. P., Ascheulov V. N., Zhomiruk P. A., Lazebnaya Yu. P. // *Stal'*. 2015. No. 3. P. 12 – 15.

JSC VNIIMT and JSC SSGPO have upgraded traveling grate pelletizing plant OK-108 number 12. As a result of modernization increased productivity of the traveling grate pelletizing plant by 6 – 8 t/h (6,7 – 8,9%) and decreased specific energy consumption by 5 kW · h/t. The main technical solution was the modernization exhauster H-7700 tract, including its replacement by exhauster GD 26 × 2, battery cyclones in the group cyclone type CN-24-2000-12 and flues tract.

**Key words:** traveling grate pelletizing plant, heat scheme optimization, iron ore pellets.

UDC 622.78.8

**Development and Implementation of the Ignition Hearth of the Sintering Machine**

Vintovkin A. A., Chistopolov V. A., Chistopolov A. V., Dengub V. V. // *Stal'*. 2015. No. 3. P. 16 – 19.

The results of development, production and operating experience of new ignition furnace sintering machine design is shown. Furnace is lined with fibrous material, and does not require drying and heating costs. Furnace is equipped with automated apex panel burners with burner stone, assembling which does not require access into the working volume.

**Key words:** fiery furnace, heating system, burner, ignition, the flame control.

UDC 622.785.5.004.18

**Heating of Sinter Burden on the Band As a Means of Reduction in Fuel Consumption and Fines Content in Sinter**

Gerasimov L. K., Druzhinin Gh. M., Khammatov I. M., Spirin N. A. // *Stal'*. 2015. No. 3. P. 20 – 24.

Research data impact on assessment heating sinter mix on sintering strand before ignition on the performance of the sinter machine in 4 modes: 2 basic ones with different composition of fluxes and 2 experimental ones presented in the article. The gas supply to the burners of the ignition furnace was canceled or reduced in the test mode. The studies found that heating the charge on the tape before

ignition, realized by reducing the sintering area of sinter, contributed to the intensification of the combustion of solid fuels in the layer. Sintering rate increased at the same time, consumption of solid and gaseous fuels and the fines content in the agglomerate decreased.

**Key words:** sinter machine, sinter, combustion, ignition hearth, ignition, heating, layer, fuel, mixture.

UDC 622.785.4.004.68

**Experience of Carrying Out Upgrading of «Midrex» Metallization Plants at the Oskolsky Electrometallurgical Works**

Mekhryakov D. V., Greznev V. Gh., Maley I. V., Petrov S. V., Fakhruddinov M. Ya. // *Stal'*. 2015. No. 3. P. 25 – 27.

Experience metallization systems modernization at OEMK showed the effectiveness of the strategic partnership pelletizing plant and metallization with MIDREX and VNIIMT for the implementation of tasks to improve performance and optimize the process of metallization. As a result, the performance of the activities undertaken plating plants increased by 15 – 20% (for DRI module № 1 increase of 45 – 50%), the specific consumption of natural gas decreased by 7,5%.

**Key words:** steel smelting (electric arc furnace (EAF) shop), production of metallized pellets (DRI), DRI module, the Midrex® Process, iron ore raw materials, basic engineering.

UDC 669.162.23

**Increase in Hot Blast Temperature of the Hot Blast Stoves by Introducing Optimal Control System**

Butkarev A. A., Butkarev A. P., Ptichnikov A. Gh., Tumanov V. P. // *Stal'*. 2015. No. 3. P. 28 – 34.

The results of the heat research of the hot blast stoves of the blast furnace number 1, the volume of 2038 m<sup>3</sup> of Chelyabinsk Metallurgical Plant confirmed the possibility of increasing the temperature of the hot blast of not less than by 30 – 40 °C due to the introduction of VNIIMT optimal control subsystem. The annual economic effect only by saving coke reaches 75 million RUB.

**Key words:** hot blast stove, optimal control system, mathematical model, algorithm, optimization, heat research.

UDC 669.162.28

**Experience of Implementation of Plants of Near a Furnace Slag Granulation by the OJSC «VNIIMT» Techniques in the Blast Furnaces of the Volume of 1260 and 4150 m<sup>3</sup> in the PRC**

Zainullin L. A., Mekhryakov D. V., Greznev V. Gh., Kai Ch. // *Stal'*. 2015. No. 3. P. 35 – 38.

Experience of implementing systems granulated blast furnace slag in the People's Republic of China has shown high performance technology VNIIMT. Achieve a given performance and process optimization is possible only with the direct participation of technology developers in the process of commissioning works.

