

ANNOTATION

Dissertational work of **Almuratova Nurgul Kanaevna**
on the topic: «**Energy-saving electric drive of centrifugal pumps
own needs of CHP**»

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Relevance of the research topic. A large number of electricity generating plants, which was built in the Soviet time, now require significant modernization in order to increase their energy efficiency, especially with regard to electric drives of the power plant's own needs.

The new Energy Conservation Program, adopted on the basis of the Law of the Republic of Kazakhstan "On Energy Saving and Energy Efficiency Improvement," dated January 13, 2012, determined the legal, economic and organizational basis for energy saving and energy efficiency activities. "Effective use of energy resources" is the achievement of a technically possible and economically justified level of use of energy resources.

The energy saving program is part of the nationwide plan to implement the annual messages of the Head of State to the people of Kazakhstan, and sets targets for energy saving and improving the energy efficiency of the country's economy, outlines the necessary conditions for implementing government measures aimed at energy saving.

During the independence of the Republic of Kazakhstan, the main equipment of the operating power plant was not actually updated, the wear and tear of the main and auxiliary equipment currently amounts to more than 60% according to some data. The volume of reconstruction and repair work is not sufficient, which is the reason for the growth of the gap between the installed and available capacity.

The main program measures of energy efficiency and energy saving in the Republic's energy sector are formed on the basis of technical re-equipment of generating capacities. They provide for the implementation of measures based on changes in the structure of the energy balance, the use of progressive and environmentally friendly technologies for burning coal and fuel oil, the use of renewable and non-traditional fuels and energy sources, as well as the implementation of a set of measures to optimize the schemes and operating modes of electrical equipment for auxiliary power plants and boiler houses, with the introduction of an adjustable electric drive on mechanisms with variable load. Research carried out by the department on increasing the energy efficiency of electric drives of auxiliary equipment for TPPs is one of the main sections of these program activities of the Republic of Kazakhstan.

In the Republic of Kazakhstan, electricity is generated in total by sixty-nine power stations with different forms of owners:

- total installed capacity - 19 798 MW;
- total available capacity - 15,765 MW;

Generally, generating power sources are:

- on coal - 74%;
- on natural gas - 11%;
- on liquid fuel -> 4%;
- hydroelectric power stations - 10%;
- on renewable energy sources (RES) - <1%.

Of these, 40% power plants are combined heat and power plants that produce combined electric and thermal energy;

Territorially, the electric power industry in Kazakhstan is conditionally divided into three zones - the Northern, Southern and Western.

The North Zone includes Akmola, East Kazakhstan, Karaganda, Kostanay, Pavlodar and (since 2009) the Aktobe region, whose power systems are united by a common network that has a developed connection with the energy system of Russia. In connection with the change in the structure of consumption in the zones of Kazakhstan with the commissioning of 500 kV «Zhitigara-Ulke» from February 2009, the Aktobe region entered the Northern Zone;

The Southern Zone includes Almaty, Zhambyl, Kyzylorda and South-Kazakhstan regions, whose power systems are united by a common electric grid that has developed communication with the energy systems of Kyrgyzstan and Uzbekistan. In 1998, the South Zone was included for parallel work with the Northern Zone. The Northern and Southern zones are connected by a 500 kV main transmission line (LEP)

The Western zone includes the Atyrau, West Kazakhstan and Mangistau regions, whose power systems have an electrical connection with Russia. At the same time, Mangistau, Atyrau and West Kazakhstan oblasts are united by a common electric network.

Thermal power plants (TPPs) in the Republic of Kazakhstan that use organic fuels can be classified by a large number of characteristics, the main and most used of which are discussed below.

TPP by type of energy released. There are so-called CPP (condensing power plants), which release only electric energy to external consumers, and CHP (Combined Heat and Power plants), which release electric and thermal energy (in the form of hot water and nap) to external consumers. Steam power turbines of condensation type are installed at the plant. They are equipped with condensers and do not have adjustable steam sampling. Usually, in the former USSR, such power stations were given the name of the state district power station, i.e. state regional electric power station, (for example, Ekibastuz GRES, etc.)

