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CONTENTS

20 AUGUST 1992

ANALYSIS AND TESTING

FERROUS METALS

NONFERROUS METALS AND ALLOYS; BRAZES AND SOLDERS

PREPARATION

TREATMENT

WELDING, BRAZING AND SOLDERING

EXTRACTIVE METALLURGY AND MINING

MISCELLANEOUS

Properties of Quartz Fibers

927D0204F Kiev POROSHKOVAYA METALLURGIYA in Russian No 5 (353), May 92 pp 92-94

[Article by V.M. Beletskiy, V.G. Lutsenko, Ye.G. Momot, I.G. Bobichenko, I.A. Ilchenko, A.V. Kondratenko, General and Inorganic Chemistry Institute at the Ukrainian Academy of Sciences, Kiev; UDC 666.189.22+666.198]

[Abstract] The lack of data on the properties of SiO_2 fibers produced from natural or synthetic quartz by sputtering in quartz burners prompted a study of the physical and chemical properties of these fibers' surface and an investigation of their behavior in aqueous media. To this end, four batches of experimental quarts fibers are produced from the same raw materials under different process conditions. The fiber diameter is measured under an Opton optical microscope, the samples' specific surface is determined by the thermal desorption of argon, and the pores' sorption volume is measured by the exiccator method; the internal hydroxyl group concentration is measured by infrared spectroscopy, the number of the surface silanol groups is measured by the methyl red adsorption, and the acidity of the aqueous solutions which were in contact with the fibers is determined by an OP-261/1 pH-meter. The dependence of the bulk hydroxyl group concentration on the specific surface of quartz fibers and the pH behavior of acidified degassed water in contact with quartz fibers are plotted and the characteristics of the four batches of SiO_2 fibers are summarized. An analysis of the findings indicates that the hydroxyl group concentration in quartz fibers produced by sputtering in quartz burners increases with the sample's specific surface. It is shown that silicon dioxide fibers bind the protons from the weakly acidic solutions whereby the proton sorption per unit of specific surface is virtually the same for all four fiber batches. Figures 2; tables 1; references 7: 4 Russian, 3 Western.

Effect of Porosity on Breaking Stress of Powder Materials Under Viscous Failure Mechanism

927D0204H Kiev POROSHKOVAYA METALLURGIYA in Russian No 5 (353), May 92 pp 95-99

[Article by S.A. Firstov, Yu.N. Podrezov, N.I. Lugovoy, A.A. Malyshenko, A.G. Zherdin, Institute of Materials Science Problems at the Ukrainian Academy of Sciences, Kiev; UDC 621.762:620.178:669.12]

[Abstract] The formal description structure of a powder material's properties based on certain model representations of its formation is discussed and it is shown that the more elementary the model, the simpler the formula describing a given property and the lower its predictive value. A number of models and approaches to describing the strength of porous powder materials is reviewed. An attempt to develop a physical model of the breaking stress formation under the viscous failure mechanism which takes into account the structure changes occurring in the material under straining is described. The strain hardening curve of armco iron in the σ-$e^{1/2}$ coordinates, the experimental dependence of the modulus of elasticity of powder iron on its porosity, the dependence of the true breaking strain on the volume fraction of pores, and the dependence of the true breaking stress on porosity with and without taking the loosening into account are plotted. The proposed model is structure-sensitive since it contains the parameters which take into account the structure of the porous space and the stress and strain redistribution, the parameters which reflect the evolution of the dislocation structure and porous structure, and the failure criteria at a microlevel under pitting failure conditions. Figures 4; references 21: 19 Russian, 2 Western.

Dependence of High-T_c Superconductor Degradation Rate on Atmospheric Air Humidity

927D0196G Moscow TSVETNYYE METALLY in Russian No 6, Jun 92 pp 52-55

[Article by M.I. Levin, M.V. Sakharov, Z.V. Yeremenko, State Rare Metals Institute; UDC 537.312.630]

[Abstract] The effect of the stability of high-T_c superconductor (HTSC) properties and composition on the moisture content in the atmospheric air which largely determines the outlook for using HTSC in science and engineering is discussed, and the lack of experimental data on the effect of rare earth metals (RZM) on the rate of HTSC degradation and the composition of their decay products as well as data on the stages which limit the process rate is noted. The article examines the HTSC degradation behavior as a function of air humidity, and samples are synthesized in aluminum oxide crucibles and tested. The crystal lattice parameters of $R_1Ba_2Cu_3O_7$ (where R=Nd, Sm, Eu, Gd, Dy, Y, Ho, and Er) HTSC samples as a function of the rare metal additive, the critical parameters of the samples as a function of the rare metal additive, and HTSC degradation parameters are summarized; the effect of the moisture content on the degradation rate, X-ray diffraction patterns of the HTSC degradation products, the dependence of the degradation rate on the rare earth metal's number, and the dependence of the degradation degree on the relative time with various limiting stages are plotted. An analysis of the findings shows that the electron structure of the lanthanides affects HTSC degradation in water vapor while the dependence of the degradation rate on the air humidity is expressed by an exponential equation; with respect to moisture effect on degradation rate, the rare earth metals can be arranged into a Eu>Gd>Nd>Ho>Dy>Sm>Y>Er series. It is also shown that the external H_2O vapor diffusion toward the grain surface inhibits degradation through a hydrate which serves as a reactive water donor. Figures 4; tables 4; references 5: 2 Russian, 3 Western.

Characteristic Features of the Change in the Properties of Zirconium Dioxide-Based Heat-Shield Coatings as a Function of Loading Conditions

927D0195A Kiev PROBLEMY PROCHNOSTI in Russian No 5, May 92 (manuscript received 10 Dec 90) pp 13-17

[Article by G.E. Brailovskiy, Strength Problems Institute, Ukraine Academy of Sciences, Kiev; UDC 539.4.015.2+621.793]

[Abstract] Applying heat-shielding coatings to the most critical and heavily loaded components of different types of internal combustion engines significantly increases their reliability and durability. In view of the importance of such coatings, a study was conducted to compare the heat fatigue and thermocyclic creep of the nickel alloy EI868 coated with gas-thermal coatings that included a zirconium dioxide-based ceramic layer with different stabilizing additives. Specifically, heat-shield coatings containing the following additives were tested: 6.2 percent Y_2O_3, 8 percent Y_2O_3, 20 percent MgO, and 30 percent CeO_2. The different additives yielded different results depending on the different loading conditions to which the test alloy specimens were subjected. After experimenting with different loading conditions (including removing the static load and maintaining only a cyclic temperature change on the test specimen's surface), the researchers concluded that different test temperatures and forces may result in an inversion of the properties of different versions of heat-shielding coatings tested. On the basis of data from the heat fatigue tests conducted, the researchers ranked the test coatings in the following order (ranked from best to worst): ZrO_2 + 20 percent MgO, ZrO_2 + 6.2 percent Y_2O_3; ZrO_2 + 8 percent Y_2O_3; and ZrO_2 + 30 percent CeO_2. On the basis of the thermocyclic creep tests, the same compounds were ranked in the following order (best to worst): ZrO_2 + 20 percent MgO; ZrO_2 + 30 percent CeO_2; ZrO_2 + 8 percent Y_2O_3; and ZrO_2 + 6.2 percent Y_2O_3. The ceramic coating based on ZrO_2 containing 20 percent MgO thus proved to be most promising on both counts. Even after the specimens of the said coating (coating thickness, 450 to 550 μm) were held under a tensile stress equal to 120 MPa for 750 hours, a plastic deformation of only 1 percent was observed to accumulate, and no cracking or peeling of the ceramic was detected. Even specimens of the said ceramic that were subjected to increasing tensile stresses reaching 200 MPa were not observed to complete the transition to the state of steady creep. The peeling of the ceramic layer from the metal substrate was determined to be one of the main mechanisms dictating the moment at which a composition effects the transition from steady creep to breakdown. The results of the experiments performed on ZrO_2 + 20 percent MgO were found to be in good agreement with data in the foreign literature. Figures 3; references 5: 3 Russian, 2 Western.

The Stress-Strained State of Edge Zones of Glass Tubes During Internal-Pressure Tests

927D0195B Kiev PROBLEMY PROCHNOSTI in Russian No 5, May 92 (manuscript received 1 Apr 91) pp 30-34

[Article by K.K. Amelyanovich and V.I. Skripchenko, Strength Problems Institute, Ukraine Academy of Sciences, Kiev; UDC 539.4:678.067]

[Abstract] Before metal pipelines are replaced by glass tubes, consideration must be given to the distinctive features of glass as a construction material. In view of this fact, the authors of the study reported herein examined various methods of determining the stress-strained state of the edge zones of glass tubes by subjecting them to testing under internal hydrostatic pressure. Specifically, they compared three testing methods. The first of the three methods analyzed was the standard method recommended in All-Union State Standard 8894-86, which calls for securing the ends of the tube being tested in endcaps of a special machine. Rubber collars are used to hold the tube tight against the machine. When the said method is used, the tube's inner cavity is sealed along the end surface. In the second testing method examined the tube's cavity is made airtight along the side inner surface in a section that is approximately one tube diameter from the end. The ends of the tube thus do not experience any force effect. This absence of a load on the end sections of tubes being tested and the related problems in realizing similar loading conditions in an actual pipeline are considered drawbacks of this testing method. This second method is, however, considered more progressive than the standard method from the standpoint of providing reliable information regarding a tube's strength. The third method examined was proposed in 1990 in a publication whose authors included the two authors of the present article. The essence of this third method lies in the fact that the tube being tested is sealed by rubber seals placed on the tube's outer surface at a distance of one diameter from its ends. When the said technique is used, the end sections of the tube being tested experience the omnilateral compressive force of the working fluid. In other words, it is as if the tube is in a hydrostatic "shroud." After conducting a numerical (finite-element) analysis of the stress-strained state of glass tubes subjected to strength tests by all three methods, the researchers concluded that the standard method is the least acceptable (i.e., least reliable) method because the results it yields regarding the load-bearing capacity of glass tubes are tainted by the distinctive features of glass at its edge zones and by the fact that the strength characteristics of a piece of glass are sensitive to the surface state of its end sections, which are generally made plane by abrasive treatment. Both the second and third methods proved better than the currently recommended method, and they result in analogous distributions of the stress components throughout glass tubes subjected to internal hydrostatic pressure tests. The third method proved to be best, however, because when it is used, the entire tube being tested is in a triaxial stressed

state, with the radial and axial loads acting as compressive stresses and the peripheral stresses functioning as tensile stresses. Figures 4; references 4 (Russian).

Plastic Compression of Long Cylinders

927D0195C Kiev PROBLEMY PROCHNOSTI in Russian No 5, May 92 (manuscript received 11 Mar 91) pp 39-44

[Article by D.V. Khvan, Voronezh Polytechnic Institute, Voronezh; UDC 620.173.2]

[Abstract] Experimental substantiation of different models of hardened bodies requires that materials' properties be studied under conditions of nonmonotonic plastic deformation. Such studies present a number of problems when long cylinders are the object of study. For this reason, a study was conducted to develop the procedure and devices required to be able to compress long cylindrical specimens ($h/d > 5$) so that standard long specimens could be studied in the loading cycle extension-compression with finite plastic deformations without the need for any additional machining related to manufacturing short specimens for the compression portion of the studies. Specifically, the author of the present article has substantiated a method of upsetting long cylinders and has demonstrated the possibility of using the said method in compression tests involving finite plastic deformations under conditions of a uniaxial stressed state. The proposed testing procedure is based on the use of supporting elements designed to keep the equilibrium shape of the test specimen stable. A series of relationships are derived for use in calculating the limiting geometric parameters of compressible rods and the supporting pressures required to upset specimens under conditions of a linear stressed state. Presented next is an example illustrating the process of calculating the taper angle of sectors serving as supporting elements in the proposed device. A comparison of the results obtained when the proposed computation method was used with both long and short cylinders with compression-extension diagrams confirms the adequate precision of the experimental data obtained by using the proposed device. The proposed device is thus recommended for use in studies of the plastic properties of materials and, after the appropriate design modifications, in tests of materials' low cycle fatigue strength when subjected to substantial plastic deformations. Figures 3; references 8 (Russian).

Strength of Large Blocks of Spherical Plastic

927D0195D Kiev PROBLEMY PROCHNOSTI in Russian No 5, May 92 (manuscript received 10 Dec 90) pp 53-55

[Article by I.I. Dyachkov and I.A. Sazonov, Strength Problems Institute, Ukraine Academy of Sciences, Kiev; UDC 539.218]

[Abstract] Spherical plastic (termed sferoplastik) is a two-phase material consisting of hollow glass microspheres of different diameters and densities. These microspheres are arranged randomly in a continuous epoxy matrix. Spherical plastic may be used as buoyancy blocks and as a filler in multilayer components of different types of hardware components. The most typical loads to which spherical plastic is subjected when it is used in hardware components are hydrostatic compression and hydrostatic compression with additional axial forces in one or more directions. Fractures of spherical plastic under hydrostatic compression are dual in nature and depend on the spherical plastic's volume. In the case of small specimens, there is a loss of stability by both the inclusion and matrix that results in an increase in initial density as the free spaces fill up with the working fluid (water). In large blocks of spherical plastic, on the other hand, cracking occurs along with the increase in density that is characteristic in small blocks of spherical plastic. This cracking is the result of the fact of the different densities of the spherical plastic's phases, which correspond to different elasticity moduli. Differences in density also result from the technology used to manufacture the material. The authors of the study reported herein have presented a short mathematical analysis of the process of the cracking of large spherical plastic blocks. On the basis of their analysis, they conclude that making pilot holes in large blocks of spherical plastic is one way of preventing them from cracking. The diameter of the holes and the distance between them are determined by solving a problem of compression in two directions of a wafer with an infinitely large number of holes. A second design decision that can help reduce cracking is to place spherical plastic-filled macrospheric shells within the volume of a large block of spherical plastic. Both techniques were effective in preventing cracking in large blocks of spherical plastic. The technique of the macrospheric shells filled with spherical plastic was preferred, however, because the said technique makes it possible to optimize the strength and density of the composite as a function of specified tactical-technical parameters. Figures 4; references 4 (Russian).

