

ANNOTATION

dissertation work

«IMPROVEMENT OF SELTING TECHNOLOGY AND IMPROVEMENT OF THE QUALITY OF METAL PRODUCTS USING INNOVATIVE TECHNOLOGIES BASED ON THE IRON-CARBON SYSTEM»,

submitted for the degree of Doctor of Philosophy (PhD)

specialty 6D070900 – «Metallurgy»

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The purpose of the dissertation work is to study and improve the steelmaking process for smelting and steel production, which helps to reduce the proportion of oxide non-metallic inclusions in finished products.

Research objectives

- conducting a literature and patent search on non-metallic inclusions and their impact on the quality of finished steel products and on the study of the separation technology of slag-metal melts in oxygen converters;
- selection of the main methods used in the conduct of scientific research and the implementation of experiments.
- design and development of installations for separating slag from metal at the outlet from the converter and improving the technology for separating metallurgical melts in order to improve the quality of the metal product.
- simulation of the process of tapping liquid steel from an oxygen converter, taking into account the speed regime and the scale factor.
- conducting experimental studies in order to identify the functional performance of technical solutions for cutting off metallurgical slag from metal.
- of research results that contribute to improving the quality of steel products by reducing the proportion of non-metallic inclusions and calculating the economic efficiency of the proposed measures .

Research methods

The main methods of research and analysis used in the performance of the dissertation work include:

- methods of statistical data processing;
- methodology of correlation and regression analysis;
- methodology for qualimetric quality assessment;
- method of metallographic research;
- methodology for calculating economic efficiency.

Main provisions (proven scientific hypotheses and other conclusions that are new knowledge) submitted for defense

- a constructive solution was developed and proposed to ensure the reduction of slag ingress into the steel-pouring ladle during the release of liquid metal, and an adequate mathematical model with a high coefficient of determination was obtained.
- a regression equation $y = -0.0043x + 0.1005$ was obtained with a sufficiently high coefficient of determination $R_2 = 0.9551$, which reflects the significant impact

of using the proposed shut-off device on a significant reduction in non-metallic inclusions in steel when it is released from the converter.

- it is proved that the proposed shut-off device reduces the number of non-metallic inclusions by 1.3% and the expected economic efficiency from the implementation of the proposed measure is 300 million tenge per year.

Description of the main results of the study

As a result of theoretical and experimental studies:

- developed and proposed technical means to reduce the ingress of slag into the steel-pouring ladle during the release of metal;

- a statistically adequate mathematical model with a high coefficient of determination was obtained, reflecting the nature of reducing the ingress of metallurgical slag into the steel ladle during the release of liquid metal using specially designed shut-off devices;

- the positive impact of the use of the proposed cut-off devices on improving the quality of steel in terms of chemical composition has been proven, namely: a significant reduction in non-metallic inclusions;

- the fact of reducing the sorting of steel by chemical composition and increasing the yield of suitable steel products from the use of the proposed cut-off devices is substantiated;

- the calculation of the economic efficiency of the proposed measures was made, which showed a significant increase in financial resources from the introduction of the proposed shut-off devices in a real metallurgical production.

Substantiation of the novelty and importance of the results obtained

The domestic metallurgical industry plays a significant role in the economy of the Republic of Kazakhstan, and also occupies one of the leading places in the formation of the state budget of the country. In this regard, the issues of ensuring the quality of steel products are very relevant. In the face of constantly growing competition, domestic metallurgical enterprises are constantly looking for ways to ensure the high quality of their products while reducing production costs.

Thus, the authors of this dissertation proposed technical solutions that improve the quality of steel being smelted by reducing non-metallic inclusions at relatively low financial costs. As a result of the scientific research, a statistically adequate mathematical model with a high coefficient of determination was obtained, which shows a significant reduction in the slag that enters the pouring ladle during the production of steel, due to the use of shut-off devices developed and proposed by the authors of this dissertation work. The use of the proposed shut-off devices improves the quality of steel by reducing non-metallic inclusions, which in turn leads to a decrease in steel sorting by chemical composition and an increase in the yield of good products. Also, the calculation of economic efficiency showed that a significant increase in profits is expected from the introduction of these cut-off devices into production.

The practical significance of the work

The practical value of the work lies in innovative devices for the separation of metal melts and slag, which help to reduce the proportion of non-metallic inclusions

in steel, which is confirmed by the receipt of five patents of the Republic of Kazakhstan for an invention, two patents for an invention in the Eurasian Patent Office.