**Key words:** blast furnace, slag granulation plant, blast-furnace slag, basic engineering.

UDC 669.162.266.242.004.68

**Experience of Upgrading Drying Stands for Lining Hot Metal Ladles**

Ryazanov V. T., Khokhlov V. A., Shulghin S. S., Oganessian Yu. M. // *Stal'*. 2015. No. 3. P. 39 – 41.

The technical rearmament of drying stands for hot iron ladles with pumped quartzite lining has allowed automatic drying on firmly set schedules ensuring highly uniform heating of the lining surface across the ladle cross-section and height. The service life of lining has been increased twofold, with gas usage per drying cycle reduced by a factor of five.

**Key words:** hot iron ladle; ladle drying stand; ladle lining; gas-burner; automation.

UDC 621.74.047.001.57:546.3-19

**Simulating the Influence of Gas Impulse and Vibration Impacts upon Formation of the Concast Strand**

Eldarkhanov A. S., Nuradinov A. S., Akhtaev S. S-S. // *Stal'*. 2015. No. 3. P. 42 – 45.

An influence of vibration and gas-impulsive mixing of melt on hydrodynamic forming process of bloom continuous-cast bar was studied by method of physics observation. It was established methods intensify hydrodynamic processes in mold and secondary-cooling zone there by its steps up processes of heat- and mass-exchanging in these zone.

**Key words:** melt, forming, continuous-cast bar, hydrodynamic processes, vibration, gas-impulsive stirring.

UDC 662.813:669.168

#### **Experience of Manufacture and Application of Brown Coal Coke**

##### **Briquettes in Ferroalloys Production**

Vorobiev V. P., Orlov P. P., Islamov S. R., Stepanov S. Gh. // *Stal'*. 2015. No. 3. P. 47 – 51.

The article discusses the theory and practice of making and using briquettes on the basis of medium temperature coke (Thermocoke) of brown coal deposits Berezovsky 2B (hereinafter – briquettes BTK) technology ferroalloys. An analysis of the advantages and disadvantages of the new material in comparison with coke. Steam coal grades B2 – B3 – Kansk-Achinsk coal basin are the matter of interest not only as fuel but also as raw material in the effective carbon reductants production for metallurgical processes. The theoretical and practical issues of briquettes produced on the basis of medium temperature coke (thermocoke) from brown coal B2 from Berezovsky mining field (further – BTC briquettes) production and use in ferroalloy technology are considered in the article. The analysis of advantages and disadvantages of a new material in comparison with metallurgical cokes is given.

**Key words:** coke, coal, thermocoke, reduction, silicon, chromium, ferroalloy furnace, gas evolution, ferroalloys.

UDC 621.771.016.2

#### **Development of Non-Destructive Rolling Regimes of the Steelgrade 08nc with a Low Mn/S Ratio**

Kolbasnikov N. Gh., Mishin V. V., Shishov I. A., Matveev M. A., Glukhov P. A., Mitrofanov A. V. // *Stal'*. 2015. No. 3. P. 52 – 59.

Integrated approach, based on a mathematical and physical simulation combination, was offered to hot ductility investigation and non-destructive hot rolling schedules development. Mathematical simulation of continuous cast billet hot rolling was carried in Deform-3D program. Physical simulation of metal thermomechanical treatment was made by Gleeble-3800. The proposed integrated approach was allowed establish the conditions to achieve maximum metal plasticity in edge areas. Developed rolling schedules successfully realized and introduced on industrial environments.

**Key words:** hot ductility, hot rolling, physical simulation, mathematical simulation, fracture criterion.

UDC 621.774.39.001.57

#### **Research into Form Changing in Pipes' Ends Heading**

Erapalov M. V., Bogatov A. A., Systertov S. V., Kulemin Yu. B. // *Stal'*. 2015. No. 3. P. 60 – 63.

The paper discusses the features of the pipe ends upsetting process on hydraulic press SMS Meer. Using the finite element method metal forming is studied and the most possible locations of defects are identified: flash on the pipe end and cavities on the inner surface of upset in the area of the die conical rib and near the pipe end. Technical proposals to reduce the rejection have contributed to the quality improvement and successful development of the drill pipe ends upsetting technology in one conversion by way of example PN73 × 9,2 mm according to GOST R 50278-92.

**Key words:** tubing, drill pipe, upsetting of pipe ends, metal forming, finite element method.

UDC 669.162:666.92

#### **Experience of Technical Reequipping and Mastering of the Regimes of the PFR Shaft Furnace for Limestone Roasting**

Madison V. V., Ryazanov V. T., Nabokikh A. A., Shulghin S. S., Kiner I. V., Kudryavtsev A. N. // *Stal'*. 2015. No. 3. P. 64 – 70.