The Behavior of Cylindrical Shells Made of Polymer Composite Materials With Defects Under Dynamic Loading

927D0195E Kiev PROBLEMY PROCHNOSTI in Russian No 5, May 92 (manuscript received 10 Oct 90) pp 59-62

[Article by M.A. Drozdov, S.I. Snisarenko, and V.I. Shlyakhov, Daugavpils; UDC 531.781.2]

[Abstract] One of the biggest problems standing in the way of wide-scale use of composite materials is that of obtaining reliable information about the presence of internal defects or flaws in the structure of the composite as a result of flaws in the manufacturing process or during the course of the finished product's use. In an effort to determine the effect that the nature of internal

defects in composite materials has on dynamic deformations, the authors of the study reported herein conducted a series of studies on fiberglass-reinforced plastic cylindrical shells. Specifically, shells with various internal flaws in their composite material (including breaks in the strip, adhesion failures, and specimens produced during deviations from the established polymerization process) were subjected to lengthwise impacts along their end faces. Shells measuring 800 mm in length, 44 mm in diameter along their outer contour, and 31 mm in diameter along their inner contour were studied. The shells were produced by the method of wet-winding a glass strip and glass filaments with impregnation in a bath. EDT-10 epoxy resin and BS V x 13 x 1 x 12 glass filament were used in a solidification regimen that included solidification at 80°C for 30 minutes followed by solidification for one hour at 160°C and then for two hours at 180°C. Nine shells with nine different defects and/or deviations in the polymerization regimen used to manufacture them were tested. A single tear in the strip did not appear to significantly alter the deformation properties of the cylinders tested. Two tears resulted in a sharp decrease in deformation characteristics, however. Adhesion failures resulted in a 15.09 percent increase in lengthwise deformation and proved to be one of the most significant defects from the standpoint of lowering the elastic (and strength) properties of the cylindrical shells tested. Specimens that had been annealed for up to 30 seconds were found to have a reduced nonstationary lengthwise deformation when subjected to an impact along their end face. Those cylinders that had been subjected to longer periods of annealing (40 and 50 seconds) were found to undergo greater lengthwise deformation upon impact. Increased polymerization temperature was also associated with an increase in lengthwise deformation. Figures 3, table 1.

New Etchant for Revealing Fine Structure of Carbonaceous Materials

927D0185D Moscow ZAVODSKAYA LABORATORIYA in Russian No 3, Mar 92 pp 27-29

[Article by F.L. Shapiro, Dnepropetrovsk Institute of Metallurgy]

[Abstract] A new etchant has been developed which will reveal, under an optical or scanning transmission electron microscope, the fine structure of porous carbonaceous materials such as coke and gas coal used as reducing agents in electrothermal alloy smelting. The earlier developed etchant, saturated aqueous solution of $K_2Cr_2O_2$ + HCl, requires heating to 80°C and a 40 min long chemical or cathodic (in special apparatus) etching time for microstructural analysis of coke-vitrinite by the method of replicas. Its drawbacks are: 1) dissolution of the fusible binder material used for preparation of replicas and consequent denudation of the porous structure; 2) frequent irregular replenishment, which together with unavoidable temperature fluctuations diminishes the reproducibility of the result of etching; 3) indeterminacy of the binder precipitation sites, which may lead to mistaken identification of binder structure and artifacts as the fine structure of coke-vitrinite. The new etchant, 20 ml saturated aqueous solution of $K_2Cr_2O_7$ + 65 ml H_2SO_4 + 18 g H_3BO_3. Chemical etching is done at room temperature and is completed within 10-15 minutes. This etchant thus facilitates a more accurate and reliable structural analysis, moreover simultaneously revealing mineral impurities as well as all structural characteristics of the host material under an optical or electron microscope. Figures 3; references 4.

Strain Resistance of Hardened Carbon Steel

927D0209E Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian No 2 (164), Apr-Jun 92 pp 15-17

[Article by V.M. Statnikov, F.D. Gamidov, S.A. Stebunov, V.G. Surkov, N.P. Denenberg, All-Union Scientific Research Tube Institute, Production Association of the Azeri Tube Mill, and Scientific Production Association of the Central Scientific Research Institute of Mechanical Engineering Technology; UDC 621.774.372.016.2:621.7.011]

[Abstract] The importance of knowing the hardened metal's resistance to straining in order to design the equipment and develop and improve the process of warm sizing of high-strength casing and coupling pipes and of estimating the process energy and force parameters, as well as the shortage of published data on the plastic deformation resistance of hardened carbon steels tempered to thermal sizing temperatures, prompted a study of the sizing and grooving process using samples cut directly from hardened (by the VTMO method) tubes in the TPU 250-2 reeling mill. The factor affecting the straining resistance and examining and the dependence of the straining resistance on the physical and chemical properties of the material and the straining degree, temperature, and rate is expressed in a general form. Two batches of tube samples are used in the study. The approximation coefficients of the ductility measurement tests of the tube batches are summarized and the upsetting test curves of steel 20 tubes are plotted. The experimental data increases the confidence of the warm sizing technology development for seamless and drawn casing and coupling tubes and makes it possible to assess the effect of the intervals between loading cycles on the straining resistance. It is demonstrated that the straining resistance under cyclical loading is 5-10 percent below that under continuous loading. Figures 2; tables 1; references 7.

Substructural Hardening of Structural Steels: One Way to Improve Their Service Properties

927D0209H Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian No 2 (164), Apr-Jun 92 pp 28-29

[Article by V.I. Bolshakov, A.N. Lukyanskova, P. Preystner, Dnepropetrovsk Civil Engineering Institute and UMIST, Great Britain; UDC 669.14.018.29:621.785.5.787.4]

[Abstract] The increasing demand for hardened structural steels in the steel-intensive industries, particularly construction, prompted a study of the correlation between the hot plastic working conditions, microstructure, and a range of service properties in low alloyed and nonalloyed structural steels. Since one of the criteria for controllable the steel treatment is producing a fine grain structure which improves the strength and toughness characteristics of the ready product. A study of the substructural hardening of structural low-pearlitic steel 09G2FB and electron diffraction and analysis data show that the steel structure after controlled rolling is characterized by a uniform dislocation distribution while the use of high tempering at a 500°C temperature with subsequent water quenching helps to stabilize the service properties; the resulting structure has an ultimate strength of 870 N/mm^2 and a yield strength of 760 N/mm^2 and a 27 percent elongation. The results confirm that ausforming makes it possible to develop a structure with a favorable range of properties and can be performed under today's conditions at metallurgical enterprises. The best mechanical properties are attained in 50 mm sheets of steel with a simple and inexpensive alloying system due to the heat treatment condition modifications. Figures 2; references 3.

Development and Implementation of Promising Versions of Rail Steel Deoxidation and Microalloying Methods

927D0209I Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian No 2(164), Apr-Jun 92 pp 32-35

[Article by V.A. Palyanichka, V.D. Roztorguyev, A.V. Pan, V.V. Matveyev, V.Ye. Semenkov, V.I. Syreyshchikova, Urals Scientific Research Metallurgy Institute, Nizhniy Tagil Integrated Iron and Steel Works, and Urals Scientific Research Institute of Ferrous Metallurgy; UDC 669.14.018.294.2:669.046.558]

[Abstract] The increasing importance of improving the service properties of rails due to the rising rail traffic volume prompted a study of the easiest methods of accomplishing this task—steel microalloying and inoculation. Thus, a method of microalloying and inoculating rail steel with a Si-Ca-Zr alloying composition (SKTsR 1) was developed and implemented at the Nizhniy Tagil Integrated Iron and Steel Works (NTMK) yet it had numerous drawbacks. This fact and the shortage of vanadium made it necessary to optimize the steel deoxidation, inoculation, and microalloying technology and search for ways of economically microalloying rail steels with vanadium-containing alloys. As a result, several methods were developed and tested; the chemical composition of the alloys and alloying compositions used for this purpose, the toughness and macrostructure of rails produced by various deoxidation versions, mechanical properties of thermally hardened steels, and the results of impact tests of 10 rail batches are summarized and the effect of the Al concentration in steel on its toughness is plotted. An analysis of the findings demonstrates that rail steel microalloying by V-containing alloys pursuant to GOST 24182-80 is the most efficient: it lowers the rate of rail downgrading due to an insufficient toughness to 3-3.4 percent, increases the ultimate strength of nonhardened rails by 30-60 N/mm^2 and of hardened rails, by

40-70 N/mm^2, and eliminates rejects usually detected by impact tests. Figures 1; tables 4.

Physical-Chemical Patterns of Mechanical-Chemical Reduction of Metals and Nonmetals From Their Oxides

927D0205A Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 5, May 92 pp 6-9

[Article by A.A. Popovich, V.P. Reva, V.N. Vasilenko, O.A. Belous, Far East Polytechnic Institute; UDC 669.273.7]

[Abstract] The need to expand the applications of mechanochemistry for processing tungsten and boron concentrates and use mechanochemical processes for direct reduction of metals and nonmetals from their oxides with subsequent synthesis of refractory compounds prompted an investigation of the physical and chemical patterns of the mechanochemical reduction of metals and nonmetals from their oxides and refractory compound synthesis. To this end, powders of chemically pure copper, molybdenum, iron, tungsten, vanadium, titanium, boron, and silicon oxides as well Mg, Al, and Ti and powders as well as a tungsten concentrate with a 54-61 percent WO_3 concentration are examined. The thermograms of the boric anhydride reduction reaction as a function of the mechanical activation atmosphere and the phase composition of the WO_3 + Mg + C compound after synthesis as a function of the mechanical activation atmosphere are plotted. The values of the mechanochemical dose at which the reaction of metal and nonmetal reduction by Mg and Al occurs with an explosion kinetics are established and it is demonstrated that the dose increases with a decrease in the reaction heat and an increase in the initial oxide formation energy; the reduction reaction is greatly enhanced by an addition of oxygen to the reactor during the oxide activation with a magnesium powder. Figures 3; tables 2; references 2.

On Minimum Theoretically Feasible Fuel Rate in Liquid-Phase Iron Reduction Furnaces

927D0205B Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 5, May 92 pp 14-16

[Article by Ye.G. Vegman, Moscow Steel and Alloy Institute; UDC 669.162.8]

[Abstract] A procedure for analyzing the burden composition of PZhV and Copex liquid-phase iron reduction furnaces and calculating the thermal equivalent of 1 kg of each component is considered in detail and a formula for computing the heat yield of the carbon burning in the tuyeres is derived. The specific coal rate per smelting is determined and the hearth performance is analyzed. The comparative efficiency of the sludge and dust processing into pig iron by the Inmetco method is evaluated. The conclusion is drawn that the comprehensive blast furnace charge analysis method first developed in 1941 by A.N. Ramm can still be used, albeit with modifications, for analyzing the charge composition and fuel rate in liquid phase iron reduction furnaces; an analysis performed by this method shows that the minimum feasible specific coal rate (with 20 percent volatile and 70 percent nonvolatile components) is 365 kg per ton of pig iron. The minimum theoretically possible solid fuel rate in using a medium-grade charge in Inmetco and Copex furnaces is equal to 580 and 790 kg/t, respectively. References 6: 5 Russian, 1 Western.

Converter Thermal Loss Analysis

927D0205C Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 5, May 92 pp 23-24

[Article by Yu.S. Paniotov, Dnepropetrovsk Metallurgical Institute; UDC 669.184]

[Abstract] The relationship between various components of thermal losses in a converter during the process and their dependence on the converter conditions are discussed and a method for assessing the magnitude of thermal losses in a converter which takes into account the correlation between the smelting unit dimensions and its capacity as well as the approximate equality of the temperature conditions of the smelting process is proposed. In so doing, it is assumed that that the heat losses per ton of converter capacity are proportionate to the specific surface of the working space and smelting duration. The specific surface is expressed as a function of specific volume and converter capacity and the smelting duration is expressed as a sum of the blast and auxiliary operation duration; the heat influx per ton of converter capacity is proportionate to the specific oxygen volume. The dependence of the thermal loss fraction on the converter capacity and specific blast rate and the comparative fractions of thermal losses on the basis of two analyses are plotted. The effect of thermal losses on the pig iron and metal charge rate is summarized. Figures 2; tables 1; references 5.

Forces Applied to Drift Pin During Hollow Ingot Casting

927D0205D Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 5, May 92 pp 27-29

[Article by M.Ya. Brovman, Scientific Production Association of the Scientific Research Institute of Mechanical Engineering; UDC 621.746.5]

[Abstract] The use of water-cooled metallic or graphite drift pins on which the inner part of the ingot is formed during the semicontinuous or continuous casting of hollow ingots is discussed and the forces applied to the ingot are analyzed in order to facilitate the casting technology and equipment design selection. The circular

cylinder and polygon-shaped drift pins are considered. The use of lubrication and flexible deformable drift pins for decreasing the friction between the ingot and the drift pin and as well as decreasing the drift pin length and reducing the ingot cooling rate for lowering friction are examined. The formula derived for calculating the friction forces between the drift pin and the ingot show that the forces do not depend on the drift pin diameter but depend significantly on the friction coefficient, drift pin length, and the shrinkage. It is noted that the drift pin force analysis can be further refined by selecting a material model which takes into account the stress relaxation. Figures 3; references 4.

Development and Implementation of Production of Electrical Engineering Items From New Al-Mg-Mn-Ti-La-Ce Alloy

927D0205E Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 5, May 92 pp 45-47

[Article by Kh. Kurbanov, M.A.F. Fouad, Metallurgy Institute imeni A.A. Baykov; UDC 621.774.2]

[Abstract] The lack of data on the deformability and plastic working temperature range of the new Al-Mg-Mn-Ti-La-Ce alloy and the requirement that the alloy be corrosion resistant prompted a study of the effect of plastic deformation and heat treatment on the corrosion behavior of the Al-Mg-Mn-Ti-La-Ce alloy in a 3 percent NaCl solution. A plasticity diagram, the anode potentiostatic diagram of the alloy, the dependence of the mechanical properties of the Al-Mg-Mn-Ti-La-Ce alloy wire on the deformation degree and of foil on its thickness, and the dependence of electrical resistance of the Al-Mg-Mn-Ti-La-Ce alloy wire on the deformation degree and of the foil on its thickness are plotted. The alloy corrosion parameters under hot straining, annealing, and aging are summarized. The study shows that the optimum temperature range for forging and stamping the alloy is 480-500°C and demonstrates that the corrosion current density, i.e., its passivation, are five- to sixteen-fold lower than that of nonalloyed A5 technical aluminum, i.e., the alloy's corrosion resistance is rather high in a neutral medium (a 3 percent NaCl solution). It is shown that the actual electrical resistance of the wire and foil made from the alloy are less than the design value, attesting to the fact that the conductors have more than sufficient conductivity. Figures 4; tables 2; references 7: 6 Russian, 1 Western.

