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NAVIGATION SATELLITE SYSTEMS AS THE AUDIT FOUNDATION FOR MINING COMPANIES*

Integrated quality management system in the modern world are an essential element of functioning and development of any production, to a great extent determines the competitiveness of the enterprise and prospects of its activities. Currently the mining industry is actively developing a field of knowledge, called «satellite technology», which has diverse practical applications in geodesy, mine surveying, control systems, mining transport and safety and control of risks, the development of tools and methods for implementing energy efficiency strategies. The examples of current uses of satellite technology over the last decade at the leading enterprises of the mining sector.

The creation of new methods of technical and economic audit determines the need for and justification of the most common and objective criteria and evaluation indicators in the design phase and launch of the satellite equipment. To extend the lifetime of spacecraft is proposed in the design stage to calculate possible effects of electrostatic discharges and to give recommendations for reducing their negative influence. Developed a new method that allows for 2-3 orders of magnitude to reduce the complexity of calculations and to reduce costs for introduction and development of satellite technologies in mining.

Key words: *quality management, navigation satellite systems, mining enterprises, strategy, innovation development, energy efficiency, technical and economical audit, design equipment, qualimetry*
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Introduction

Mining as a basic industry, making a significant contribution to the economic development of the country. The accelerated development of the industry contributes to the implementation of the latest achievements in the field of production organization and management, and staff training for its subsequent adaptation of innovative processes [1]. One of the most actual problems of mining companies refers to the formation of an effective system of quality management for products and works; building comprehensive automation and remote control systems of technological processes [2].

Currently actively developing a field of knowledge that called «satellite technology», which had diverse practical applications in geodesy, geological exploration, mine surveying, as well as in control systems for the mining transportation complex, to ensure safety and control risks tools and techniques that improve energy efficiency.

A key vector of development of innovations in mining is the creation and implementation of new technological solutions on a deserted excavation and transport of mineral products when using hardware and software tools that form a comprehensive production management system. The idea of the program «Intelligent mining», where management is carried out remotely or completely automatically. The effectiveness of the use of navigation satellite systems (NSS) in the mining industry is reflected in many ways: in the renewal and replenishment of the topographic base for territorial objects of mining enterprises; control of the observance of the boundaries of allotments and conservation areas; environmental quality monitoring; integrated mapping of geological formations in the system of mineral exploration; planning capital construction and creating the infrastructure of communications.

NSS are increasingly being developed by various States and find use in mining countries such as USA, Germany, France, UK, Canada, Chile, China, Japan. Of course, traditionally, the priority use of satellite technology belongs to the Military-industrial complex. In Russia space methods have been actively used in exploration, particularly when searching for oil and gas fields in the second half of 1980-ies, then appeared high-quality images with the domestic satellite of the Kosmos series [3]. Unfortunately, the lack of active competition on the enterprises in the planned economic system has not contributed to the development of qualitatively new satellite technologies. Their production and use was costly. In the period 1990-ies, despite the relatively high profitability of the mining industry compared with other industries, could not be achieved due to the effective technical development and cost reduction in the manufacture of spacecraft and satellite navigation systems. Given the high cost of designing and launching equipment, for the decade remained lagging behind the advanced samples, the application of NSS in the real sector was narrowed

The practice for navigation satellite systems in mining industry

Consider the most effective examples of the use of NSS in the largest companies, the resource sector of economy of Russia and abroad.

A navigation information system «Dispatch» in the United States, developed by Modular Mining Systems, has been tested and now applied on Tiron quarry. There is result for the performance of loading and transport equipment which increased by 11%.

In the domestic market has formed several companies developing diverse automated information and navigation system for mining enterprises. For example, the «QUARRY»

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has been used successfully in more than 40 mining complexes of Russia, Kazakhstan and Mongolia. The system uses a number of mining companies belonging to holdings «Erdenet», «Severstal», «Mechel», «Sibuglemet». A continuous process of receiving information is via the radio modems uses WI-FI. The use of high-precision satellite navigation in conjunction with existing systems is intended to carry out an effective adjustment of trade flows. Adopt information technology solutions can improve the performance of the equipment by 15-20%, to ensure the safety of mining works under conditions climatically unfavourable regions, reduce production costs and increase volume of extraction of minerals [4].

