AP23486482. Development of information models for managing technological processes of metallurgical production, monitoring their functioning. sc.sp. – Kazhikenova S.Sh.

Relevance

The solution to the problems of quality and competitiveness of industrial enterprises is based on rationalization and the use of the latest information modeling technologies in order to modernize existing and create new facilities taking into account the latest requirements.

The current project solves a topical scientific problem – creation, development of information models (IM). An algorithm for creating information models from a conceptual mathematical model to special configurations of a computer model has been built. Verification of information models with real technologies Vanyukov, ISASMELT™, Ausmelt, ElTeniente, Salvador, Mitsubishi, QSL, Outokumpu, KIVCET has been carried out. For each technological scheme of copper, lead, zinc, tin production, an information model has been developed taking into account the indicators of the content and extraction of the target component at each level of its hierarchical structure. Topics related to the verification and certification of software used to develop information models have also been touched upon.

Project goal

Development of an information model for managing production processes based on the fundamental law of conservation of the sum of information and entropy; verification of an information model for managing production, covering all technological stages of mining-enrichment-smelting-converting-rough refining-electrolytic refining in non-ferrous metallurgy; creation of a reference model of production in the context of generating scientific, technical and socio-economic reserves at the micro, meso, and macro levels.

Expected and achieved results

The current project solves a relevant scientific problem – creation, development of information models (IM) based on the principles of mathematical modeling, information theory, computer modeling, theory of metallurgical processes. An algorithm for creating information models from a conceptual mathematical model to special configurations of a computer model has been built. The proposed approach is based on a hierarchical scheme of modeled production processes with an end-to-end technology: mining – enrichment – smelting – converting – rough refining – electrolytic refining. The project is interdisciplinary. To solve the problems set in the project, a connection of 7 different disciplines was carried out, each of which has its own subject, object, research methodology: mathematical modeling; computer modeling; programming; statistical data processing and analysis; physicochemical methods of analysis; theory of metallurgical processes; metallurgy of ferrous, non-ferrous and rare metals. The project employs DataScientists – mathematicians and physicists, programmers and metallurgists. The project's executors are specialists in mathematical modeling, physical modeling, programming, machine learning, optimization methods and complex data analysis methods, they consult on production technologies and help to correctly interpret data. Our product - information models integrated into the production process and allowing to work more efficiently - can be created only thanks to the collective participation of all the listed departments.

The scientific novelty of the research conducted consists in the creation of new mathematical models and software modules for the development of information models covering all technological stages in the production of non-ferrous metals: mining-enrichment-smelting-converting-rough refining-electrolytic refining.

Scientific developments, hypotheses, and project ideas are new.

The adequacy and correctness of the mathematical model has been proven. The developed information model is intended to solve current problems of socio-economic and scientific-technical development of the Republic of Kazakhstan, balanced risk management of mining and metallurgical enterprises.

In 2024, a mathematical model was developed for upgrading existing and creating new process flow charts in the production of non-ferrous metals; an IM was developed for process stages of copper production for the content and extraction of the target component at each level of the Vanyukov, Outokumpu, Salvador, ElTeniente schemes. The scientific novelty of the research consists in the creation of new mathematical models and software modules for the development of information models covering all process stages in the production of non-ferrous metals from mining to electrolytic refining in order to obtain an industrial product of the required quality. Wolfram Mathematica was used to construct and visualize diagrams, graphs of functions of one or more variables, networks, graphs, geographic information, interactivity and movement in any of the classic formats.

Received 2 Certificates of state registration of rights to a copyright object.

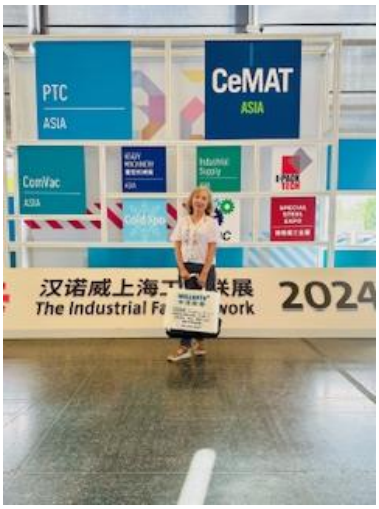

Figure 1– The process of working on a project

Research group

1 Kazhikenova Saule Sharapatovna - scientific director, doctor of technical sciences, associate professor, head of the department of Higher mathematics Abylkas Saginov Karaganda technical university

ORCID ID https://orcid.org/0000-0002-6937-1577

Researcher ID: P-5627-2017

Scopus Author ID: 36106908300

2Shaikhova Gulnazira Serikovna - responsible executor, candidate of technical sciences, Acting associate professor of the department of Higher mathematics Abylkas Saginov Karaganda technical university

ORCID IDhttps://orcid.org/0000-0002-2036-3023

ResearcherID: DQU-5346-2022

Scopus Author ID: 57218284243

3 Shaltakov Sagyndyk Nagashibayevich - PhD, acting associate professor of the department of Physics Abylkas Saginov Karaganda technical university

ORCID IDhttps://orcid.org/0000-0002-1186-1178

Researcher ID: DPX-0894-2022

Scopus Author ID: 25025169700

4 Makasheva Astra Mundukovna - performer, doctor of technical sciences, professor, dean of the mechanical engineering faculty of Abylkas Saginov Karaganda technical university

ORCID IDhttps://orcid.org/0000-0003-2249-3435

Researcher ID: X-1472-2018,

Scopus Author ID: 57210040092

5 Kassymova Leila Zhumazhanovna – performer, PhD, acting associate professor of the department of Higher Mathematics Abylkas Saginov Karaganda technical university

ORCID IDhttps://orcid.org/0000-0003-2249-3435

Researcher ID: DXM-0187-2022,
Scopus Author ID: 5721980185
6 Tuleutayeva Zhanar Mukatayevna – performer, PhD, head of the department "Mathematical analysis and differential equations" KarU named after academician E.A. Buketov
ORCID ID https://orcid.org/0000-0003-0532-279X
Researcher ID: BBD-8568-2021,
Scopus Author ID: 57203509963
7 Akhmetova Sandugash Sovetovna – performer, candidate of technical sciences, associate professor of the department of Higher Mathematics Abylkas Saginov Karaganda technical university
8 Shaltakova Ainura Nigmatolovna– performer, master's student at Abylkas Saginov Karaganda technical university

Information for potential users:

The developed information model is designed to solve urgent problems of socio-economic and scientific-technical development of the Republic of Kazakhstan, balanced management of mining and metallurgical enterprises. The target audience is enterprises of the mining and metallurgical industry. Information models integrated into the production process make it possible to implement new production solutions cheaper and easier, develop new products with lower economic costs; will reduce the labor intensity of engineering by up to 40% when developing the second and subsequent projects, obtain an expert assessment of metallurgical production in terms of generating scientific, technical and socio-economic reserves at the micro, meso and macro levels.

Application area:

The target audience is enterprises of the mining and metallurgical industry.

Date of information update: 08.11.2024