Study of Sheet Material Joining by Plastic Metal Working Methods

927D0205F Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 5, May 92 pp 52-53

[Article by S.M. Tikhonov, Yu.D. Zheleznov, A.V. Starshinov, V.V. Srasyuk, V.F. Takki, Moscow Steel and Alloy Institute; UDC 621.7-41.011.]

[Abstract] The importance of joining sheet blanks with a considerable thickness difference by the plastic metal working method (OMD) in a production line environment is stressed and several appropriate designs are considered. The method performance is checked experimentally using a special tool rigging whose advantages of over welding and riveting are due to the small number of operations which can be easily automated. A.D. Tomlenov's equation describing the mean pressure per unit area in indenting a spherical plunger into a plastic half-space is analyzed and the conclusion is drawn that other things being equal, the expansion process is more intensive when the spherical plunger radius is small, necessitating the use of smooth spherical plungers with a minimum radius when joining stacks of sheets. The findings confirm that the method of plastic metal working is promising for joining two sheet blanks with a widely differing thickness. The energy vs. force and process parameters of the joining technology are determined on the basis of the plasticity theory methods, making its possible to develop recommendations for making tools for implementing the procedure. Figures 2; references 3.

Energy Aspects of Interparticle Powder Material Failure

927D0205G Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 5, May 92 p 93

[Article by V.A. Barannikov, V.M. Panovko, Metallurgy Institute imeni A.A. Baykov; UDC 621.762.01]

[Abstract] It is asserted that the conclusion (*FiKhOM* No. 1, 1989, pp. 112-116) drawn on the basis of a physical-chemical analysis of the topochemical reactions in a solid phase compact that under the powder material compaction conditions by plastic metal working methods (OMD), the bond strength is proportionate only to its surface is flawed and the concepts of the destruction volume are unconvincing while the strength vs. force dependence cannot be physically interpreted unambiguously. It is stated that the correct quantitative relationship between the strength and bond surface can be derived from the energy considerations. The dependence of the bond strength on the square root of (fS_x) parameter is plotted; is it a straight line with a 0.91 correlation. A formula for calculating the deformation energy of a unit material volume as a function of Poisson's ratio is derived and it is shown that a powder sample fails and even breaks up into particles when this energy is equal to the energy of new surface formation. It is also demonstrated that the proportionality between the bond strength and the square root of the bond surface does not depend on the type of the stressed state. Figures 1; references 4.

The Efficiency of Blast Furnace Smelting With a Variable Content of Oxygen in the Blast

927D0179A Moscow STAL in Russian No 3, Mar 92 pp 4-7

[Article by Yu.S. Yusfin, A.P. Pukhov, N.P. Sysoyev, and P.I. Chernousov, Moscow Institute of Steel and Alloys and Tulachermet Scientific Production Association; UDC 669.162.28]

[Abstract] The authors of the study reported herein examined the efficiency of blast furnace smelting with a variable oxygen content in the blast. Specifically, they analyzed the operation of the blast furnaces at the NLMK [not further identified] during the period from 1974 through 1987. The blast furnace process used at the said combine is distinguished by the combined use of a blast with high parameters and an increased percentage of pellets in the charge. The blast used contains up to 40 percent oxygen with a natural gas flow rate of 150 to 160 m^3/t and between 40 and 45 percent pellets in the charge. The analysis enabled the authors to draw a number of conclusions. Specifically, they discovered that when the oxygen content in the blast is increased without improving the reducing operation of the gases in the furnace (i.e., when the degree of direct reduction [r_d] remains constant or is altered only slightly [by 1 to 3 percent]), enriching the blast with oxygen only increases furnace productivity and smelting intensity to a specified threshold concentration. The higher the r_d, the sooner this threshold concentration is reached. Given the currently existing blast furnace technology, which is to say, without any improvements in blast furnace and air heater design, the threshold concentration of oxygen in a blast ensuring an efficient and stable process is between 34 and 35 percent. Under future conditions, given the priority of economic requirements, enriching blasts with oxygen will gain only limited popularity and will only be used as a means of expanding the use of fuels with a low combustion heat, when air heaters are being repaired, or when a short-term intensification of smelting is required. The technique of blasting nitrogen heated to a high temperature is a feasible way of reducing specific coke consumption when blast furnaces are operating at a reduced intensity. A "critical" oxygen concentration (about 15 percent) was also noted. Below an oxygen concentration of about 15 percent, the size of the blast has more of an effect on heat input with a blast than temperature does. At oxygen concentrations above 15 percent, on the other hand, the opposite effect is observed. Figures 9; references 9 (Russian).

Improving the Quality of Pipe Steel by Killing It With Aluminum and Microalloying It With Titanium

927D0179B Moscow STAL in Russian No 3, Mar 92 pp 18-19

[Article by Yu.G. Yaroslavtsev, V.P. Kopaleyshvili, A.Ye. Sochnev, A.N. Lomashvili, T.A. Shatirishvili, and N.O. Gvamberiya, Donetsk Ferrous Metals Scientific Research Institute, Georgia Polytechnic Institute, and Rustavi Metallurgy Plant; UDC 669.18.046.55:669.71+669.14.018-462]

[Abstract] The authors of the study reported herein examined the effect of killing with aluminum and microalloying with titanium on the quality of pipe steel. Specifically, they studied the effect of using different amounts of aluminum (0.3, 0.45, 0.75, and 0.90 kg/metric ton) and different amounts of 30 percent ferrotitanium (0.5, 1.0, and 1.5 kg/metric ton) on the quality indicators of 45T(15) and 20T(18) pipe steel. The said steels were smelted at the Rustavi Metallurgy Plant in 200-ton open-hearth furnaces based on a scrap ore process. In all of the study melts, the metal was killed in the furnace before tapping with 25 percent ferrosilicon. The remaining deoxidizing agents were added in the ladle with care to maintain a homogeneous metal composition. The uphill method was used to cast the steel into 8.3-metric ton ingots. The round billets were produced on a 900/750 round billet mill, and the pipes were produced on 140 and 400 pipe-tube mills. The study steels conformed to the requirements set in All-Union State Standard 1050-74 with respect to the content of the main elements and their mechanical properties. Tests performed on the study melts established that adding aluminum in an amount ranging from 0.45 to 0.55 kg/metric ton and 30 percent ferrotitanium in an amount ranging from 0.75 kg/metric ton to 45T and 20T steel results in a product with a uniform fine-grained structure and a high fracture toughness. Specimens of 45T and 20T steel killed and microalloyed with the said amounts of aluminum and ferrotitanium were found to have a reduced probability of defect formation both when in a hot-rolled state (during the actual process of manufacturing pipes) and when in a normalized state (when the pipes were in use). The tests conducted further established that using the proposed combination killing and microalloying technology makes it possible to increase the output of grade I pipes by 3.0 to 6.0 percent. Table 1.

Protecting Metal Stream Against Reacting With the Atmosphere During Teeming Into Ingot Molds

927D0179C Moscow STAL in Russian No 3, Mar 92 pp 19-22

[Article by V.I. Gerner, D.Ya. Povolotskiy, A.V. Tokarev, M.M. Strekalovskiy, O.K. Tokovoy, and L.A. Alym, Chelyabinsk Scientific Research Institute of Metallurgy, Chelyabinsk State Technical University, and Chelyabinsk Metallurgy Combine; UDC 621.746.58]

[Abstract] The secondary oxidation of metal when it is teemed into chill molds has a significant effect on steel quality. The steel was poured from a ladle with a stopper, and the stream was protected against secondary oxidation by inert gas by means of a hollow ring mounted on the runner's hopper. When this method of protecting the metal was used, the oxygen content around the stream during teeming ranged from 3 to 10 percent. New design

decisions became necessary after the change to teeming from ladles with slide gates. The authors of the present article describe one promising direction for creating a device to protect a stream of teemed metal from coming into contact with the atmosphere. The method is based on using a flow of neutral gas in order to isolate the metal stream from the environment. After studying the aerodynamic processes at work when a flow of neutral gas is used to protect a metal stream, the researchers designed an experimental unit and model of a device that would use argon to protect a metal stream from secondary oxidation as it is being teemed into chill molds. The basic principle underlying the device's operation is that of creating a double-row gas curtain around the protected portion of the stream of teemed metal. The flow rate of air (20 to 60 m^3/h) that was used in the model corresponded to a flow rate of argon ranging from 600 to 1,600 m^3/h under actual industrial conditions. The tests demonstrated that the most effective protective device would have a distance of 60 mm between the rows of nozzles and would use screens to separate the rows. Tests of the new device conducted on a laboratory stand confirmed that it provides good separation of the streams flowing from the openings of the inner and outer rows. The attachment device of the new design was tested as steel was poured from the top and bottom in converter, open-hearth, and electric furnace shops at the Chelyabinsk Metallurgy Combine. The industrial version of the device is in the form of a torus with holds of different diameters in the outer and inner rows. The gas flow is restricted by screens from the outer and inner sides. When the device developed to protect a metal stream against secondary oxidation is used with argon under a pressure of 40 to 90 kPa and when the distance between the slide gate collector and the runner hopper is between 50 and 70 mm, the concentration of oxygen close to the metal stream is between 2 and 3 percent. Tests performed on specimens of ShKh15SG bearing steel cast into chill molds while the new protective device was used confirmed that using the new device results in a finished product that is less contaminated with oxide inclusions and globules and has improved surface properties. Calculations performed established that using the new device makes it possible to reduce the amount of defective billets and reduce defective metal products by 0.18 percent as compared with when metal is cast without protection of the stream. It is anticipated that using the newly developed device will result in a yearly cost savings of 149,300 rubles at the Chelyabinsk Metallurgy Combine. Figures 3; references 4 (Russian).

Expanding the Assortment of Corrosion-Resistant Steel That May Be Smelted in 100-t Electric Furnaces

927D0179D Moscow STAL in Russian
No 3, Mar 92 pp 22-24

[Article by M.V. Korneyev, A.V. Ivanov, V.S. Baldin, and Yu.Ya. Melnikov; UDC 669.187.25]

[Abstract] The Chelyabinsk Metallurgy Combine is one of the country's main suppliers of corrosion-resistant steel. Along with the traditional assortment of type 18-10 steel, the combine has begun producing about 70 types of corrosion-resistant steel in electric furnaces with capacities ranging from 5 to 100 tons. Because the combine's shops have the capability of producing large qualities of hot- and cold-rolled sheets, the combine's electrometallurgists worked to expand the assortment of corrosion-resistant steels that could be smelted in its 100-ton electric furnaces. The said furnaces, which have a 32 MVA transformer, are used to smelt steel in a single-stage process. Because of the absence of equipment for extrafurnace treatment, the electrometallurgists have been exploring the possibilities of producing corrosion-resistant metal in a monoprocess. Specifically, they have conducted their search to expand the assortment of corrosion-resistant steels that may be smelted in the said furnaces in the following directions: developing and assimilating a technology to smelt new ferrite types of steel; developing an optimal process to produce low-carbon steel with nitrogen; and improving the technology of smelting hard-to-deform chrome-nickel and chrome-nickel-molybdenum steel. New processes were developed for producing various steels. The process for smelting 04Cr19NVTi steel (which was originally developed at the Electric Welding Institute imeni Ye.O. Paton) was modified to include the following in the charge: carbon wastes (from 45 to 50 percent), type B-10 and B-18 alloy wastes (from 20 to 30 percent), and ferrochrome carbide (10 percent). The chromium content in the charge ranged from 12.5 to 16.8 percent, and the carbon content ranged from 0.77 to 1.04 percent. Finished products made of the new sheet steel were found to possess high technological properties and to meet the public health requirements imposed for consumer goods. Other research based on preliminary research performed at the Central Scientific Research Institute of Ferrous Metallurgy imeni I.P. Bardin made it possible to recommend the production of 05Cr20Ni14NMn5 steel containing up to 0.05 percent C, 4 to 7 percent Mn, and 14.5 to 16.0 percent Cr. Yet other research made it possible to determine the optimal parameters of the process of smelting 20Cr23Ni18 steel. The combined use of aluminum, boron, and titanium to kill the said steel was shown to result in the required plastic properties coupled with a minimum amount of defective product. It is projected that introducing these new developments will result in a cost savings of more than 500,000 rubles. Figures 2.

Smelting Corrosion-Resistant Nitrogen-Containing Steel in Direct-Current Arc Furnaces

927D0179E Moscow STAL in Russian
No 3, Mar 92 pp 24-26

[Article by Yu.N. Shelgayev, N.I. Vorobyev, V.G. Yevchenko, and L.G. Gurevich; UDC 669.187.5]

[Abstract] The firm Mechel developed a new process for making different types of nitrogen-containing corrosion-resistant steels in 6- and 12-ton direct-current (DC) arc furnaces. The process developed for making high-alloy nitrogen-containing corrosion-resistant steel in a DC arc furnace makes it possible to produce a broad assortment of steel types and profiles, including a very complex modern extra-low-carbon type of steel alloyed with chromium, nickel, manganese, and molybdenum and meeting the requirements imposed in both domestic and foreign standards. The new process is being used to produce the high-alloy 02Cr25Ni22NMo2, which has a nitrogen content of 0.15 to 0.25 percent, and 600-mm-diameter forgings from type 03Cr17Ni12NMo2 steel. The former is smelted in 6-ton DC arc furnaces by alloying the purest of alloying materials and Armco iron. The choice of the said materials, coupled with preparation of the furnace lining and the virtual absence of carburization, results in a finished steel containing 0.020 percent C. Tests performed on the finished steel have confirmed that its total content of carbon, sulfur, phosphorus, and oxygen does not exceed 0.04 percent. VCrNi600N nitrided ferrochrome was used in the final melting. The steel is cast into ingot molds by the uphill method to produce ingots weighing 0.7 to 1.25 metric tons. Exothermal slag briquettes possessing an optimal concentration of deoxidizing agents and modifiers are used to lubricate the ingot molds. The new steel's high strength and plastic mechanical properties remain stable after hardening and exceed (by a factor of 1.5) the requirements stipulated in the respective standards. Tube shells, forgings, and rolled stock produced from the new steel are characterized by a dense macrostructure, and their α-phase content does not exceed 0.5 points. The new steel has especially good corrosion resistance. In its delivered state, the steel does not experience more than 0.03 mm of corrosion per year, which is an order of magnitude better than the amount stipulated in the standards. An analogous technology has been used to produce 600-mm-diameter forgings of X2CrNiMoN steel in accordance with the standard DIN 17440. The results of tests performed on the said steel were analogous to those obtained in the tests on the newly developed 02Cr25Ni22NMo2.

