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RESEARCH INTO THE PHYSICAL, MECHANICAL, OPERATIONAL, AND TECHNOLOGICAL PROPERTIES OF ALLOYS SYNTHESIZED BY EXOTHERMIC PROCESSES

ДОСЛІДЖЕННЯ ФІЗИКО-МЕХАНІЧНИХ, ЕКСПЛУАТАЦІЙНИХ ТА ТЕХНОЛОГІЧНИХ ВЛАСТИВОСТЕЙ СПЛАВІВ, СИНТЕЗОВАНИХ ЕКЗОТЕРМІЧНИМИ ПРОЦЕСАМИ

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Abstract. *In this work, the authors investigated various iron-carbon thermite alloys analogues of industrial alloys - their mechanical and operational properties, chemical composition, optimized the composition of the metallurgical charge and heat treatment modes, namely, synthesized thermite steels, special cast irons, tool materials: tool thermite carbon steels, high-speed steels, alloyed hard tungsten-cobalt alloys, and carbide steels. The microstructures of the above-mentioned alloys, their mechanical, technological, and operational properties are analysed.*

Key words: *Thermite alloys, properties, chemical composition, structures, thermite process.*

Анотація. *В роботі досліджено різні залізовуглецеві термітні сплави-аналоги промислових сплавів - їх механічні та експлуатаційні властивості, хімічний склад, оптимізовано склад металургійної шихти та режими термічної обробки, а саме: синтезовано термітні сталі, спеціальні чавуни, інструментальні матеріали: інструментальні термітні вуглецеві сталі, швидкорізальні сталі, леговані тверді вольфрамокобальтові сплави, карбідосталі. Проаналізовано мікроструктури вищезгаданих сплавів, їх механічні, технологічні та експлуатаційні властивості.*

Ключові слова: *Термітні сплави, властивості, хімічний склад, структури, термітний процес.*

Introduction.

Creation of alloys on the basis of combined processes makes it possible to synthesize cast alloys, which are being obtained now by other technologies. The investigation of the properties and structures of such alloys is a primary task that will allow detecting strictly the field of their application. At the same time non-ordinary method of obtaining the alloys leads to creation of materials with features different from obtained by industrial methods [1,2].

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The given thesis is denoted the development scientific bases shaping phase and structured condition of cast alloys with improved official and technological characteristics and development on their base of competitive technologies of their syntheses by way dedicated to investigating of alloys synthesized by metallothermy and by selfpropagating high-temperature synthesis (SHS); to making up of theoretical principles of synthesis, to establishing of connection between the structure of fluid state of cast iron with the characteristics of metallothermy burden and to putting of synthesized materials into practice of cast industry.

Theoretical and experimental research.

Theoretical calculations of burden compositions are founded on establishing the dependence between component activities in systems from the third while using Hillert equation. The usage of Screinemaker coordinates instead of ordinary coordinates for geometric interpretation of the equations gives a unique possibility to simplify and solve them with the reduction of quantity of approximations only to two, both of which are being fully confirmed in most of the cases in concrete examples of calculating of *Fe–C–Si* and *Fe–C–S* systems.

The investigations allowed detecting the peculiarities of these materials, in the first turn, heightened viscosity (connected, obviously, with deoxidization by aluminium which is in the composition of the burden), as well as fine-grained structure.

While using high-overheated alloys for heating of metallothermy addition of large cast iron mouldings and high-alloy steels in serial and mass production improved method of burden calculating has been proposed. Synthesized high-overheated iron-carbon alloys are fit to thermite welding of blanks and instrumental alloys-for metallurgic welding together of instrumental plates to the base of the tool.

The authors also studied non-ferrous thermite metals (bronze and brass) and the use of non-ferrous thermite alloys to improve the feeding of bronze moulds with liquid metal. Experimental studies on cladding during the strengthening of cast iron moulds with exothermic alloying mixtures, as well as the results of modification in the inner cavity of the mould, were analysed. Foundry thermite alloys are used limitedly in machine-building though the given method may due to some preferences give an essential economical and technical effect in solving of separate tasks in heavy branches of techniques. First of all it is high speed of burning process and simultaneously of technological melding the absence of necessity of complex technological equipment (foundry furnaces, autoclave with temperature control, pressure and composition of medium); the absence of necessity of huge courses of electrical energy (thermite methods of melding demand energy only for initiating of the reaction), universality of the method. Besides, the given methods permit to use waste materials of metallurgical thermic and metal cutting industries (iron scale, grist of aluminium and manganese chip, grist of waste materials of graphite electrodes, riddling of alloying composition, modificators, dust out of the filters in metallurgical industry, etc). It's worth noting that this methods become economically useful while it is necessary: to obtain cast blanks of spare parts urgently under conditions for away from industrial canters, making of blanks of conditions of experimental production; besides exothermic mixtures made for methods mentioned above may be applied for technology of exothermic founding editions of high temperature gradient which allow not only to economize fluid metal but to improve metal properties of subadditional zone (in the first turn mechanical) and to improve microstructure with modification using microdoping by aluminium and alloying composition.

Conclusions.

As a result of the conducted studies, it was found that cast hard alloys and carbide steels synthesized by combined methods can successfully replace hard tungsten-cobalt alloys obtained by industrial methods, their hardness is within 90-94

HRA. The cutting properties of the synthesized tool alloys studied are not worse than hard alloys obtained by industrial methods. Thermite alloys for use in casting and welding technologies - carbon and alloy steels, high-strength cast irons - were identified, the properties of the resulting welded joints were established, the influence of thermite welding conditions on the quality of the joint was investigated, metal-thermal mixtures for thermite welding and the design of metal-thermal reactors were developed.

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ANALYSIS OF THE CORROSIVE EFFECT OF HEAT TRANSFER FLUIDS ON SOLAR HEATING SYSTEM MATERIALS AND CHANGES IN THEIR PROPERTIES IN STAGNATION MODE

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Abstract. *The performance and environmental safety of solar thermal systems strongly depend on the choice of heat transfer fluids, especially under stagnation and high-temperature conditions. In such regimes, thermal degradation of fluids and corrosion of metallic and polymeric components may significantly reduce system reliability. This study compares the corrosion behavior and environmental aspects of common heat transfer fluids, including water, propylene glycol, mineral oil, nanofluids, and ethanol–water solutions. The analysis shows that water and propylene glycol exhibit notable limitations related to corrosion, scaling, and degradation at elevated temperatures. In contrast, ethanol–water mixtures demonstrate a favorable balance of thermal performance, freeze protection, and environmental acceptability. With proper material selection and corrosion inhibition, alcohol-based heat transfer fluids can be considered a promising alternative for solar thermal systems operating under stagnation-prone conditions.*

Key words: *solar heating systems, heat transfer fluids, stagnation mode, corrosion resistance, environmental safety, solar system materials, corrosion inhibitors.*

Introduction.

The active introduction of solar heating systems is seen as an important tool for decarbonising the energy sector and reducing the negative impact of traditional heating on the environment. At the same time, the environmental safety of such systems is largely determined by the stability of the physical and chemical properties of heat transfer fluids and their interaction with the materials of the structural elements of solar installations. Disruption of these interactions, especially in extreme thermal conditions, can lead not only to a decrease in the technical reliability of the