

**BR24993020 “Development and implementation of technology for the production of complex-alloyed steels with homogeneous structure due to synergistic effects on the melt”- s.r. Issagulov A.Z.**

**Annotation of the program:**

One of the leading sectors of our country's economy is the mining and metallurgical industry. A significant part of the equipment used in the mining and metallurgical industry operates in extremely aggressive conditions (wear, high temperatures, corrosive effects, etc.).

In this regard, most of the equipment is made of complex alloy steels, which determines the high cost. At the same time, the equipment usually lasts no more than two years on average, after which it is replaced or repaired. After this, the equipment is replaced or repaired, which in turn leads to downtime, reduced productivity, etc.

In this regard, to increase the reliability and service life of equipment it is required to use materials with enhanced performance properties. At the same time, the possibilities of increasing mechanical properties and durability of complex alloyed steels through the use of new alloying elements and/or heat treatment are practically exhausted.

The use of new alloying elements in such steels actually leads to the development of new alloys with the subsequent development of technological modes of melting, casting production, finishing of parts, etc. In this case, material and time investments are required to develop new technology and implement it in production.

This program proposes to approach the solution of creating parts from complex-alloyed steels with enhanced performance properties using a fundamentally new approach that provides minimum costs to improve the mechanical properties and service life of parts made of such steels.

**Purpose of the program:**

Development of technology for manufacturing of complex-alloyed steels with homogeneous and defect-free structure due to synergy of external and internal influence on the melt in the process of primary crystallization by nanopowder modifiers, inoculants and joint magnetic and vibration treatment to improve the performance properties of castings and subsequent implementation of the technology in production.

**The objectives of the program are:**

1. Monitoring of the Kazakhstan market to determine the use of complex-alloyed steels and monitoring of global trends, structure and properties management and analysis of conditions for their adaptation to the industrial conditions of the RK.

As a result of solving the above task:

- the most common grades of alloy steels used in RK in the production of parts of mining and metallurgical equipment will be determined, problems in their manufacture and operation will be identified;

- types of nanomodifiers and inoculators are determined on the basis of information analysis.

The criterion for the fulfillment of the above task will be the choice of research objects and research subjects.

2 Identify and implement logistics measures for the effective implementation of all technological steps.

The solution of this task is important for determining the sequence of technology implementation.

The criterion for the fulfillment of this task will be a flowchart of the process with the availability of linkage to certain production sites.

3. mathematical and computer modeling of thermodynamic systems of complex-alloyed steels.

This task will describe the processes of phase formation occurring during crystallization of complex-alloyed steels under the influence of various factors.

The criterion of success in solving this task will be the modeled diagrams of the thermodynamic equilibrium state of the experimental systems and preliminary mathematical dependences of various technological parameters on the properties of the melt.

4. Development of melt treatment technology after release from the furnace by controlling the structure and properties through the introduction of nanopore modifiers and external influence during the crystallization period.

There are several subtasks in this task, which indicates that this task is the main task:

- selection of types of nanomodifiers and inoculants taking into account the available data on modern production;

- development of a hypothesis for improving the properties of a complex alloy using nanomodifiers and treatment with magnetic and mechanical influences;

- carrying out basic experiments in laboratory conditions and drawing up the experiment planning matrix;

The criterion of successful solution of the task will be the preparation of a preliminary technological map with the definition of all technological parameters.

5. Study of structure and properties of complex-alloyed steel cured under the developed technological regimes in order to adjust the steel treatment process.

This task is constant during the whole duration of the Program implementation and is directly related to the previous one.

The criterion for the fulfillment of this task will be the establishment of dependencies between the amount and nature of nanomodifiers and inoculants, parameters of magnetic and mechanical influence modes on the structure and properties of the investigated objects.

6. Approbation of the developed technology in industrial conditions and production of a batch of castings to determine their durability under operating conditions.

According to the results of this task solution the conditions will be determined and the technological modes of technology utilization in production will be adjusted according to the results of the developed technology approbation.

The criterion of completeness of the task will be the act of industrial testing and production of prototypes.

7. Development of technological documentation for further implementation of the developed technology at the country's enterprises specializing in metallurgical and foundry production.

The importance of solving this task lies in the necessity to use regulations at the production facilities for implementation of the developed technology, for promotion of the obtained results by means of advertising campaign with further commercialization of the Program results.

The criterion for the fulfillment of the task will be the act of implementation and the process flow chart agreed with the relevant production facility.

8. Conducting an advertising campaign of the developed technology in order to expand the range of potential consumers, promote the product in the market and increase its competitiveness.

The solution of this task will contribute to the popularization of the achieved results, search for potential partners, which will allow to commercialize the scientific results of the Program.

The criterion for solving this task will be the signing of at least 3 agreements of intent with partners in production.

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