Optimizing Metal Charge Composition When Smelting Corrosion-Resistant Steel

927D0179F Moscow STAL in Russian No 3, Mar 92 pp 26-27

[Article by A.D. Pereverzev, V.M. Shifrin, V.N. Turovskiy, K.P. Verbitskiy, and G.V. Konovalov, Dnepropetrovsk Metallurgy Institute, Dneprospetsstal; UDC 669.187.25]

[Abstract] Studies performed at the plant Dneprospetsstal regarding the production of chrome-nickel corrosion-resistant steel by the method of using oxygen in basic arc furnaces and remelting wastes demonstrated that reducing the concentration of nickel in the metal charge by 2-2.5 percent by means of adding it to the cooling additive mixture reduces nickel losses and increases nickel uptake. The Dnepropetrovsk Metallurgy Institute and Dneprospetsstal then proposed a rational process for alloying metal with nickel in order to reduce nickel losses, optimize the cooling additive balance, increase the use of inexpensive carbon ferrochrome, eliminate metallic nickel from the metal charge, and add it to the final oxygen blast as a part of the cooling additive mixture so that the amount of nickel in the molten metal will be at the lower bound of the said type of steel. According to the new process, final correction of the metal's chemical composition with consideration for the reduced nickel losses is made after the postblast slag has been killed and the cooling additives have penetrated the melt. For various reasons, the proposed simultaneous reduction in nickel content and increase in chromium content by adding VCr800 to the charge and increasing the percentage of wastes in the charge were not achieved. For this reason, an additional series of pilot commercial melts were made and the results reported herein. The quantities of chromium and nickel used in the charge were calculated in accordance with equations by the authors in 1984. In these repeat studies, reducing the amount of nickel in the charge resulted in a 2.3 percent increase in the start-to-finish use of nickel, including a 0.5 percent increase during the course of the oxidation period. This increase in the efficiency of nickel utilization was attributed to the higher quality of the charge used and a decrease in vaporization of the nickel. Analysis of the composition and amounts of materials included in the charge and the melt added during the course of the reduction period demonstrated that the new experimental process results in increased consumption of VCr800 and type B-26 wastes, as well as in a sharp reduction in the consumption of metallic nickel, a decrease in the consumption of low-carbon chromium, and a marked increase in the consumption of B-26 wastes for cooling down the metal. Table 1; references 3 (Russian).

Optimizing the Temperature Regimen of the Continuous Casting of Corrosion-Resistant Titanium-Containing Steel

927D0179G Moscow STAL in Russian No 3, Mar 92 pp 27-28

[Article by R.A. Garafutdinov, B.Ya. Baldayev, N.G. Savinova, and M.A. Tsvetkov, Cherepovets Metallurgy Combine; UDC 621.746.27.047]

[Abstract] The existing techniques of producing continuously cast slabs of 08-12Cr18Ni10Ti corrosion-resistant steel call for selecting the optimum metal temperature in the intermediate ladle as a function of casting conditions and level of the technology. Experience gained in casting the said steel has shown that the difference between the temperature of the metal in the teeming and intermediate ladles and the temperature of the metal fed to the melt are both decisive in the production of high-quality slabs. The combined effect of

this temperature difference, vacuuming during extrafurnace treatment, and effective protection of the metal stream during teeming was studied. The studies performed established that improving the surface quality of a billet cast from 08-12Cr18Ni10Ti steel facilitates maximum denitriding of the metal during extrafurnace treatment and suppression of denitriding during continuous casting. The studies further established that this may be accomplished by reducing the temperature at the end of extrafurnace treatment to a level not exceeding 1,565°C and by ensuring that the difference between the temperature of the metal in the teeming ladle and that in the intermediate ladle does not exceed 45°C. When these measures were introduced into a process for producing corrosion-resistant titanium-containing steels that involved the use of a 100-ton blast furnace and machine for continuously casting slab billets, production of slabs that were classified as defective due to surface flaws was reduced by a factor of 2 to 3, and losses of metal when they were conditioned before rolling were reduced from 6-7 to 4-5 percent. Figures 3, table 1.

Improving the Quality of Continuously Cast Corrosion-Resistant Steel Billets

927D0179H Moscow STAL in Russian No 3, Mar 92 pp 29-32

[Article by S.V. Kuberskiy, R.V. Kakabadze, A.F. Kolosov, Yu.M. Nechkin, and N.N. Perevalov, Serp i moloto (Sickle and Hammer) Metallurgy Plant, Moscow Institute of Steel and Alloys; UDC 621.746.628.047]

[Abstract] By introducing a process for continuously casting steel, the plant Sickle and Hammer was able to bring its machine for continuously casting billets up to its design capacity and begin producing continuously cast billets of more than 70 type of steel. This in turn enabled the plant to consistently fill its orders for a wide variety of steel products. In an effort to further improve the plant's products, a study was undertaken in which specimens of rolled stock obtained from imported rolled metal and from continuous cast billets produced at the plant itself were compared. Specifically, the two sets of specimens were compared from the standpoint of their chemical composition, gas saturation, and level of contamination with nonmetallic inclusions. The studies performed established that rolled stock produced from continuously cast metal has mechanical properties that are identical to rolled stock produced from conventional ingots. The studies further established that any efforts to further increase the plasticity and performance products of metal products made of titanium-alloyed corrosion-resistant chrome-nickel steel of the austenite class must proceed in the direction of tightening up requirements related to chemical composition. Specifically, the chromium:nickel and titanium:carbon ratios must be reduced, the level of manganese in the metal must be stabilized at close to its upper boundary, titanium losses must be reduced by controlling the steel's oxidation state, and additional measures must be taken to protect the metal against secondary oxidation. The authors conclude by recommending that the existing specifications regarding the minimum concentration of titanium in the steel must be revised because existing monitoring methods do not make it possible to estimate the percentage of titanium in a solid solution. Figure 1, tables 2.

Increasing the Quality of Continuously Cast Round Billets Made of Corrosion-Resistant Chromium-Nickel Steel

927D0179I Moscow STAL in Russian No 3, Mar 92 pp 32-37

[Article by V.V. Frolochkin, V.A. Salautin, V.Ya. Genkin, V.Yu. Kuznetsov, and A.A. Safronov, Volzhsk Pipe Plant and Central Scientific Research Institute of Ferrous Metallurgy imeni I.P. Bardin; UDC 621.746.628.047]

[Abstract] The Volzhsk Pipe Plant has contracted with the Italian firm Italimpyanti to produce 830,000 metric tons of cast blooms of carbon and alloy steel for seamless pipes produced on a continuous mill and 210,000 tons of round billets made of carbon and alloy steel for a pipe-pressing shop. Researchers from the pipe plant worked together with researchers from the Central Scientific Research Institute of Ferrous Metallurgy imeni I.P. Bardin as well as the plant Dneprospetsstal and the All-Union Scientific Research and Technological Design Institute of the Pipe Industry to determine whether it is fundamentally possible to produce hot-pressed pipes from round continuously cast billets of chrome-nickel corrosion-resistant steel. The researchers also worked to establish quality criteria and preliminary processing requirements for the cast billets. Melts of the following steels were used to produce semicontinuously cast round billets: 12Cr18Ni10Ti (used for two of the six melts), 08Cr18Ni10, 03Cr18Ni11 (used for two of the melts), and 03Cr19NMn3Ni10. The resultant billets were then used to produced pipes 219 mm long and 10, 12, or 20 mm in diameter. On the basis of the tests performed, the researchers concluded that it is fundamentally possible to use semicontinuously cast ingots of chrome-nickel corrosion-resistant steel to manufacture hot-pressed pipes. The studies also demonstrated that the negative effects that the transcrystallite structure at the surface of cast billets has on the surface quality of finished pipes may be eliminated by reducing the starting billet and then subjecting it to recrystallization when heating it for rolling. The best pipe surface quality was obtained when billets of titanium-free low carbon steel were used. The main task remaining in the process of establishing the production of continuously cast round billets of titanium-containing steel is that of developing process parameters that will result in cast billets without surface defects and with the proper cross section. Figures 6, tables 3; references 4 (Russian).

Production of Boiler Tubes

927D0179J Moscow STAL in Russian No 3, Mar 92 pp 56-59

[Article by A.A. Kobus, T.P. Vashchilo, L.V. Opryshko, G.I. Gulyayev, and V.V. Chelyshev, All-Union Scientific Research and Technological Design Institute of the Pipe Industry Scientific Production Association and Volzhsk Pipe Plant; UDC 621.774:621.181.021]

[Abstract] In 1988 the Volzhsk Pipe Plant began manufacturing commercial boiler tubes by the method of hot pressing in their new shop furnished with equipment purchased from a consortium of foreign firms. The plant also developed a pressing and heat treatment process designed for use with the shop's new equipment. Test batches of pipe were produced from 260-mm-diameter billets obtained from the Serov Metallurgy Plant. The following types of steel were used: 20, 15MnSi, 15CrMo, and 12Cr1MoV. After debugging of the production process had been completed (also in 1988), the plant began supplying commercial batches of hot-rolled and hot-pressed commercial boiler tubes made of 20 and 15MnSi steel in accordance with specification TU 14-3-460-75. The pipes produced by pressing (on presses with a force of 20 and 55 MN) had thinner walls than those produced by rolling (the former had an 85-96 percent deformation versus the 60-80 percent deformation of the latter). The said pipes were the first domestically produced pipes whose quality conformed to the requirements stipulated in specification TU 14-3-460-75 and whose geometric indicators conformed to the requirements set in TU 14-3-1526-87. Plant workers were unable to successfully use the two other steels tested (15CrMo and 12Cr1MoV) due to a lack of the equipment required for double heat treatment (normalization and tempering). Tables 2.

Production of Iron-Based Powder Sheets

927D0179L Moscow STAL in Russian No 3, Mar 92 pp 78-79

[Article by L.S. Shmelev and V.K. Sorokin, Vyksa Metallurgy Plant and Nizhegorod Polytechnic Institute; UDC 621.762]

[Abstract] A series of iron-based powder sheets has been developed based on a series of previously reported theoretical and experimental studies. The new sheets are intended for a variety of uses, including as filter, antifriction, and abrasive diamond (containing 25 percent) materials. From a chemical composition standpoint, they are essentially analogous to materials produced by other techniques. The new powder-based sheets are available in a wide range of thicknesses (from 0.04 to 7.5 mm), lengths (190 to 1,000 mm), and widths (25 to 600 mm). The rolled sheets are produced in porous (consisting of up to 45 percent pores) and nonporous versions. The powdered sheets may be produced in thicknesses constituting roughly as much as 1 percent of the diameter of the roller and produced on mills with roller diameters ranging from 50 to 900 mm. The maximum achievable thickness (without sacrificing sheet quality) depends on the quality of the starting powders. Cr18Ni15 steel with a relative bulk density of 26-28 percent, for example, may be used to produce sheets with a maximum porosity of 48 percent. The sheets are sintered in bundles in batch furnaces (sometimes in a vacuum). When nonporous sheets are required, sheets with a porosity of 25-30 percent are subjected to additional compacting rolling with intermediate sintering-annealing until the desired thickness is achieved. Table 1; references 3 (Russian).

Ferronickel Production at Pobugskoye Nickel Works and its Development Outlook

927D0196A Moscow TSVETNYYE METALLY in Russian No 6, Jun 92 pp 8-11

[Article by A.Ye. Burochkin, Pobugskoye Nickel Works; UDC 669.243]

[Abstract] Advanced methods of producing ferronickel from local oxidized low-grade nickel ores containing 0.97 percent Ni at the Pobugskoye Nickel Works developed by the Gipronikel State Nickel Industry Design Institute, especially the methods of regulating the melt temperature and recovering the excess heat released in the converter due to the silicon, carbon, and chromium oxidation and the technology for cooling the melt in an acid converter using the Krivoy Rog iron ore and nickel-containing byproducts of Ni-alloyed steel and alloy melting are described. The new method calls for producing only the FN-5 refined ferronickel at first, then expanding production to casting ferronickel brands used in various machines. Production of a complex Fe-Ni-Co-Cu alloying composition and FN-K ferronickel developed by the Casting Problems Institute at the Ukrainian Academy of Sciences, the Magnit Production Association in Novocherkassk, and the Pobugskoye Nickel Works for making the YuNDK alloy used in permanent magnets is summarized and a block diagram of commercial ferronickel production at the plant is cited. The raw material extraction and preparation for smelting, the electric melting of the cinder, and the ferronickel refining and casting are outlined. The new technology is waste-free and all gases liberated in the process are scrubbed to remove dust; the gas effluents meet the maximum permissible concentration requirements while the resulting dust and sludge are returned back to the production cycle. Electric furnace slag is used for making crushed stone for road construction. The measured taken to decrease the electric power consumption are described. Figures 1.

Current Practices of Oxidized Nickel Ore Processing Abroad

927D0196B Moscow TSVETNYYE METALLY in Russian No 6, Jun 92 pp 11-17

[Article by M.L. Veyzager, S.P. Kormilitsyn, State Nickel Industry Design Institute; UDC 669.243(4-87)]

[Abstract] Current practices of processing oxidized nickel ores which account for 80 percent of world nickel reserves but yield only 43.4 percent of commercial products used at 11 plants in the capitalist countries as well as in the former Yugoslavia, Poland, and eastern Germany are reviewed and compared to the methods used at the Pobugskoye Nickel Works (PNZ)—the principal producer of ferronickel in the CIS. The technologies used to make ferronickel and converter matte and the hydrometallurgical methods are outlined and the annual Ni output, Ni concentration in the ore, brief process description, and the final product are summarized. A procedure developed by the ELKEM company and first implemented in 1958 at the Doniambo plant (New Caledonia) is described and an ELKEM process chart is cited. The impurity content (C, Si, P, S, Cu, and Cr) in ferronickel according to the ISO 6501 standard is summarized. It is stressed that for any plant, the final decision on the expediency of using a particular production technology should be made only on the basis of a feasibility study allowing for the local conditions. Cobalt recovery from the converter matte is considered. Figures 1; tables 2; references 15: 6 Russian, 9 Western.

