ANNOTATION

Dissertations for the degree of Doctor of Philosophy (PhD) in the educational program 8D07203 – Metallurgy

ABSTRACT

of the Dissertation for the degree of Doctor of Philosophy (PhD) in the educational program 8D07203 – Metallurgy

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«Research and development of technology for the production of castings from antifriction cast iron by casting on smelted models using raw materials of Kazakhstani content»

Relevance of the study

Since the appearance of the first mechanisms and up to the present time, the main reason for the loss of machine performance is wear. Wear occurs due to the friction of the working surfaces of the parts in contact with each other. The friction–wear process takes place at the point of contact, starting from the moment the surfaces come into contact and ending with the release of the formed compressed wear products from the friction zone. Mainly movable joints are exposed to friction and wear. However, fixed parts can also wear out if they are affected by a flow of matter, be it gas, liquid, or solid particles. Wear under conditions of abrasive friction is considered to be the most intense. Thus, exposure to pulp, a liquid medium with particles of solids, quickly incapacitates stationary pump housings. In addition to the consumable parts of ground pumps, elements of belt and other conveyors, buckets of excavators and other types of mining and metallurgical equipment are exposed to similar effects.

The Karaganda region is traditionally a leader in the mining and metallurgical region of the Republic of Kazakhstan, therefore, the need to improve the quality of materials and technologies for manufacturing interchangeable parts of mining and metallurgical equipment is an urgent task.

The object of the study is castings from experimental antifriction cast iron, made by casting according to smelted models using raw materials of Kazakhstani content.

The subject of the study was the structure and properties of antifriction cast iron after modification, the properties and composition of the shell for die casting, obtained using clay from a Kazakhstani deposit.

The purpose of the study

The purpose of this work is to improve the operational properties of antifriction cast iron by changing the alloy structure and developing a technology for the production of castings from it using cast-model casting using raw materials of Kazakhstani content.

Research objectives

To achieve the goal, it is necessary to solve the following tasks:

- to conduct an information analysis of global trends in improving the properties of antifriction cast iron. Choose a modifier and the technology of its use;
- to investigate the effect of the modifier on the graphite phase parameters;
- to investigate the microstructure and properties of the experimental alloy;
- to investigate the effects of shell composition on its properties and casting properties;
- to draw up a technological map of the technology for obtaining castings from an experimental alloy by casting on smelted models using Kazakhstani raw materials.

Practical significance.

Based on the results obtained in the dissertation:

-the optimal amount of modifier (titanium carbide) was determined, which ensures an improvement in the parameters of the graphite phase and an improvement in the tribological properties of the alloy;

-a method has been developed to reduce pitting on the surface of the casting obtained by LVM;

-a technology has been developed for the production of castings from an experimental recommended alloy by die casting using Kazakhstani raw materials;

Scientific novelty.

As a result of the study, the following results were obtained for the first time:

-the relationship between the amount of modifier and the parameters of the graphite phase in the cast iron structure has been established. It is shown that the introduction of titanium carbide in an amount of 0.2-0.3% by weight leads to a decrease in the average size of graphite by about 40%, the area of graphite inclusions and the shape factor by almost 2 times.;

- the relationship between the parameters of the graphite phase in the cast iron structure and tribological properties has been established. It has been experimentally proven that a decrease in the size and area of graphite inclusions leads to an increase in hardness with a decrease in the coefficient of friction. The optimal form of graphite in the structure is finely dispersed inclusions of the simplest form.;

-the effect of the amount of modifier on the tribological properties of antifriction cast iron has been established. It was found that the introduction of titanium carbide in an amount of 0.2-0.3% by weight increases the hardness and wear resistance of the alloy by an average of 20% and reduces the coefficient of friction by 1.5 times.;

-the dependences between the fractional composition of the suspension for the manufacture of the shell during die casting and its technological properties have been established. It is shown that the optimal fraction for the preparation of the suspension is 200-300 microns in size. The use of such a fraction makes it possible to increase the survivability of the suspension and sedimentation resistance by an average of 40%;

-the effect of the fractional composition of graphite powder used for processing on the pitting area has been established. The optimal graphite powder

fraction of 100-200 microns has been established, which ensures minimal graphite consumption and protection from pitting.

Scope and structure of the dissertation:

The dissertation consists of the following parts: content, list of abbreviations and designations, introduction, the main part of 5 chapters, conclusion and appendices.

The dissertation consists of 96 pages of typewritten text, 31 figures and 19 tables, and includes a bibliographic list of 112 names of sources..

Approbation of the work:

According to the research results, 11 scientific papers have been published, including:

- 1 article in a journal included in the Scopus database (Metalurgila, Croatia, 37th percentile);
- 3 articles in journals recommended by the KOKNVO of the Ministry of Foreign Affairs of the Republic of Kazakhstan: "Proceedings of the University" No. 2 (87), 2022, (Karaganda, Kazakhstan), "Science and Technology of Kazakhstan" No. 1, 2024, (Karaganda, Kazakhstan), "Proceedings of the University" No. 2 (95), 2024., (Karaganda, Kazakhstan);
- 1 article in a journal included in the Russian Science Citation Index (Foundry Production, No. 4,2023, Moscow, Russia)
- 1 patent of the Republic of Kazakhstan for a utility model;
- 5 publications in the proceedings of scientific and technical conferences of various levels.

Place of research work.

The work was performed at the Department of Metallurgy and New Materials, at the International Center for Materials Science, the Laboratory of Engineering at the Karaganda Technical University named after Abylkas Saginov, the Laboratory of Structural Analysis and Properties of Materials and Nanomaterials of the Ural Federal University named after B.Yeltsin (Yekaterinburg, Russia), as well as at the production site of KMZ LLP.Parkhomenko" (Karaganda region, Kazakhstan).