Compliance with the directions of scientific development or state programs

The topic of the dissertation work corresponds to the specialized scientific direction «Production and processing of metals and materials» according to the priority «Geology, mining and processing of mineral and hydrocarbon raw materials, new materials, technologies, safe products and structures» of the National Scientific Council under the Government of the Republic of Kazakhstan.

Description of the contribution of the doctoral student to the preparation of each publication

The author's personal contribution is to carry out the bulk of the theoretical and experimental research outlined in the dissertation work, including the development of theoretical models, experimental research methods, research, analysis and presentation of the results in the form of publications and scientific reports.

On the topic of the dissertation work published 10 scientific papers, including: 1 (one) peer-reviewed article scientific publication on the scientific direction of the dissertation topic indexed in Science Citation Index Expanded Web bases of Science (Clarivate Analytics) and according to CiteScore in the Scopus database (Elsevier), 3 (three) articles in the domestic publication in the field of metallurgy recommended by CQASEME RK, 1 (one) article in the collection e International scientific and practical conference. Also received 3 patents of the Republic of Kazakhstan and 2 Eurasian patents.

Information about the main publications indexed in the Science Citation Index Expanded Web of Science database (Clarivate Analytics), in a peer-reviewed scientific publication that has a CiteScore percentile in the Scopus database (Elsevier) on the dissertation topic:

1. **Zhaslan RK**, Zhautikov BA, Romanov VI, Aikeyeva AA, Yerzhanov AS Improvement of methods for semi-finished carbon product tapping from the basic oxygen furnace (BOF). Metallurgija Volume 61, Issue 1, January 2022. Scopus percentile-46.

Information about publications in domestic publications in the field of metallurgy scientific journals on the topic of the dissertation:

1. F.B. Zhautikov, V.I. Romanov, B.A. Zhautikov, A.A. Babenko, **R.K. Zhaslan**. Experience in the deoxidation of a carbonaceous intermediate with limited use of ferroalloys. Magazine "Industry of Kazakhstan", Almaty. № 3 (107) 2019. P.52-53.

2. B.A. Zhautikov, V.I. Romanov, F.B. Zhautikov, **R.K. Zhaslan**, A.I. Zhumageldinov, N.A. Abzalbek, O.B. Togyzbaev. Device for transporting materials / Bulletin of the East Kazakhstan State Technical University named after D. Serikbaev, Ust-Kamenogorsk, № 4 2019. P. 97-99.

3. B.A. Zhautikov, F.B. Zhautikov, R.I. Romanov, **R.K. Zhaslan** Experience in optimizing the slag regime in the converter and reducing the proportion of oxide non-metallic inclusions in steel / Bulletin of Shakarim Semipalatinsk State University, Semey, № 2. 2020. P.112-115.

Information about the reports reported and discussed based on the results of the dissertation work at the International and Republican scientific and practical conferences:

1. B.A. Zhautikov , V.I. Romanov, F.B. Zhautikov , **R.K. Zhaslan** . Blocking device for separation of melts / International scientific-practical conference " Improving the quality of education, modern innovations in science and production", dedicated to the 80th anniversary of the founder of EITI named after academician K. Satpaev d.ph.m.s. _ Academician of the APS of Kazakhstan Mardenov M.P., Ekibastuz, May 15-16, 2020. pp.31-33.

Information about security documents for the object of intellectual property:

1. Eurasian patent № 038619 «Device for the separation of melts». Received 2021 Zhautikov B. A. , Romanov V. I., Aikeeva A. A., Zhautikov F. B., Amenova A. A., **Zhaslan R. K.**

2. Eurasian patent № 038902 «Method of producing metal from a converter». Received 2021 Zhautikov B. A., Romanov V. I., Aikeeva A. A. Zhautikov F.B. Amenova A. A., **Zhaslan R. K.**

3. Patent of the Republic of Kazakhstan for utility model № 6354 «Converter». Bull . № 34 dated 08/27/2021. Zhautikov B. A., Romanov V. I., Aikeeva A. A., Zhautikov F. B., Zhaslan R. K.

4. Patent of the Republic of Kazakhstan for the invention № 35140 «Steel-smelting unit tap hole». Bull. № 24 dated 06/18/2021. Zhautikov B. A., Romanov V. I., Aikeeva A. A., Zhautikov F. B. Nogaev K. A., **Zhaslan R. K.**

5. Patent of the Republic of Kazakhstan for the invention № 34480 «Knot for blocking a device for separating melts»ю Bull. № 30 dated 07/30/2020. Zhautikov B. A., Romanov V. I., Aikeeva A. A., Zhautikov F. B., Amenova A. A., **Zhaslan R. K.**