On Converting Urals Nickel Works to Ferronickel Smelting in Shaft Furnaces

927D0196C Moscow TSVETNYYE METALLY in Russian No 6, Jun 92 pp 17-19

[Article by I.D. Reznik, T.A. Kharlakova, O.V. Konyayev, State Nonferrous Metallurgy Institute; UDC 669.243]

[Abstract] The practice of using shaft smelting of oxidized nickel ores to make matte for subsequent separate Ni and Co recovery used at Urals nickel smelteries is contrasted to the electric smelting of oxidized nickel ores to produce ferronickel currently used abroad. The advantages of ferronickel smelting over matte smelting are discussed and it is noted that in the former, up to 90 percent of Co passes to ferronickel and is paid for at nickel rates since there are no customers of Fe-Ni-Co ternary alloys. A method proposed by the Gintsvetmet for smelting ferronickel in a shaft furnace with a sealed furnace top and the advantages of shaft furnace smelting over electric smelting are outlined. It is suggested that Urals nickel smelteries be transferred to the shaft furnace method based on the successive experience of the New Caledonia nickel works as well as the West plant in Germany. The initial data for analyzing the comparative efficiency of matte and ferronickel smelting are summarized and the technical and economic indicators of the ferronickel and matte smelting are compared. The ferronickel smelting method is free of sulfur dioxide emissions and is characterized by an 85-90 percent Co recovery vs. 34-40 percent for the matte smelting method. Figures 1; tables 2.

New Process of Oxidized Nickel Ore Smelting in Two-Zone Unit

927D0196D Moscow TSVETNYYE METALLY in Russian No 6, Jun 92 pp 19-21

[Article by O.A. Ryzhov, Ye.M. Vigdorchik, K.I. Mosiondz, O.I. Zheldybin, L.B. Tsymbulov, Ye.I. Yezhov, M.R. Rusakov, State Nonferrous Metallurgy Institute; UDC 669.243.1:552.578.1]

[Abstract] A new process of coke-free oxidized nickel ore smelting in a two-zone smelter—an alternative to existing shaft furnace smelting—proposed due to an

acute shortage of coke and an increasing stringency of environmental regulations is discussed. The new method is based on combining two processes developed at the Gipronikel Institute: smelting oxidized nickel ores to make ferronickel and depleting slags and recovering metals from the oxidized melt in electric furnaces with the help of the reducing agent delivered to the near-electrode zone. The principal advantages of the new coke-free oxidized nickel ore smelting, primarily the use of easily available and relatively cheap fuels, extensive oxygen utilization, and use of intensive melt stirring to improve the heat and mass transfer, are outlined and the electric furnace specifications are summarized. The matte smelting process is environmentally clean and results in production of matte containing 20-25 percent Ni. A study of pilot ferronickel smelting batches examined at the Ufaleyskiy Nickel Works shows that the process is characterized by a 94.8 percent Ni and 85-87 percent Co recovery into ferronickel with a 12-18.5 percent Ni content. Figures 1; references 2.

Measuring Dispersed Particle Size in Liquid Aluminum Sputtering by Ejection

927D0196E Moscow TSVETNYYE METALLY in Russian No 6, Jun 92 pp 35-37

[Article by B.R. Osipov, All-Union Aluminum and Magnesium Industry Institute; UDC 621.762]

[Abstract] The relationship between the dispersed particle size on the work done in changing the surface of the original large drops is discussed and the functional dependence of the mean small drop radius on the maximum work done in transforming a large drop into small drops and against the surface tension forces is derived. The effect of the liquid spraying nozzle diameter on the fraction composition of the atomized aluminum powder and the pulverized particle distribution curves on a logarithmically probabilistic scale are plotted. Four types of powders are identified by an experiment conducted at the All-Union Aluminum and Magnesium Industry Institute (VAMI), depending on the propellant rate, chemical composition of the melt, working gas pressure, and the ejection sputtering element configuration. An analysis of the mean particle size distribution shows that it follows the lognormal law (LNR); a formula is derived for calculating the mean particle size distribution for dispersed aluminum powders. The formulas and the curves make it possible to determine the yield of any fraction: in the studies conducted with dispersed aluminum powders, the minimum and maximum distribution mean and standard deviation are equal to 26.6-81.3 μm for the former and 2.34-4.07 for the latter. Figures 2; references 9.

Local Process of Acid Solution Neutralization From Hydraulic Washout of Titanium Production Waste

927D0196F Moscow TSVETNYYE METALLY in Russian No 6, Jun 92 pp 48-50

[Article by Yu.P. Kudryavskiy, R.G. Freydlina, E.I. Bondarev, V.A. Azarov, Yu.A. Polyakov, Russia's Titanium and Magnesium Institute and BTMK; UDC 669.295.002.8]

[Abstract] Rapid silting of the slime pond for storing the waste from TCl_4 production due to the high concentration of the hydrolyzing salts and attempts to prevent these salt solution discharged into the "white sea" (as the pond is called) prompted the development of an alternative waste processing method which involves hydraulic washout of the spent melt, pulp circulation until saturated solutions are obtained, neutralization with lime milk to pH=8.0-8.5 with subsequent sediment flocculation, and final sediment filtering and rinsing. A flow chart of the new process is cited, the neutral effluent clarification from hydraulic washout of titanium chlorinators, acid effluent solution neutralization and pulp filtering, and economic losses from dumping 1 t of spent fusion cake are summarized. An analysis of the local waste neutralization technology shows that its implementation improves the environmental conditions in the water basin by eliminating highly toxic waste discharges and preventing a loss of 18 million rubles. The use of 130-150 percent of stoichiometric lime milk concentration leads to a total precipitation of metals. Figures 1; tables 3; references 1.

Effect of Timed Heat Treatment of Melt on Phase Composition of R6M5F3 High Speed Steel Powder

927D0204A Kiev POROSHKOVAYA METALLURGIYA in Russian No 5 (353), May 92 pp 1-3

[Article by L.A. Poznyak, S.Ya. Golub, Yu.V. Sorokin, A.S. Fomichev, Institute of Materials Science Problems at the Ukrainian Academy of Sciences, Kiev; UDC 621.735]

[Abstract] The efficacy of timed heat treatment (TVO) of melts for producing high speed steel powders by the gaseous spraying method is discussed, and the effect of the timed heat treatment of the R6M5F3 high speed steel powder and the solidification rate on the characteristics of the particle phase composition is investigated in four powder batches: a commercial batch from the Dneprospetsstal works; a batch produced by conventional technology at the Institute of Materials Science Problems at the Ukrainian Academy of Sciences; a batch produced by sputtering a melt overheated to 1,800°C without an exposure to this temperature; and a batch produced by spraying a melt using the TVO, including a melt overheating to 1,750°C and a 15 min exposure to this temperature, cooling to 1,550°C, and sputtering at 1,550°C. Diffraction patterns of gas-sprayed high speed steel powders are plotted. The X-ray diffraction study performed using a DRON-3 diffractometer in monochromatic radiation and an HCG-4A diffractometer in Co*K* radiation shows that the phase composition differences are the greatest in powders with a ≤ 50 μm fraction produced by overheating the melt to 1,800°C before spraying; these particles contain primarily δ-ferrite with a small fraction of austenite and MC carbide. The phase composition behavior as a function of the particle size and overheating degree are consistent with the microhardness data: HV=850 MPa for large particles in batch 4, 750 MPa for small particles in the same batch, and 650 MPa for the small fraction in batch 3. Figures 1; references 6.

Stability of Moisture Capacity of Alba Alloy Powder Doped by Si, Mg, and Ti

927D0204B Kiev POROSHKOVAYA METALLURGIYA in Russian No 5 (353), May 92 pp 4-6

[Article by I.N. Ganiyev, N.A. Kurbanova, L.T. Dzhurayeva, B.B. Dzhabbarov, Chemistry Institute at the Tadzhik Academy of Sciences, Dushanbe; UDC 621.762:669.71:893.782.721.295]

[Abstract] The shortcomings of the Alba aluminum-barium alloy powders, particularly their high activity due to the high Ba concentration, are discussed and an attempt is made to increase the Alba alloy stability and moisture capacity by additionally doping it by Si, Mg, and Ti. To this end, alloys are produced in SNV vacuum lab furnaces in a high-purity Ar atmosphere. The effect of Mg and Ti additions on the amount of gas liberated from the Alba powder in water at room temperature and the dependence of the Alba alloy powder's moisture absorption on the Si, Mg, and Ti concentration in it are plotted. The effect of Si on the Alba alloy stability at various phase compositions, the percentage change in the powder mass of doped Alba powder during moistening, and the moisture capacity of the $BaAl_4$ alloy doped by Si, Mg, and Ti are summarized. An analysis of the findings shows that alloy powders containing 1-3 percent of the dopant (by mass) which corresponds to the limit of its solubility in the $BaAl_4$ intermetallic compound are characterized by the highest stability. Figures 2; tables 3; references 3.

Effect of Sintering Temperature and Duration on Physical-Mechanical Properties of Steel PK40N2M

927D0204C Kiev POROSHKOVAYA METALLURGIYA in Russian No 5 (353), May 92 pp 38-43

[Article by A.I. Ulyanov, R.G. Fayzullin, N.A. Sidorov, A.I. Zvonarev, G.Ya. Bushmeleva, Engineering Physics Institute at the Urals Department of Russia's Academy of Sciences, Izhevsk, and NIIMT at the Izhstal Production Association; UDC 621.762]

[Abstract] The reasons for the spread of the strength characteristics of carbon steel powder products are discussed. And the confidence coefficient of the magnetic methods of nondestructive testing of the structural state and strength characteristics of sintered steel PK40N2M is investigated by studying its physical and mechanical properties as a function of the sintering temperature and duration fluctuations. To this end, rectangular samples are produced by single-pass compaction of a mixture of initial components to a 6.9 g/cm^3 density, then sintering them in dissociated ammonia under varying temperatures within a 1,100-1,270°C range for 0.5-3 h. The coercive force, saturation magnetization, modulus of elasticity, density, HB and HRC hardness, yield strength, ultimate strength, elongation, reduction of area, and toughness are measured. The effect of the sintering temperature on the density, hardness, saturation magnetization, coercive force, and modulus of elasticity of steel, the effect of the sintering temperature on the yield point, ultimate strength, elongation, reduction of area, and toughness of steel, the behavior of density, hardness, saturation magnetization, coercive force, and elasticity modulus of steel as a function of the sintering duration, and the behavior of the yield strength, ultimate strength, elongation, reduction of area, and toughness of steel as a function of the sintering duration are plotted individually. The study shows that the coercive force generally reflects the structural changes occurring in the material under heat treatment which determine its strength characteristics. A need for further studies is stressed. Figures 5; tables 1; references 6: 5 Russian, 1 Western.

Surface Alloying of Fe-Based Powder Materials

927D0204D Kiev POROSHKOVAYA METALLURGIYA in Russian No 5 (353), May 92 pp 53-59

[Article by S.G. Agbalyan, D.E. Malyan, E.S. Abovyan, N.N. Manukyan, L.G. Galstyan, S.A. Asila, Yerevan Polytechnic Institute; UDC 539.389.2:621.762]

[Abstract] The effect of chemical processing and heat treatment on powder materials and the use of complex alloying for the purpose of surface hardening of structural powder materials are discussed; and the structure of the diffusion layers is investigated both after metal plating and diffusion annealing. The characteristics of the surface layer of powder materials after metal plating, the element percentage distribution in the diffusion layer depth of powder materials after annealing, and the results of mathematical processing of the diffraction analysis data and certain structural parameters of metal-clad samples are summarized; and the diffraction profiles of the (220) reflex of powder samples are plotted. The study shows that the chemical composition of Fe-C-Cr, Fe-C-Cr-Ni, and Fe-C-Cr-Mo diffusion layers is close to that of standard low carbon steels 40Kh, 40KhN, and 38KhM while steels P40Kh, P40KhN, and P38KhM have $(\alpha+Cr_{23}C_6)$, $(L+(Cr, FeNi)_7C_3)$, and $(\alpha+(Cr+FeMo)_7C_3)$ components. After diffusion annealing, the elements are uniformly distributed in the layer to a 1.5-3.0 mm depth. The two- to three-fold decrease in the integral intensity of α-Fe reflexes revealed by a diffraction analysis confirms the formation of substitution solid solutions on the basis of α-Fe during the diffusion annealing; no lattice parameter patterns are established. Figures 3; tables 3; references 3.

Phase and Chemical Transformation During Partially Stabilized ZrO_2 Sintering

927D0204E Kiev POROSHKOVAYA METALLURGIYA in Russian No 5 (353), May 92 pp 85-89

[Article by M.I. Kabanova, V.A. Dubok, Institute of Materials Science Problems at the Ukrainian Academy of Sciences, Kiev; UDC 621.762.5:661.883:666.3/.7]

[Abstract] The differences in the phase composition occurring during the sintering of partially stabilized ZrO_2 (ChSDTs) near the surface and in the bulk of the items and the poor reproducibility of the yttrium concentration behavior in the surface layer are discussed; and the behavior of the phase composition and stabilizing yttrium addition concentration in the surface layer of samples produced by sintering of powder compacts of various structures in the air and in a vacuum is investigated. To this end, ceramic samples with 97 percent ZrO_3 and 3 percent Y_2O_2 produced by semidry one-sided compaction under a 250 MPa pressure and sintering at various temperatures from powders synthesized by different methods are examined. The yttrium addition concentration is determined by an emission spectral analysis using an SP-30 instrument with an IVS-28 arc excitation source while the phase and chemical composition are studied on untreated surfaces. The X-ray phase analysis is conducted using a DRON-3 diffractometer in Cu*K* radiation and the yttrium concentration behavior near the surface is measured by the X-ray fluorescent method using an FRA-30 instrument by exciting two Y fluorescence frequencies: *K* and *L*. The dependence of the Y_2O_3 concentration in the 1 and 40 μm layers on the sintering temperature is plotted. A comparison of the phase and chemical compositions of sintered samples indicates that the impurities in the initial powders affect their concentration in the ceramics. The conclusion is drawn that the phase and chemical compositions of the surface layer are determined by the initial powder purity and the sintering temperature and conditions. For example, sintering in the air leads to the surface layer enrichment with yttrium oxide and the T'-phase only in the samples containing a silicon impurity while sintering in a vacuum leads to an yttrium oxide and T'-phase depletion in the surface layer and a decrease in the lattice parameters. A formula is suggested for calculating the amount of the nonequilibrium tetragonal T'-phase forming due to a nondiffusive transition from the cubic phase. Figures 1; tables 2; references 14: 5 Russian, 8 Western, 1 Eastern.