Geological survey of enterprises of «ALROSA» are equipped with high-precision foreign and domestic equipment. NSS here for 15 years is used for the maintenance of geological and geophysical personnel in the field. In quarries, the company used high-performance drilling equipment: drilling rigs LF-90 (Canada), УБ-3,5 (RF). Satellite positioning machines in the quarry is carried out with the purpose of more accurate orientation of blast holes and more efficient use of explosives. Information about current depth and speed of drilling, the hydraulic pressure provides an indication of the intensity of drilling in a rock mass at various points of the wells. The results of exploration work carried out with the use of NSS, show prospects and the possibility of discovery of new diamondiferous deposits [5].

General trends in the development of innovative control systems are the following: the use of high-speed and stable wireless telecommunication facilities that provide transmission of large amounts of telemetry and video data; the use of high-precision NSS, which allow the positioning of the equipment with centimeter accuracy; the introduction of professional software platforms and tools with the purpose of the automated dispatch of mining equipment.

New energy theory of crisis management in the economy, the resource sector is based on the fundamental laws to achieve the necessary specificity and precision of parameter estimates. This complex system is characterized by the abundance of internal structural relationships and the interaction elements on obstructer level that will determine the most important regularities [6].

Researches were conducted by Spanish scientists (The University of Oviedo) for 233 organizations and were determined how organizational context variables and factors, especially, time, size, resources and competitive strategy affect the development of enterprises and in particular, innovation, proactiveness and risk-taking [7].

The methodology and results of calculating the energy efficiency of NSS equipment

Integrated quality management system in the modern world are the basis of functioning and development of any production, and to a great extent determine the competitiveness of the enterprise and prospects of its activities. The creation of new methods of technical and economic audit related to the need for and justification of the most common and objective criteria and evaluation indicators. To effectively manage the innovation process requires the ability to objectively predict the effectiveness of equipment at the design stage and run [8]. In this regard, the most important task of improving energy efficiency, which is based on the search of renewable energy sources and their adoption in resource-saving innovative technologies: in addition to solving environmental problems will help to develop related areas in energy [9–14]. Consider solving the problems of efficiency and quality of use of the equipment NSS on the basis of qualitative calculations for the mining industry.

In this case an important limiting factor for the effective operation of spacecraft within the NSS framework used for mining stands electrification and related electrostatic discharges. Electromagnetic interference (crosstalk), which are created by discharges, are often the cause of interruptions in the operation of the onboard avionics, and an intensive discharge currents will lead to irreversible damage of components of the apparatus. The calculation of the pattern of spreading of the current design space of the equipment through structural electro-physical model takes a very long time throughout the procedure to determine the interference to the onboard cable network. The calculation of the equivalent electrical circuit of large satellites on the basis of the most productive software LTSpice has longer duration [15]. In the US to calculate large systems we have developed a software platform NanoSpice, which calculates 10-100 times faster than methods used in existing programs above [16]. But a prerequisite for NanoSpice is a costly supercomputer.

Currently have active development of the method of constructing electrical models for simplified schemes of reduction, under which we understand the reduction of order of systems. The main goal of reduction in the study is reducing computational cost and improving the quality of results for use in mining. Developed a qualitative approach of a reduction of the linear model scheme based on the exclusion of subvectors, including the phase variables, if their values have a size of no more than 1–2% of the dimension DC, which is applied in the region of the discharge. The alignment of the reduced computational scheme is based on the specificity of the used matrices [17-21]. This will improve the performance of design processes. Personality driven instruments reflected in the calculations of the transient currents in the local area of the satellite schematics.

The proposed method allows to reduce the cost of hardware and software by 10–15% and also significantly improve the quality and the possibilities of using NSS in the framework of technological processes of mining companies.

Conclusion

Emerging innovative transport and space systems for efficient quality applications for the mining industry will be based on the implementation and upgrading of a number of NSS. The development of a deserted mining Geotechnology will promote further active implementation of effective organizational and technical solutions in the field of GLONASS, automated software platforms, robotics and various electronics to enhance the efficiency of the flow of production processes.

The results of the experiments developed methods based on computer display by: computing the reduced scheme with almost no loss of accuracy will be carried out the same calculations and using well known algorithms, but with increased speed by orders of magnitude. Created on the basis of the generated reduced computational model can be used as a model elements to a higher level of quality solutions improve the organization of the NSS for mining companies.

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