ANNOTATION

Dissertation of **Aubakirova Nazira**

on the topic: **"Research and development of methods for optimizing the power parameters of technological machines using composite materials in mechanical engineering and power engineering"** for the degree of Doctor of Philosophy (PhD) in the educational program 8D07110 – "Digital engineering of machinery and equipment"

Relevance of the research topic. An analysis of the energy consumption of machine-building production in Kazakhstan shows that machine-building is one of the leading manufacturing industries, but at the same time, a significant part of the country's electricity is generated by traditional methods, mainly based on coal. At the same time, Kazakhstan is actively developing renewable energy sources (RES), planning to increase their share in the energy mix. High transportation costs and energy intensity of production also have a negative impact on the activities of the complex's enterprises, which lead to a low level of profitability and price competitiveness of their products. High depreciation of fixed assets, outdated equipment and technologies do not allow to ensure profitability of production.

Energy saving and energy efficiency improvement are primarily the implementation of organizational, technical, technological, economic and other measures aimed at reducing the amount of energy resources used in the country.

With the growth of a country's economy, the consumption of energy resources usually grows at the same rate as the gross domestic product (hereinafter referred to as GDP) of the economy, since economic growth is accompanied by an increase in production and consumption of resources. In each of these segments, there is an increase in the consumption of all types of energy resources (coal, gas, gasoline, electricity, heat, and others). In addition, with the growth of the population and the well-being of the population, the consumption of energy resources is growing rapidly. As you know, an extensive economic growth factor is realized by a quantitative increase in resources, and an intensive economic growth factor is determined by an increase in the quality of management systems, technologies, the use of innovations, modernization of production and labor productivity. In this regard, it is necessary to use energy conservation and energy efficiency improvement not only for energy and environmental safety, but also as a tool for industrial modernization.

Modern energy systems face challenges in integrating various energy sources, including renewable ones. These changes require new approaches to ensure optimal energy distribution, reduce losses, and increase system reliability.

The integration of renewable energy sources into existing energy networks creates the need for more flexible methods of energy flow management, which actualizes the need to use logistical methods.

At the same time, new composite materials that have appeared in other industrial sectors make it possible to replace metal and get rid of these disadvantages. The research of new composites with properties that make it possible to use these materials in mechanical engineering is very relevant.

This dissertation is devoted to solving energy conservation issues in the mining and manufacturing industries, as well as the use of composite materials with specific properties and technologies for their manufacture and application.

The purpose of this work is to increase the efficiency of machine-building enterprises through the development and integration of new renewable energy technology, as well as the use of composite materials with improved characteristics and appropriate operating conditions in gearboxes.

The main idea of the work is to solve a multi-criteria task, which consists in integrating approaches to improve the reliability and energy efficiency of equipment at machine-building, mining and oil-producing enterprises.

Research methodology. During the dissertation, a comprehensive research method was used, including a critical analysis of scientific and technical literature and industrial production experience, conducting theoretical research, laboratory experiments, design and technological developments, bench tests, statistical processing of experimental results using mathematical statistics methods.

Research objectives.

1. Analysis of the energy activity of enterprises of the machine-building, oil and gas, mining and metallurgical industries of the Republic of Kazakhstan.
2. Development of a hydroelectric power system (RES), which provides for the use of hydrodynamic fluid flow energy to generate electrical energy;
3. Analysis and theoretical justification of the use of composite materials, providing products from them with improved strength and technological characteristics;
4. Mathematical modeling of gear housings made of polymer materials and determination of the optimal polymer grade.

The objects of the research are the production technology of gearboxes and composite materials used in mechanical engineering.

The subject of research is new renewable energy technologies, as well as the use of composite materials with improved characteristics and appropriate operating conditions in gearboxes, which can increase the efficiency of the extractive and processing industries.

Scientific provisions submitted for protection:

1. Analysis and statistical processing of data on energy consumption in the extractive and manufacturing sectors of the economy.
1. Development of a new technology for mini hydroelectric power plants with an average efficiency of 39% of a hydro turbine with electricity generation in real conditions up to 11 kW. Development of recommendations on the use of

mini hydroelectric power plants in all extractive and processing sectors of the economy.

2. Selecting polymer materials for the gearbox housing and performing static calculations in SolidWorks Simulation. The real boundary conditions are set in the hull model: fixing the base, preloading the cover bolts and bearing reaction loads. To assess strength and stiffness, three characteristic loading modes are considered, determined based on geometry and transmission parameters.

3. Mathematical modeling of the stress-strain state of the housing, equivalent stresses according to the Mises criterion and displacements, and displacement of axial distances, and deflections of flanges.

4. The polymer, which will be used in the manufacture of gear housings, must have increased load resistance, not shrink, not form cracks, not lose properties under the influence of temperature and moisture.