Thermal Stability of Aluminum Composite Materials Containing Copper, Molybdenum, and Zinc Sulfides

927D0204G Kiev POROSHKOVAYA METALLURGIYA in Russian No 5 (353), May 92 pp 89-92

[Article by A.T. Volochko, I.N. Rumyantseva, Engineering Physics Institute at the Belarus Republic Academy of Sciences, Minsk; UDC 621.762]

[Abstract] The use of copper- and iron-based aluminum composites (KM) with nonmetallic inclusion particles in contact with solid lubricants on the basis of metal sulfides is discussed; and the the thermal stability of aluminum composites is investigated by metallographic, X-ray diffraction, and complex differential thermal (DTA) analyses. The mechanism of the sulfide interaction with the base is examined and the behavior of the material structure and properties is studied. In so doing, an extruded sample from the PA-4 aluminum powder is used as a standard. The sample friction coefficient and hardness are measured at each process stage. The differential thermal analysis curves of a composite with Cu_2S, MoS_2, and ZnS inclusions and the behavior of the friction coefficient and hardness of aluminum composites with Cu_2S, MoS_2, and ZnS inclusions as a function of exposure to a 500°C temperature are plotted. An analysis of the findings shows that only MoS_2 interacts with Al under heating, forming an Al_2S_3 phase while copper sulfide turns under heating into a Cu_9S_5 phase. There are two modifications of ZnS after the extrusion.

The conclusion is drawn about the expediency of producing composites and composite products at temperatures below 400°C and reinforcing the composites with sulfides by alloying the aluminum base without subsequent heat treatment. Figures 3; references 11.

Platinum Alloy Scrap Processing for Cold Crucible Remelting

927D0196I Moscow TSVETNYYE METALLY in Russian No 6, Jun 92 pp 66-68

[Article by N.M. Slotintsev, Ye.I. Rytvin, Ye.V. Lapitskaya, L.F. Urazova, Stekloplastik Scientific Production Association; UDC 669.018.45]

[Abstract] Ways of efficiently utilizing platinic metals in equipment for producing high-quality glass, silicate fibers, and other silicate items by means of nonrefining processing of this equipment after the expiration of its service life is discussed; and it is noted that such processing of worn-out equipment—secondary raw materials and scrap—from platinic metals calls for removal of silicate inclusions from the surface with subsequent induction melting combined with electromagnetic confinement of the melt within a sealed cold crucible. A Pt-Rh-Ru-35-0.1 alloy is used to test the technology. The impurity element concentration in the alloy before and after remelting in a cold crucible, the quality indicators of the microinclusions (MKV) in alloy samples after operation and following cold crucible remelting, the qualitative analysis of alloy inclusions before and after remelting under various gases, and the high-temperature strength characteristics of the alloy after remelting in a cold crucible; and the service life of the products made from the alloy are summarized. The study shows that remelting of the scrap platinic metals with flux ensures a long time to failure; the longest service life of items made from the platinic alloy scrap is attained after the metal is cleaned in hydrofluoric and hydrochloric acid. Tables 4; references 3.

Equipment Upgrading and Hot Strip Rolling Practices

927D0209D Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian No 2 (164), Apr-Jun 92 pp 13-15

[Article by A.G. Svichinskiy, Karaganda Integrated Iron and Steel Works; UDC 621.771.237.016.2:658.589]

[Abstract] Two ways of increasing the output of sheet steel, increasing the efficiency of its production, and improving its quality—by bringing on stream new rolling mills or upgrading the equipment, improving technology, and developing and implementing advanced designs—are compared and it is noted that the latter path is often more economical, simpler, and faster to realize.; the possibility of increasing the output and improving the sheet product quality is demonstrated using the example of wide-strip hot mill 1700 at the Karaganda Integrated Iron and Steel Works (ShSGP). It is shown that by upgrading wide-strip hot mill 1700 at the Karaganda Integrated Iron and Steel Works, equipping the continuous furnace with warm riders, heat insulating the water-cooled pipes, overhauling the strip cooling system on the run-out roller table of the mill, and installing a second group of coiling machines as well as taking measures to improve the temperature, straining, and speed conditions of the rolling process, the plant is able to increase the mill output by more than 5 percent and decrease the number of metal strips rolled in violation of the temperature specifications by almost two-fold. References 1.

Developing Technology for Making High-Strength Tubes From 36NKhTYuM5 Alloy

927D0209F Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian No 2 (164), Apr-Jun 92 pp 19-20

[Article by A.V. Chub, I.P. Ostrovskiy, T.Ya. Vasilyeva, V.A. Omelchenko, All-Union Scientific Research Tube Industry Institute; UDC 621.774:669.14.018.295]:621.78]

[Abstract] The constantly rising demand for metallic materials with elevated operating properties necessitated by the development of new technologies and the resulting complication of the chemical composition of steels and alloys due to the need to add the alloying component prompted an investigation of the procedure for making high-strength tubes from the 36NKhTYuM5 alloy widely used in flexible sensors with an ultimate strength after age hardening of at least 1,400 N/mm^2. Process stage tubes with a 25 x 1.5-2.0 size manufactured by the Nikolayev Southern Tube Mill according to the TU 14-242-221-83 specifications are used as the source material. The heat treatment conditions are outlined and the behavior of the ultimate rupture strength and elongation of tubes from the 36NKhTYuM5 alloy as a function of the grain size number (i.e., the hardening temperature) and the behavior of the ultimate rupture strength and elongation of tubes from the 36NKhTYuM5 alloy as a function of the aging temperature are plotted; an analysis of the findings shows that as the aging temperature is increased from 650 to 750°C, the ultimate rupture strength increases, peaking at 750°C, whereby the ultimate rupture strength is equal to at least 1,400 N/mm^2; the elongation changes little within this temperature range but the rupture strength decreases in the case of aging due to a partial phase dissolution and coagulation. No significant difference in the deformation degree is recorded before or after aging. It is suggested that aging be carried out at a 750°C temperature for 4 h. Figures 2.

Secondary Aluminum Alloy Refining to Remove Mg Impurity

927D0196H Moscow TSVETNYYE METALLY in Russian No 6, Jun 92 pp 59-60

[Article by V.M. Grigorenko, Donetsk Nonferrous Metallurgy Institute; UDC 669.71.48.054]

[Abstract] The shortcomings of treating casting melts with the cryolite- and chloride-containing titanium production waste flux and vacuum distilling for removing magnesium impurities are outlined and the possibility of reducing the cryolite consumption by two-fold or substituting it with its components with or without oxidizing agents is investigated. To this end, casting aluminum alloys of the Al-Si-Cu-Mg-Mn and Al-Mg systems with 1.30-1.90 percent Mg content are used. The fluoride, fluoride-carbonate, and chloride-carbonate refining processes are examined. The magnesium removal indicators of the Al-Mg system are summarized and the methods of magnesium removal from the aluminum melt are compared. The technical and economic indicators of the 45-min long magnesium removal process are cited. An analysis of the above methods indicates the expediency of halving the cryolite consumption or substituting it with its components with or without oxidizing agents and demonstrates that dolomite can be very efficient as an oxidizing agent. Tables 3; references 2.

Ultrasound Quality Control of Solid Railroad Wheels

927D0179K Moscow STAL in Russian No 3, Mar 92 pp 67-69

[Article by M.F. Yevsyukov, M.I. Staroseletskiy, G.Ye. Pakhomov, A.P. Shuvalov, and L.I. Bondarenko, Ferrous Metallurgy Institute and Nizhnndneprovsk Pipe Rolling Plant; UDC 620.179.16:629.4.027.4]

[Abstract] A new ultrasound inspection method was developed for use in controlling the quality of solid (rolled in one piece) railroad wheels produced at the Nizhnedneprovsk Pipe Rolling Plant. The new ultrasound inspection technique, which was introduced at the plant in 1985-1987, entails the use of an inspection instrument that is in turn based on a contactless electromagnetic-acoustic

[EMA] method of exciting and receiving ultrasonic vibrations. The EMA method is based on the effect of the conversion of high-frequency electromagnetic vibrations into acoustic vibrations and vice versa by the surface of the metal being inspected in a constant magnetic field. The unit's operating frequency is adjusted based on a control specimen with artificial flaws occupying an area of 7 mm^2 in the form of a flat-bottomed drilled cavity 3 mm in diameter and 40 mm deep. The unit's sensitivity tuning level meets U.S. ASTM A25-81 and ASTM A504-83 standards. A frequency of 2 MHz is used during the inspection process, and a gap of 0.8 to 1.0 mm between the converter and inner side surface of the wheel being inspected is used. Tests of the new ultrasonic inspection unit and process confirmed that they may be used to detect actual metallurgical and rolling flaws (including liquation, flakes, bubbles, slag inclusions, and films) measuring 3 mm or more. The studies performed further established that using the new ultrasound inspection procedure in conjunction with sampled macroinspection results in solid wheels of the required quality. Since the new procedure was introduced at the Nizhnedneprovsk Pipe Rolling Plant, between 0.2 and 0.5 percent of the sold wheels produced have been found to have internal flaws (of these, 80 to 85 percent involve a break in continuity in sections of liquation). Figures 3.

Electric Welded Carbon Steel Pipes for Domestic Refrigerators

927D0209G Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian No 2 (164), Apr-Jun 92 pp 26-28

[Article by V.I. Mizera, K.I. Shkabatur, A.I. Derevyanko, T.P. Rodionova, I.V. Lobanova, All-Union Scientific Research Tube Industry Institute; UDC 621.774.21:621.791.7]:641.546.44]

[Abstract] The inadequacy of existing smooth bore electric welded pipes used in domestic refrigerators prompted the use of new electric welded pipes of the same small size but with a capillary serrature with a 0.1-0.2 mm depth; this increases the maximum cooling from -6°C to -18°C or lower and improves the refrigerator performance. Since the local industry does not produce such pipes, the production technology for small-diameter carbon steel electric welded pipes with ragging is examined and the basic requirements imposed on the refrigerator pipe-making practices are formulated. The pipe diameters and serrature parameters and the mechanical and performance properties of the pipes are summarized; under the new technology, the pipes are made form coil steel 09kp with a strictly controlled Cu concentration; the optimum serrature cut by knurling has a bevel angle of 90° and a 0.15 mm rounding radius at the bottom; the pipes are subsequently welded by rectified direct current. The use the new pipes will result in savings of 500,000 rubles per year due to decreasing the cost of domestic absorption refrigerator production and lowering the energy outlays for their operation. Tables 2; references 7: 5 Russian, 2 Western.

Results of Numerical Analysis of Stresses and Displacements During Surfacing of Dredge Casing's Inner Surface

927D0203A Kiev AVTOMATICHESKAYA SVARKA in Russian No 1 (466), Jan 92 pp 3-6

[Article by V.I. Makhnenko, Ye.A. Velikoivanenko, F.L. Demura, V.M. Mozok, Electric Welding Institute imeni Ye.O. Paton at the Ukrainian Academy of Sciences; UDC [621.791.927.5:669.018.25:626.833-2]:539.4.014.001.24]

[Abstract] The use of analytical methods for the characteristic cases of working surface facing (surfacing) of thin dredge parts is discussed and this approach is used for the most complicated elements of the dredge casing which must be surfaced on the inside. To this end, mechanized surfacing of the 20R-11 dredges is performed by electric arc using flux-cored PP-Np-350Kh10B8T2 wire by a continuous method with minimal shutdowns in order to correct the electrode position. Certain assumptions are used to simulate the surfacing process for the purpose of numerical analysis, e.g., that the casing is a thin shell of revolution. The results of physical experiment and numerical analyses shows that the most radical displacements occur in surfacing the inner casing surface without bracing the casing itself and are roughly equal to 2.4 mm while surface preheating does not significantly diminish the radial displacements—they decrease merely to 2.2 mm. The use of rigid casing edge bracing decreases radial displacements to 1.3 mm which is less than the permissible deviation of +1.5 mm. Figures 4; tables 2; references 2.

Structural Transformation in High-Strength Steel 12Kh2N4MD Under Effect of Thermal Cycle of Electron Beam Welding

927D0203B Kiev AVTOMATICHESKAYA SVARKA in Russian No 1 (466), Jan 92 pp 13-16

[Article by V.I. Zagornikov, V.G. Vasilyev, D.P. Novikova, T.A. Korniyenko, Electric Welding Institute imeni Ye.O. Paton at the Ukrainian Academy of Sciences; UDC [621.791.72.052:669.14.018.295]:620.18]

[Abstract] The shortcomings of welded structures from high-strength KhNM steels subjected to electroslag remelting (EShP) and martempering, especially the low heat-affected area (ZTV) stability and cold cracking, are discussed and it is speculated that electron beam welding creates better conditions for joining; consequently, the austenite transformation in 60 mm thick samples of steel 12Kh2N4MD are investigated. To this end, steel samples are examined and continuous cooling transformation diagrams are plotted using two simultaneous simulation procedures. The characteristics of the structure formation in the weld and heat-affected zone under the effect of a concentrated energy source, i.e., the electron beam, analyzed with the help of the above two techniques made it possible to identify austenite decay not only by the martensitic but also the bainite kinetics within a narrow temperature range and establish the bainite and retained martensite concentration as well as the temperature range of martensitic transformations which eliminates clod cracking and ensures optimum mechanical properties of the welded joints. It is recommended that the metal be cooled at a rate of 5 to 30-40°C/s in order to ensure the optimum electron beam welded joint properties. Figures 5; references 6.