The study of burning conditions in a PFR lime shaft kiln after its re-equipment has shown the possibility of a sufficiently effective burning of limestone possessing quality and strength characteristics which are lower than those specified by the kiln manufacturer. The produced

soft-burnt lime has CaO + MgO activity of at least 92 – 94% and natural gas burning rate varying from 105 to 115 m<sup>3</sup> per ton of lime depending on the type of lime and productivity.

**Key words:** lime production, PFR- lime shaft furnace, technical re-equipment, start-up burner, firing conditions.

UDC 621.783

#### **Thermal Furnace with a Combined System of Heating**

Druzhinin Gh. M., Ashikhmin A. A., Maslov P. V., Popov A. B., Loshkarev N. B., Galkin S. A. // *Stal'*. 2015. No. 3. P. 70 – 74.

The description of complex reconstruction of the thermal chamber furnace with rolling hearth for heat treatment of welded metalwork is provided then. The main heating system with a twelve high-speed recuperative burners is added with the system of recirculation of heating flue gases that provides uniformity of a temperature field of the furnace with accuracy no more than ± 10 °C. Results of commissioning and regime and adjustment tests of the furnace are given.

**Key words:** heat-treatment furnace, heating system, recuperative burner, regime and adjustment tests, uniformity of heating.

UDC 621.3.036.662

#### **Creation of Furnace Electric Heaters with Radiation-Convective Way of Heat Exchange**

Zainullin L. A., Kalganov M. V., Kalganov D. V., Loshkarev N. B., Fatkhutdinov A. R., Pughin A. I. // *Stal'*. 2015. No. 3. P. 75 – 77.

Electric heaters are designed and manufactured with the radiative-convective heat transfer process between the heating elements and the walls of the enclosure. During researches in industrial conditions it was shown that a way of an intensification of heat removal from electrospirals due to blowing by their stream of the heat carrier by means of the high temperature circulating fan raised service life of heaters for 30 – 50%. The tight case of heaters allows to use them in furnaces with the protective or aggressive atmosphere.

**Key words:** electric heater, heating convection furnace, radiation-convective heat transfer.

UDC 62-784.23:697.982

#### **Application of Centrifugal Ventilators in Performance of the Thermal Convective Furnace in the Cooling Regime**

Zainullin L. A., Spirin N. A., Kalganov M. V., Kalganov D. V. // *Stal'*. 2015. No. 3. P. 78 – 80.

The scheme of the convective circulation furnace with a full cycle of heat exchange for heat treatment of elongated shape products, operating in the mode of periodic change the direction of flow to the opposite. To intensify the process of cooling products through effective supply and remove the coolant from the working area such furnaces used reversing flow devices, consisting of two centrifugal fans, one of which operates on a aerodynamic locking device. Shows the experimental control characteristics reversing flow devices assembled on the basis of various types of centrifugal fans. The data obtained can be used in the development of convection furnaces circulating of heat exchange with the full cycle.

**Key words:** heating convection furnace, reversing flow device, centrifugal fan, aerodynamic locking device.

UDC 62-784.23.697.982

#### **Furnace of Thermal Degreasing of Fiberglass Mesh Equipped with Radiation-Convective Electric Heaters**

Zainullin L. A., Kalganov M. V., Kalganov D. V., Spirin N. A., Dziubailo R. V., Li V. A. // *Stal'*. 2015. No. 3. P. 80 – 82.

The furnace of thermal degreasing of a cloth of fiberglass is put into operation. This furnace is equipped with electric heaters with radiation-convective type of heat exchange. Capacity of the furnace and quality of products is provided at the expense of an intensification of process of convective heat exchange by means of the circulating high-temperature fan. Use of the saved heat in the camera of heating of the furnace allowed to raise three times a thermal heat flux on processed to a load in comparison with the existing thermal power of heaters. It allowed to increase at 1,2 – 1,5 time furnace capacity in comparison with the decisions existing earlier. Use of electric heaters with the tight case significantly reduced probability of an exit them out of operation thanks to lack of influence of the aggressive furnace atmosphere. The developed

technology can be used in furnaces for heat treatment of materials in protective and aggressive atmosphere.

**Key words:** fiberglass mesh thermal degreasing furnace, radiation-convective heaters, high temperature fans.

UDC 621.78.084

**Jet Water Cooling in Thermal Hardening of Rolled Stock of Non-Symmetrical Section**

Lipunov Yu. I., Eismond K. Yu., Nekrasova E. V., Zakharchenko M. V., Yaroshenko Yu. Gh., Abramov E. V. // *Stal'*. 2015. No. 3. P. 83 – 87.

An advanced water jet cooling technique for rolled metal with irregular shape, replacing the traditional one – oil quenching, is presented. The technique was validated by the test bench experiments and implemented in industry. Using the water jet thermostrengthening it is possible to ensure autotempering optimum temperature by adjusting the length of the cooling. It allows receiving the metal structure that provides high mechanical properties and service characteristics of metal.