Scientific novelty of the research

1. The optimal design model of a mini hydroelectric power plant has been developed with the identification of the optimal profile of the turbine working body and the flow of liquid. At the same time, the diameter of the conveying line (pipe) it has no significant advantage, unlike tilt.

2. A pattern has been established in the functionality of the hydroelectric power system due to the possibility of additional controlled adjustment effects on the parts. (nodes) of the turbine for changing the distance between the bearing surfaces of the hubs and (or) changing their relative relative (angular) position relative to each other, resulting in a change in the cross-section of the aerodynamic profile of the turbine, improving its hydrodynamic characteristics (including performance in hydrodynamic power generation).

3. A pattern of changes in the strength of the material under various power conditions and thermal conditions has been established, depending on both the mechanical properties of the material and its thermal conductivity and coefficient of linear expansion.

The validity and reliability of scientific statements, results and recommendations is based on the use of standard proven research methods and methods, the use of physical and chemical laws, high convergence of the results of theoretical and experimental data, using methods of statistical processing of experimental results with a high correlation index.

The practical significance of the work. A mini hydroelectric power plant has been developed and implemented into the production cycle, and the technical and technological capability has been proven. Mathematical calculations and laboratory studies have confirmed the possibility of using polymers, depending on the load, in the housings of machine parts used in the mining and processing industries.

The author's personal contribution consists in the formulation and justification of the topic of the dissertation research, the formulation of tasks, and

the conduct of theoretical and experimental research, the formulation of scientific proposals, the proof of their novelty, the development of methodological support for the work carried out, the development of conclusions and recommendations.

Approbation of the work. During his doctoral studies, he co-authored 6 papers, including 2 articles in journals reviewed on the Scopus database (SUSTAINABLE DEVELOPMENT OF MOUNTAIN TERRITORIES, Licensee MDPI, Basel, Switzerland Surfaces) with high Q2 quartile; 2 articles in journals recommended by the Education Control Committee and Ministry of Education of the Republic of Kazakhstan; 1 Innovative Patent for invention № 6897 of the Republic of Kazakhstan and 1 Eurasian Patent for Invention № 046299.

Scope and structure of the dissertation

The dissertation consists of an introduction, 4 sections, main conclusions, a list of references and 11 appendices.

The volume of the dissertation is 98 pages of typewritten text, 19 tables, 35 figures, 95 references.

Publications in international peer-reviewed scientific journals included in the Scopus/Web of Science database

1. Aubakirova N.K., Yelemesov K.K., Baskanbayeva D.D., Bortebaev S.A. Improving the energy efficiency of an enterprise by installing hydroelectric power systems for generating electricity in its water supply systems // Sustainable development of mountainous territories. – 2024. – T. 16. – №2. – C. 642–654. DOI: 10.21177/1998-4502-2024-16-2-642-654.

2.Chuchvaga, N.; Aubakirova, N.; Tokmoldin, N.; Klimenov, V.; Boukhvalov, D.W. A Comprehensive Approach to Optimization of Silicon-Based Solar Cells. Surfaces 2024,7,951–968. https://doi.org/ 10.3390/surfaces7040062

Articles in publications recommended by the Committee for Quality Assurance in Science and Higher Education of the Ministry of Education and Science of the Republic of Kazakhstan

1. D. D. Baskanbayeva, K. K. Yelemesov, M. K. Myrzakulov, E. E. Sarybayev, N. K. Aubakirova Composite in industry engineering
The problem of using materials // science and technology of Kazakhstan. ISSN 2788-8770. _ № 2, 2024 . C. 59-73 https://doi.org/10.48081/MIQJ9460

2. D. D. Baskanbayeva, K. K. Yelemesov, L. B. Sabirova , N. K. Aubakirova integration of safety and efficiency of compressor units in oil production// Scientific and technical journal "Neft and gas" 2024 6 (144), Kazakhstan, Almaty-P.48-63.

A patent for an invention

1. K.K.Yelemesov D,D.Baskanbayeva, S.A.Bortebayev E.A.Sarsenbayev, Aubakirova N.K. Hydroelectric power system for electricity generation
Innovative patent for invention of the Republic of Kazakhstan No. 6897 Non-

profit Joint Stock Company Kazakh National Research Technical University named after K.I. Satpayev (KZ) RSE "National Institute of Intellectual Property" Ministry of Justice of the Republic of Kazakhstan 08/23/2024

2. K.K.Yelemesov D,D.Baskanbayeva, S.A.Bortebayev E.A.Sarsenbayev, Aubakirova N.K. "Hydroelectric power system for electricity generation" Eurasian patent for invention No.046299 Non-profit Joint Stock Company Kazakh National Research Technical University named after K.I. Satpayev (Kz) February 23, 2024