On Analyzing Diffusion Bonding of Dissimilar Materials

927D0203C Kiev AVTOMATICHESKAYA SVARKA in Russian No 1 (466), Jan 92 pp 22-24

[Article by P.K. Yanyshev, G.A. Aleksandrova, Moscow Aviation Technology Institute imeni K.E. Tsiolkovskiy and First Moscow Industrial Teachers College; UDC [621.791.4.052:539.378.3:669.018.29].001.24]

[Abstract] Two types of diffusion bonding of dissimilar materials, matched and unmatched, are discussed and it is noted that direct stress analyses and measurements in

joints are more reliable than data on the thermal coefficient of linear expansion (TKLR) which may serve only for crude estimates of the matching degree of the joined blanks. Three examples of stress analysis of diffusion-welded male and female parts (glass with metal, ceramics with metal, and multilayer sheet joint with ceramics at the center) are considered and the conclusion is drawn that the temperature-induced stress analysis allowing for the moduli of elasticity and dimensions of the joined elements results in a lower error than existing methods; moreover, the spread of the joint parameters may be limited by taking into account the state of the material and using ordered structures; it is shown that the structure may be ordered by means of stabilizing annealing; the experiments reveal that the ceramics and glass and multilayer sheet with ceramics joints rupture under cooling. Figures 2; tables 2; references 3.

Argon Arc Spot Welding of Thin-Sheet Finned Steel Structure Elements

927D0203D Kiev AVTOMATICHESKAYA SVARKA in Russian No 1 (466), Jan 92 pp 31-33

[Article by L.M. Lobanov, V.N. Zaichko, Electric Welding Institute imeni Ye.O. Paton at the Ukrainian Academy of Sciences; UDC 621.791.754'293.002:624.016.7-415]

[Abstract] The increasing demand for thin-sheet welded structures with spot welds which ensure lower deformation and small heat-affected area (ZTV) dimensions prompted a study of argon arc welding of finned thin-sheet steel structures, such as three-layered panels in which a housing consisting of parallel walls is welded to the skin; the advantages of argon arc welding over the laser beam welding due to the difficulty of focusing the laser beam are noted. The nonconsumable-electrode argon-arc spot-welding (ADTS NE) method and the pulsed arc welding technology developed by the Siaki Company for this purpose are examined and the effect of the filler metal volume on the breaking shear force is plotted. An analysis of the method demonstrates that the thermal cycle of nonconsumable-electrode pulsed argon-arc spot-welding can be controlled by the integral pulse technique. In an experiment, finned steel structures were welded with a slot weld made of individual spots with a 25 mm pitch. The mechanical tests of the welds reveal several areas with different types of fracture; all tests are performed without breaking the skin or tearing its surface. The UD496 numerical control welding unit developed for implementing this procedure is suitable for horizontal welding of items with an up to 2,500 x 1,100 mm dimension using an I181 power supply with programmed welding cycle control. The nonconsumable-electrode argon-arc spot-welding method makes it possible to ensure the requisite spot weld quality with a +/-3 mm welding tool positioning accuracy. Figures 2; references 2.

Computerized Electron Beam Welding Process Control System

927D0203E Kiev AVTOMATICHESKAYA SVARKA in Russian No 1 (466), Jan 92 pp 44-45

[Article by V.I. Kislyy, Electric Welding Institute imeni Ye.O. Paton at the Ukrainian Academy of Sciences; UDC 621.791.72.03-52]

[Abstract] A computer-aided electron beam welding unit (ELU) control system developed at the Electric Welding Institute imeni Ye.O. Paton at the Ukrainian Academy of Sciences for welding small items is described and its block diagram is cited. The unit is capable of fully automating all welding operations, including the preparation procedures, for open and closed butt welds with a random orientation and a length of up to 10 m. The system is also capable of automatically determining the joint coordinates, moving the electron beam gun (ELP) according to a stored program, automatically measuring the distance from the gun to the part and correspondingly controlling the beam current, focusing current, and beam scan amplitude, monitoring the equipment status before and during welding, and informing the operator about the process status and emergency situations. The new unit does not call for special welding operator skill training and increases the operating and control reliability. Figures 1; references 2.

Unit for Twin-Electrode Shielding Atmosphere Welding of Air-Cooling Device Chambers

927D0203F Kiev AVTOMATICHESKAYA SVARKA in Russian No 1 (466), Jan 92 pp 51-52

[Article by B.P. Ptitsyn, V.M. Leybzon, A.D. Kartashov, All-Union Scientific Research and Design Institute of Chemical and Petroleum Engineering, Volgograd and Chemical Machinery Institute, Borisoglebsk; UDC 621.791.754.03:62-712]

[Abstract] The method and equipment designed at the All-Union Scientific Research and Design Institute of Chemical and Petroleum Engineering and the "Khimmash" Chemical Machinery Institute for automatic consumable electrode welding of inner seams of air-cooling device (AVO) chambers in a shielding gas (CO_2 or Ar+CO_2 in a 80:20 ratio) using two VDU-509 welding power supply units are described and schematic diagrams of the welding unit and the chamber are cited. The A-1412 automatic welder mechanism upgraded for simultaneously advancing two wires is used as a feed device. The shielding gas is delivered autonomously to each welding torch. The Sv-08G2S wire is used as the filler. The use of the twin electrode arc welding method made it possible to address the issue of welding long seams inside products with a limited inner cavity space and avoid product deformations. The welding unit and procedure are implemented in Borisoglebsk. Figures 2.

Manganese Concentrate Pelletizing by Hot Compaction Method

927D0209A Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian No 2 (164), Apr-Jun 92 pp 3-4

[Article by V.F. Moroz, V.S. Baraban, Ferrous Metallurgy Institute; UDC 622.788.32:622.341.2]

[Abstract] It is virtually impossible to use untreated fine concentrates in ferroalloy production and thus increase the Mn recovery from ores; the shortcomings of the traditional methods of manganese concentrate preparation for subsequent process stages (e.g., sintering) prompted a study of disperse manganese concentrate pelletizing by other methods, such as hot briquetting. To this end, hot briquetting of manganese concentrates is investigated in a lab hot compaction unit whereby samples are molded in a graphite mold within a range from room temperature to 1,000°C, resulting in cylindrical briquettes with a 14 mm diameter. A carbonate manganese ore concentrate of the 3-10 mm class reduced to a 0-3 mm size and a flotation manganese ore concentrate with a 0.-0.5 mm size are used as the initial components. The chemical composition of the concentrates and the compression strength and density of the brunettes produced at various temperature and pressures are summarized. An analysis of the process shows that briquettes whose strength properties meet the requirements of ferroalloy production can be produced at a 700-800°C temperature and a 100 MPa pressure. It is demonstrated that moisture is removed and carbonates decompose during the briquetting process; this has a positive impact on the briquette properties and facilitates their fusing in the furnace. Tables 2; references 2.

Analysis of Blast Furnace Slag Basicity's Effect on Sulfur Content in Pig Iron

927D0209B Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian No 2 (164), Apr-Jun 92 pp 4-5

[Article by V.A. Kobelev, Ye.F. Shkurko, Ye.Yu. Barakovskikh, A.D. Nikanorov, S.P. Rogozhnikov, Urals Scientific Research Institute of Ferrous Metallurgy and Magnitogorsk Integrated Iron and Steel Works; UDC 622.788.32:622.341.2]

[Abstract] The increasingly stringent requirements imposed on the quality of conversion pig iron, particularly its sulfur content, due to bringing on stream the oxygen converter at the Magnitogorsk Integrated Iron and Steel Works (MMK) prompted an investigation of the relationship between the sulfur content in pig iron and the blast furnace thermal conditions, charge quality, and slag basicity. Eight linear regression equations of the slag basicity vs. pig iron sulfur content are derived and the dependence of the sulfur concentration in pig iron on the slag basicity in individual blast furnaces and the converter plant as a whole are plotted. Formulas are derived for calculating the sulfur concentration in pig iron; they produce the results which are consistent with the actual data. The study makes it possible to suggest expressions for calculating the dependence of the sulfur distribution coefficient between the slag and pig iron on the slag basicity for the specific conditions at the Magnitogorsk Integrated Iron and Steel Works. Figures 2; references 1.

Study of Mill Scale Briquette Composition and Structure

927D0209C Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian No 2 (164), Apr-Jun 92 pp 10-13

[Article by Z.I. Nekrasov (deceased), V.F. Moroz, V.I. Negoda, B.G. Rudovskiy, Ferrous Metallurgy Institute; UDC 620.191.32:622'188]:[669.017.3:620.18]

[Abstract] Rolling mill scale—one of the best iron-rich scrap products in metallurgy—is usually returned to the process stage through sintering and is used as a charge additive for caking. A new technology of pelletizing mill scale by hot briquetting and the requirements for producing briquettes with good metallurgical properties are discussed and the reduction heat treatment preparation and briquetting of mill scale as well as the phase composition and structure of the prepared charge and briquettes are investigated. To this end, scale was reduced in a lab rotary kiln in the shifting fluidized bed within an 800-1,000°C temperature range using natural gas and gassified coal (brand G) from western Donbass. The phase composition and structure are examined under a Neophot-2 optical microscope and Camebax scanning electron microscope. Polished scale and briquette microsections are examined in reflected light; chemical etching with a hydrochloric acid solution in alcohol is used to reveal the structure. Mill scale from the Krivorozhstal Integrated Iron and Steel Works is used in the study. The microstructure of the mill scale, briquettes from scale reduced by natural gas, and briquettes from scale reduced by carbon, and the surface structure of partially reduced scale are cited and the chemical and granulometric composition of scale and briquettes and the composition of a charge produced by scale reduction with coal as well as the properties of briquettes compacted from this charge are summarized. An analysis of the findings shows that briquettes with a 10 kN/sample strength or more are produced at an 850°C temperature and a 108 MPa pressure from a charge reduced by carbon at 850-1,000°C or natural gas at 800-1,000°C. Figures 4; tables 3; references 7.

On Comprehensive Approach to Solving Problem of Ore Dressing Production Line Design and Automation

927D0209K Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian No 2 (164), Apr-Jun 92 pp 42-44

[Article by I.V. Novitskiy, Dnepropetrovsk Mining Institute; UDC 622.733-52.001.63]

[Abstract] A set of generalized parameters which characterize the work of any link in a consecutive chain of ore dressing technology machines is outlined and the most common optimization tasks and their mathematical expressions are summarized. The relationship between three types of such optimization problems—optimization of the machine design at the development stage, optimal design of production systems, and optimal on-line control—is considered and the distribution laws of the random production line efficiency is plotted. The need for a comprehensive approach to solving these and other types of optimization tasks is identified as ensuring the possibility of exercising optimal control at the equipment design and production system development stage. It is shown that failute to adhere to the specified constraints in on-line control is a symptom that the production system is designed incorrectly. Figures 2.

Industrial-Scale Studies of Heap Gold Leaching From Pre-Pelletized Ores

927D0196J Moscow TSVETNYYE METALLY in Russian No 6, Jun 92 pp 68-70

[Article by G.A. Stroganov, G.V. Tsykunova, Irkutsk State Scientific Research Institute of Rare and Nonferrous Metals; UDC 622.485+622.794.2]

[Abstract] The expediency of prepelletizing poorly filterable ores and the ore dressing industry waste prior to heap leaching of gold is noted; and the results of industrial-scale studies of heap leaching of gold from oxidized ores from one Eastern Siberia deposits preceded by prepelletizing carried out in a unit consisting of a mixer, a granulator, and filtering columns using two ore samples and two overburden rock samples are presented. The dynamics of heap gold leaching from prepelletized ores and overburden rock are plotted and the heap gold leaching indicators of prepelletized ores and overburden rock, the composition of the low-basicity resin saturated during the heap leaching cycle, and the gold concentration and fraction distribution in the eluted solution are summarized. The study confirms the expediency and efficiency of preliminary auriferous clay ore pelletizing prior to leaching and it demonstrates the advantages of using low-basicity anionites for recovering gold from the heap leaching solutions. Up to 86.8-93.4 percent Au is recovered from ores and up to 60.8 percent Au from the overburden rock. It is recommended that the finding be used in planning and conducting heap leaching methods. Figures 1; tables 3; references 2.

Study of Possibility of Using Disc Gravity Machines in Separation

927D0196K Moscow TSVETNYYE METALLY in Russian No 6, Jun 92 pp 70-72

[Article by L.A. Lomovtsev, L.F. Subbota, S.A. Kravtsov, K.V. Nikolayenko, A.G. Shtarev, Ferrous Metallurgy Machining Institute; UDC 622.76/.77]

[Abstract] The advantages of proven granular and finely ground material separation technologies employing Bartles-Mosley and Cross-Belts separators with an orbital separating surface vibration are discussed and the possibility of using inclined vibrating surfaces for separating finely ground ores is investigated at the Ferrous Metallurgy Machining Institute and the designs of continuous-action disc gravity separators are developed. The equation of the ore slurry motion and separation are derived and solved and a schematic diagram of the KOD-3 orbital disc concentrator and its specifications are cited. For illustration, the results of tungsten-containing product separation in the KOD-3 at various disc rotation speeds and the results of auriferous ore separation on the SKM-1 concentrator table and KOD-3 disc gravity separator are summarized and compared. The advantages of the gravity separators over the concentrator tables are manifested most clearly in processing complex products, e.g., slurries consisting of fractions with a varying dressability, including poorly dressable (0.020-0.010 mm) ores. Lab studies demonstrates that a concentrate with 1.5-2.0 percent of useful component and a 60-70 percent recovery rate can be produced from Sn- and W-containing 0.040-0 mm slurries in a gravity separator. Thus, separation of minerals in a water flow on an inclined surface performing orbital vibrations makes it possible to process numerous poorly dressable products of various compositions. Figures 1; tables 3; references 3: 2 Russian, 1 Western.

On Need for Geodesic Monitoring of Structure Deformations at Integrated Iron and Steel Works

927D0209J Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian No 2 (164), Apr-Jun 92 pp 41-42

[Article by L.I. Kamyanaya, A.I. Chirva, Krivoy Rog Mining Institute; UDC 528.482:669.013.5]

[Abstract] The need to monitor the stability of industrial enterprise buildings to ensure their safe and reliable operation is stressed and it is noted that geodesic surveying and monitoring is the principal method of accomplishing this task. The measures which must be taken in order to set up deformation monitoring of production facilities at integrated iron and steel works and their stages are outlined; in so doing, five groups of structures are identified according to their design, purpose, and sensitivity to various external and internal factors. It is shown that to ensure that the geodesic monitoring program is successful, it is necessary to optimize and improve the monitoring methods and accelerate the development of regulatory documents governing such procedures on the basis of existing Building Standards and Rules (SNiP). References 4.

