ANNOTATION
Dissertation for the degree of Doctor of Philosophy (PhD)
in the specialty: 6D060400 - Physics
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DEVELOPMENT OF SCIENTIFIC FOUNDATIONS AND METHODS FOR STUDYING THE THERMOPHYSICAL AND STRUCTURAL PROPERTIES OF METALLIC MELTS WITH THE AIM OF IMPROVING QUALITY OF PRODUCTS

Relevance of work:

The issue of providing the needs of the domestic industry with high-quality products determined the need to develop scientific foundations and methods for studying the thermophysical and structural properties of metal melts. The theory of the liquid state is not a simple section of the modern theory of metallurgical processes. Any substance in the liquid state is a difficult object to establish not only quantitative but also qualitative patterns. It is known that in the field of studying the structural properties of solid elements, a rich material has been created using elements of quantum physics and chemistry. The properties of liquid structures have been studied less.

Conducting experiments in metallurgy is an expensive and extremely difficult task. The simplest and most effective way to evaluate furnace processes is through numerical simulations. Scientific research carried out in these areas makes it possible to find solutions to numerous problems associated with molten systems.

In this regard, the relevance of the work is determined by the objectively urgent need to develop non-stationary physical and mathematical models of the structural properties of molten metals for the Zhezkazgan copper rod plant with subsequent implementation.

Purpose of the work: is the development of non-stationary physical and mathematical models of the flow of copper melt and the construction of the distribution of the velocity profile.

The object of research: the viscosity and fluidity of molten systems in "Southwire - 2000" processing equipment on the example of molten copper.

Research objectives. In accordance with the goal in the dissertation, the following tasks were solved:

– development and construction of non-stationary physical and mathematical models of the flow of copper melt;

- establishing the relationship of correlation functions with the radial distribution functions;

– determination of viscosity by methods of physicochemical analysis, taking into account the degree of association of elementary clusters for Cu, Zn, Al, Sn, Pb, Fe.

Scientific novelty:

- an algorithm for constructing a physical and mathematical model of non-linear equations of incompressible molten systems was developed;

- an algorithm for constructing the distribution of the flow rates of molten systems and integrating the equations of hydrodynamics on the basis of numerical experiments are developed which make it possible to predict the technological parameters of casting metal melts;

- for the first time, the basic properties of the viscosity of molten systems were determined using methods of physical and chemical analysis, taking into account the degree of association of elementary clusters for Cu, Zn, Al, Sn, Pb, Fe.

Practical value of the work: The study of the rate of convergence of the solutions of the approximating problem to the solutions of the original problem of hydrodynamics made it possible to develop an algorithm for the numerical integration of the equations of hydrodynamics, which makes it possible to predict the technological parameters of pouring metal melts. The validity and reliability of theoretical studies is confirmed by comparing the results with the parameters of the flow of copper melt in “Southwire – 2000” technological equipment. Based on numerical experiments, the distribution of the melt flow rates in the technological

equipment is constructed. The theoretically established optimal melt flow point of copper is in good agreement with the temperature of the flow of real movement of melts in technological equipment, as well as with the chaotic particles concept according to the extreme influence of their most energetic varieties - liquid and vapor.

Research methods:

When performing dissertation research, the following methods were used: mathematical modeling, physical and chemical analysis, quantum-statistical method, quantum effects, iterative methods, computer modeling, correlation analysis, the concept of chaotic particles.

Provisions for Defense:

- results of physical and mathematical modeling and numerical solution of the equations of hydrodynamics of melts;
- analysis of the physical parameters of the transfer coefficients of the equations of hydrodynamics on the example of the viscosity of molten systems;
- the results of calculations by the methods of physical and chemical analysis of the viscosity of molten systems, taking into account the degree of association of elementary clusters for Cu, Zn, Al, Sn, Pb, Fe.

Place of research work. The work was carried out at the Department of Engineering Thermophysics named after prof. Zh.S.Akylbaev in "Karaganda University named after academician E.A. Buketov.

Approbation of the work: The main scientific results of the dissertation work are presented in 12 publications issued in the Republic of Kazakhstan and abroad.

4 articles (Bulletin of Karaganda University - 2 articles, Proceedings of the University - 1 article, Science News of Kazakhstan - 1 article) have been published in the publications recommended by the COXON MES RK.

There are 3 articles in the journals included in the Scopus database, ("Archives of Control Sciences" percentile 71, "Eurasian Physical Technical Journal" percentile 15, "Journal of theBulgarian Chemical Communications" percentile 15).

The author has published 5 reports at international scientific and practical conferences (personal participation). The results of the thesis were discussed at the International Scientific Conferences: “Chaos and structures in nonlinear systems. Theory and experiment ", Karaganda, November 22-23, 2019. "Innovations in the field of natural sciences as the basis for the export-oriented industrialization of Kazakhstan", April 4-5, 2019. Almaty; "Integration of science, education and production - the basis for the implementation of the Plan of the Nation" June 14-15, 2019. Karaganda; International conference FMNS (FMNS - 2019) Southwestern University named after Neofit-Rilski, Bulgaria June 26-30, 2019; "Deformation and Fracture of Materials and Nanomaterials", Moscow, November 19-22, 2019 Patent No. 35062 "Instrumental method for studying a complex substance for density" from 05/14/2021, SIS No. 2348 "Physical and mathematical problems of hydrodynamics of melts" from March 10, 2019.

The structure and scope of the thesis:

The thesis is presented on 113 pages of text, contains 31 figures and 14 tables, it consists of an introduction, 4 sections, a conclusion, a list of used sources of 136 titles.