**Key words:** thermostrengthening, controlled cooling device, oil quenching, joint bar (fishplate), mechanical properties.

UDC 621.783.223.2

**Automatic Facility for Thermal Processing**

Ashikhmin A. A., Druzhinin Gh. M., Popov A. B., Khammatov I. M., Chistopolov V. A., Loshkarev N. B. // *Stal'*. 2015. No. 3. P. 87 – 89.

In many engineering and metallurgical enterprises there is a need in the heat treatment of small parties, and sometimes individual products for different purposes. JSC «VNIIMT» has developed a fully automated plant for heat treatment up to 500 kg of steel products of various shapes.

The unit is designed for manufacturing operations heating, hardening or normalizing and tempering or austenitizing products from different steel grades.

**Key words:** heat treatment, automation, austenitizing, annealing, tempering, heating furnace.

UDC 669.15.018.58

**Anomalous Alteration of Magnetic Parameters of Alloy of the System Fe – Ni – Si – B in an Amorphous Condition**

Kornienkov B. A., Libman M. A., Molotilov B. V., Kadyshv D. I. // *Stal'*. 2015. No. 3. P. 90 – 91.

The effect of annealing, performed in the amorphous state, of magnetic properties of amorphous Fe–Ni–Si–B alloys has been studied. After annealing, the samples were cooled on air under external magnetic field or external elastic stress. It has been shown, that the dependence of saturation magnetization on the annealing time is very complex, if the samples were cooled under external stress, and in the same time the Curie temperature is also dependent on the annealing time, but this dependent is not brightly pronounced. Simultaneously, modification of the coercive force of material with annealing time was not detected (up to the moment of crystallization start). The obtained results are discussed considering cluster structure of the amorphous alloy and assuming the dependence of magnetic moment on the size of the cluster.

**Key words:** amorphous alloys, saturation magnetization, Curie temperature, coercive force, cluster, magnetic domain boundary.

UDC 621.771.26.06-52

**Development of a Technological Information System of the Universal Rail-and-Structural Rolling Mill**

Shpak D. Gh. // *Stal'*. 2015. No. 3. P. 92 – 94.

There was worked out and implemented «Universal rail and section mill technological data system» at OJSC «Chelyabinsk Iron & Steel Works». The article presents the general aspects of the project, experience of implementation.

**Key words:** information technologies, information system, web-technologies, web-portal, PCS (process control system), PLC (programmable logic controller), automated working station.

UDC 699.81:662.99

**Research into Fire-Retardant Coating «Volcano»**

Kitaitsev V. M., Klyshnikov S. T., Kukui B. Gh., Plastinin A. I., Glazyrin S. S. // *Stal'*. 2015. No. 3. P. 95 – 97.

Thermal insulation and fire retardant coating series «Volcano» based on hollow microspheres for use in engineering, construction, energy and metallurgy was developed. Thermal properties were determined. This coating may be used for insulation and fire-retardant material.

**Key words:** fire protection, thermal insulation, thermal properties.

UDC 621.783.2:669.054

**Rotor-Vortex Units for Thermal Processing of Burden Materials of Metallurgical Conversion**

Podkovyrkyn E. Gh., Korshunova E. Gh., Bakov A. V., Sovetkin V. L., Matiukhin V. I. // *Stal'*. 2015. No. 3. P. 98 – 99.

The principle is stated, indicators of operation of rotor-vortex units for drying of disperse materials and processing of ferriferous technogenic waste are given. The technological scheme of installation for drying of quartz sand is described. Results of the comparative settlement analysis of operation of the rotor - vortex unit and a rotary kiln for drying of small coke are given.

**Key words:** drying, firing, industrial waste, rotor-vortex unit.

UDC 662.98

**Development of the Method of Jet-Torch Intensification of Metal Heating Processes**

Malikov Gh. K., Lisienko V. Gh., Shleimovich E. M., Loshkarev N. B., Druzhinin Gh. M. // *Stal'*. 2015. No. 3. P. 100 – 103.

The advantages of the method developed in VNIIMT jet torch heating (FSA) of the metal, in particular a marked decrease in the mass of refractory materials and a significant improvement in operating conditions furnace linings. Presented stoves SPS and features of their thermal performance. It is shown that the thermal efficiency of modern furnaces SPS can reach 65%, and the emission of nitrogen oxides in them even when heating air to 650 °C does not exceed 30 ppm.

**Key words:** heating, furnaces, direct-flame-impingement heating, DFI heating technology, Oxy-fuel heating systems, reduction in lining temperature, conservation of nitrogen oxides.