Improving Cost Accounting in Open Hearth Steelmaking

927D0209L Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian No 2 (164), Apr-Jun 92 pp 61-63

[Article by I.A. Medvedev, Ye.I. Mamontova, S.I. Bushchenko, Dnepropetrovsk Metallurgy Institute; UDC 669.141.243:[657.471:65.012.12].001.76]

[Abstract] A study of 15 large ferrous metallurgy enterprises with a total of 150 open hearth furnaces of varying capacity and 13 double-bath smelting units aimed at developing recommendations for improving the system of accounting for the outlays of ferroalloys and calculating the cost of steel production at these plants is described. Cost fluctuations of 1 ton of open hearth carbon steel in single- and double-bath furnaces at the Karaganda, Zaporozhstal, Magnitogorsk, Imeni Ilicha, Makeyevka, Cherepovets, Orsk and Khalilovo, Krivorozhstal, imeni .I. Petrovskiy, Nizhniy Tagil, Kommunarsk, imeni F.E. Dzerzhinskiy, Kuznetsk, Azovstal, and Donetsk integrated iron and steel works as well as the industry average are summarized. Ferroalloy outlay rates for steel 40sp in single-bath open hearth furnaces at four plants are examined for illustration. These procedures make it possible to identify hidden internal reserves for further lowering the cost of production by saving ferroalloys and increasing the open hearth plant efficiency. The conclusion is drawn that individual brands of groups of brands with similar properties must be analyzed in order to facilitate the cost analysis; it is also stressed that the losses from changing the brand of steel and rejection losses must be incorporated in the cost of production calculation. The need for using advanced instrumentation and computers is emphasized. Tables 2.

Enterprise Cost Analysis Under Market Conditions

927D0209M Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian No 2 (164), Apr-Jun 92 p 65

[Article by S.V. Zolotarev, V.N. Merkachev, A.F. Tapor, Odessa Polytechnic Institute and Odessa Steel Mill Association]

[Abstract] The importance of promptly discovering plan, standard, and norm violation, identifying culprits, and taking timely remedial measures for improving management is stressed and the following classification of cost factors is suggested for unit cost accounting: structural shift, a change in the wage level, and a change in pricing. The recommendations developed by the Odessa Polytechnic Institute for calculating and analyzing the shop-level cost of production on the basis of the aforesaid factors along two principal lines—the shop-level wage fund for individual expenditures and the wage fund as an economic element of outlays—are discussed. The Odessa Polytechnic Institute is offering a manual of its enterprise cost analysis under market conditions for 60 rubles.

Image Filtering in Optical Granulometer for Crushed Materials

927D0209N Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian No 2 (164), Apr-Jun 92 pp 66-67

[Article by V.I. Korniyenko, V.V. Glukhov, BISIP Interbranch Scientific Production Enterprise; UDC 622.13':[681.785.52:519.688]]

[Abstract] The shortcomings of existing algorithms and programs of granulometer video information processing on a microcomputer, particularly the considerable time it takes (more than 1 minute), prompted the need for filtering off the noise background from the image data in the measurement and communication channels of an optical granulometer for crushed materials which result in small image defects. The filtering process calls for smoothing and identifying the binary image fragment boundaries. The line-by-line and column-by-column binary filtering procedures which include a set of algorithms for breaking up and merging the image frame fragments are considered in detail. The use of the proposed algorithms makes it possible to improve the immediacy of the on-line control process, simplify the optical granulometer hardware, and relax the computer memory requirements, thus virtually removing the

response speed constraints. The procedure can be realized using a single PC with several video cameras. References 1.

Explosion Hazard of Powder Mixtures for Making Carbide Steels

927D0204I Kiev POROSHKOVAYA METALLURGIYA in Russian No 5 (353), May 92 pp 102-104

[Article by G.I. Vasilyeva, V.G. Tokhtuyev, Institute of Materials Science Problems at the Ukrainian Academy of Sciences, Kiev; UDC 614.833]

[Abstract] The parameters which characterize the explosion hazard of titanium carbide and high-speed steel R6M5K5 powders as well as their mixtures in a 1:1, 2:1, and 1:4 ratio intended for making carbide steels are examined experimentally. To this end, the titanium carbide powder is produced by wet grinding in a vibration mill with subsequent drying. The powder's explosion hazard in the suspended state is investigated in a unit equipped with a 3,400 cm^3 vertical reaction chamber while automatically recording the process behavior. An electric spiral heated to 1,100°C and a pyrotechnic igniter are used to initiate ignition; the temperature during the igniter combustion reaches 2,500°C. The study shows that the titanium carbide powder with a 6 m^2/g specific surface is extremely active in the suspended state and explodes at a pressure of 0.43 MPa with a pressure rise rate of up to 10 MPa x s^{-1}; the process can be inhibited by a nitrogen shielding atmosphere. The high-speed steel R6M5K5 steel is not very active in the suspended state and its lower concentration limit of flame propagation (NKPR) is 615 g/m^3 while the explosion pressure does not exceed 0.15 MPa with a maximum pressure increment rate of no more than 1.5 MPa x s^{-1}. The safe oxygen concentration for the former powder is 12.3 percent and for the latter—18.4 percent and the ignition temperature is 300°C and 1.075°C, respectively. The presence of the titanium carbide powder in a mixture with steel powder determines the mixture's high activity; even at a 1:4 ratio, the mixture explodes at a 0.35 MPa pressure with an increment rate of up to 10 MPa x s^{-1}. The minimum ignition temperature of this mixture is 785°C and its spontaneous ignition temperature in the layer is 320°C. Tables 1.

On Toxicity Classes and Hazard Levels of Arsenic-Containing Industrial Waste

927D0197A Moscow TSVETNYYE METALLY in Russian No 3, Mar 92 pp 9-11

[Article by N.I. Antipov, L.N. Vasilyeva, State Nonferrous Metals Institute; UDC 669.778]

[Abstract] The complexity and diversity of the environmental protection tasks is addressed from the viewpoint of Decree No. 4286-87 of 5-13 May 1987 by the USSR Public Health Ministry and USSR State Committee on Science and Technology which introduces a classification of industrial waste by the toxicity class and hazard level and mandates the methods of its safe use, neutralization, and burial. In addition to the maximum permissible concentration (PDK) factor, the LD_{50} lethal dose concept is used in determining the toxicity index K_i; relevant formulas for calculating the index through both factors are derived. The chemical substance hazard level (from extreme hazard to low hazard) classification, the hazard level classification of arsenic-containing industrial waste, the permissible analytical safe As content in various waste products calculated on the basis of the maximum permissible concentration factor, the permissible safe analytical As content in various waste products calculated on the basis of the lethal dose; and the toxicity index of arsenic-pyrite concentrate cinder of the former Angara Iron and Steel Works are summarized. For class I hazard level (extreme), the following figures are recommended: an upper toxicity index of 129 for the As content in the soil on the basis of the MPC factor and 75 for the As content on the basis of the lethal dose; the safe levels are defined as 0.002 percent for AsO_3 and <1.5 percent for metal arsenates. Tables 5.

Pyrrhotite Leaching by Sulfur Dioxide: A Solution to Environmental and Technological Problems of the Norilsk Mining and Metallurgical Combine

927D0190A Moscow TSVETNYYE METALLY in Russian No 5, May 92 pp 8-10

[Article by S. I. Sobol and E. M. Timoshenko, State Research Institute of Nonferrous Metals; UDC 669.2/.8]

[Abstract] The Norilsk Mining and Metallurgical Combine is coming under government-mandated controls to cut atmospheric emissions of sulfur dioxide by 73 percent before 2005 as compared with 1990 levels. One way being proposed to meet this requirement is greater use of hydrometallurgical techniques in processing of pyrrhotite concentrates. The technique of autoclave oxygen leaching has a yield of extracted nonferrous metals, especially platinum, that is not very high. Present levels at the combine are (in percentages): 87 Ni, 78 Cu, 83 Co, 75 Pt and Pd, 50 Rh, and 30-35 for the Ir, Ru, Os group. Consequently, only concentrates with the lowest economically feasible contents of nonferrous metals and platinoids are processed using autoclave oxygen leaching.

The authors propose introducing a so-called "anhydride" autoclave technique based on selective leaching of pyrrhotites with SO_2. In it, iron passes into solution in the form of $FeSO_4$, and the pyrrhotite sulfur and the sulfur in SO_2 pass into elementary sulfur. Reagent SO_2 could be supplied by building units for producing it in liquid form from sulfur-containing gases of pyrometallurgical works of the combine, as is done at plants such as Akita in Japan and Tacoma in the USA.

Studies by the State Research Institute of Nonferrous Metals indicate that the "anhydride" technique could

increase the extraction yield of basic components of pyrrhotite concentrates to the following levels (percentages): 96-97 Ni and Co, 99 Cu, 98 Pt and Pd, 95 Ir, Rh and Ru, with up to 85 percent of sulfur captured in elementary form. Other advantages of the "anhydride" technique are a much improved environmental situation on the plant grounds and in the surrounding area, and elimination of the need for a precipitator of nonferrous metals from leaching solutions. The operating conditions of the anhydride autoclave technique are: T = 90-130° C; P of SO2 = 0.1-0.25 MPa, time = 2 hours. Together with the iron in pyrrhotite, 1-3 percent Ni and <1 percent Co pass into solution; copper and platinoids remain in the sulfur-sulfide residues. Tables 1, figures 1, references 7: 5 Russian, 2 Western.

Removal of Sulfur Dioxide from Fuming Gases

927D0190F Moscow TSVETNYYE METALLY in Russian No 5, May 92 pp 24-26

[Article by V. N. Kazakov and V. D. Khripin, State Research Institute of Nonferrous Metals; UDC 669.162]

[Abstract] Results of testing of a pilot unit for removing sulfur dioxide from fuming gases at the Ryazan Nonferrous Metals Plant are presented. A venturi tube with an elongated neck is used as the absorber in this unit, which has been installed between induced draft fans of the first and second lines of a system for removing dust from fuming gases. The venturi tube has four atomizers for the absorbent solution. The pilot unit was tested with the lime method and the zinc method.

Lime milk containing 162 g/l CaO was used as the absorbent solution for the lime method. Tests results showed that at an initial concentration of sulfur dioxide in the gas of 0.3 percent, the concentration after passing through the pilot unit was 0.004 percent. The total time of tests using the lime method was 1,540 minutes. One series of tests at the same operating conditions took up 61.7 percent of this time (950 minutes), and the results for this series showed that at a solution pH greater than 10, the sulfur dioxide concentration in the purified gas was 0.0038 percent, giving a purification efficiency of 98.56 percent.

In the zinc method the absorbent used was dust oxides from two different sources, containing 66-67 percent and 74 percent zinc, respectively. The content of zinc oxide in suspension in the tests was approximately 80 g/l. The operating conditions of the pilot unit were the same as in the lime method. In tests with zinc oxide from one source, the initial SO_2 concentration in the gas fluctuated from 0.062 to 0.106 percent, and after treatment it averaged 0.025 percent, for an average purification efficiency of 68.6 percent. With zinc oxide from the other source, the average initial SO_2 concentration in the gas was 0.133 percent, and the average concentration after treatment was 0.013 percent, for an average purification efficiency of 89.9 percent.

The test results are said to indicate that the venturi tube with elongated neck is a very effective absorber, which may be explained by good contact of reactants and fast bonding reactions of SO_2 due to high turbulence of the gas flow in the neck. Tables 3, figures 2, references: 4 Russian

Questions of Safety in Magnesium Powder Production

927D0190I Moscow TSVETNYYE METALLY in Russian No 5, May 92 pp 47-48

[Article by B. R. Osipov, V. N. Kititsa, and L. G. Grebenkina, All-Union Institute of Aluminum and Magnesium; UDC 621.762+614.834]

[Abstract] Conditions which can lead to fires and explosions in magnesium powder production are discussed. Systematic investigations of fires were not conducted for a long time, probably because fires in this type of production were not frequent. Only in the last 15 years has the All-Union Institute of Aluminum and Magnesium been conducting systematic analysis of accidents. Elimination of sources of sparks and timely removal of dust are key factors in preventing accidents. Ducts in pneumatic transport systems should be inspected and cleaned of dust periodically. Improving the quality of casting of ingots is said to be key to reducing the danger of sparking in milling of magnesium ingots.

Results of studies of conditions (temperature, pressure, etc.) in which magnesium powders in layers or in aerial suspension can ignite or explode and conditions of flame propagation are also presented. A study of static electricity in magnesium powder production indicated that presently used technology is safe from the standpoint of the possibility of electrical discharges from static electricity, but all equipment and duct work of magnesium powder production must be reliably grounded.

The areas most in need of research for improving safety of magnesium powder production are said to be improving the quality of casting of magnesium ingots to eliminate sparking in the milling process, and finding optimum materials for extinguishing burning magnesium powder.

Forms That Components Take in Wastes of Wolframite Concentrate Processing

927D0190K Moscow TSVETNYYE METALLY in Russian No 5, May 92 pp 51-53

[Article by A. N. Zelikman, N. A. Borisova, and N. N. Rakova, Moscow Institute of Steel and Alloys; UDC 669.27.054.8]

[Abstract] Data are presented from studies of the forms that components take in wastes from the processing of wolframite concentrates using the method of melting with sodium carbonate followed by treatment of the melt

with water. This type of processing results in the formation of a solution of sodium wolframate and wastes which contain tantalum, niobium, scandium, iron and manganese.

Data are given on the content (weight percentages) of oxides of tungsten, iron, manganese, niobium, tantalum, silicon, calcium, aluminum, titanium, tin and sodium found in the wastes by chemical analysis. X-ray phase analysis was used to study the phase composition of wastes. Descriptions are given of the phase composition of the following main components of the wastes: tungsten, tantalum, niobium, iron, manganese, silicon and calcium oxides. Tables 3, figures 1, references 4: 2 Russian, 2 Western.

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