All CHP plants can be conditionally divided into industrial ones, i.e. steam for technological needs; heating with heat release, usually in the form of hot water for heating, ventilation and hot water supply of enterprises and population, industrial and heating, which combine the quality of the CHP - industrial and heating type.

At the CHP, as a rule, steam turbines of the heating type are installed: with back pressure, with adjustable steam samplings and a condenser. Condensing turbines can also be installed to cover peak thermal loads. Peak water-heating

boilers installed at the CHPP are used, or the CHP works in conjunction with district boiler houses. The boundary between IES and CHP is rather conditional.

Many CPP have in their composition punching boiler rooms, and from unregulated withdrawals of condensation turbines steam is taken to the network water heaters, i.e. CPP can supply nearby companies and villages with heat, as well as provide their own needs. Many power plants, originally built as typical CPP, were later reconstructed and became thermal power plants. For example, at Almaty power plant in the sixties four turbo-generators of type K-50-90 were installed.

The different types of fuel used in Kazakhstan in thermal power plants, the structure of technological schemes of stations and their arrangement have a significant effect on equipping stations with own-use mechanisms and, accordingly, for electric power consumption by their electric drives. Basically, these drives use short-circuited asynchronous motors with a supply voltage of 6/10 kV or 380 V.

In some cases, use DC motors (feeders of raw coal, dust, etc.). Accordingly, the networks of own needs are formed. The most powerful electric drives are connected to a network with a voltage of 6/10 kV, the rest to the 380V network.

When connecting to an existing network of stations of regulated electric drives having semiconductor converters in their composition, it is necessary to take into account a number of factors related to the features of the operation of these devices.

The regulation of the operating modes of centrifugal pumping units is hitherto carried out by throttling (dampers, latches, etc.), bypassing, changing the number of pumps involved. All these methods are obviously energy-consuming. The modern development of the electrical and electronic industry allows the use of an adjustable electric drive to ensure the necessary supply and pressure of pumps of any power.

The operation of powerful converters can have negative effects on the power quality indicators. Concerning, applicable transducers must comply with the requirements of electromagnetic compatibility with power supply networks.

The use of adjustable electric drives should provide for uninterrupted power supply to their control systems, either from its own source, which is part of the delivered converter, or from the DC buses of the station, powered from storage batteries. Therefore, the structure of the electrical circuits of the auxiliary needs of the stations is an important factor affecting the choice of equipment and the definition of technical requirements for converters in the modernization of electric drives of specific mechanisms.

To perform the energy saving tasks set in the dissertation in electric drives of own needs (DON), the operating modes and the status of the DON for the existing and the most typical Atyrau and Almaty thermal power plants were chosen for practical study.

The aim of the dissertation work is the development and synthesis of object - oriented energy - saving VFD centrifugal pump units for the needs of TPPs. This goal determined the following main tasks of the thesis:

- to carry out a study of operating modes of electric drives of Own Needs (ON), subject to improvement and modernization;

- Conduct a comparative analysis of the possible systems of an adjustable electric drive of the ON. To substantiate the feasibility of the VFD at the CHP of the TPP of the Republic of Kazakhstan, as the most economical way of regulating the flow and pressure;

- to determine the rational schemes of VFD for the construction of inverters taking into account the existing level of development of the power element base;

- create a methodology and algorithms for calculating the electromagnetical and electromechanical processes of the VFD of centrifugal mechanisms; to carry out research and analysis of processes and energy indicators of the VFD in a system with an asynchronous electric motor (AD), specifically for electric drives of the CHP TPP of the RK;

- to conduct research and analysis of processes and energy indicators of the VFD in a system with an asynchronous electric motor (AD), specifically for electric drives of the CHP of the thermal power station of the Republic of Kazakhstan;

- to develop a VFD system for pumping units ON and to make an analysis of the parameters of a centrifugal pump;

- develop recommendations for calculating the parameters of the power circuit components of electric drives in the energy saving mode;

- to develop the system of VFD of the electric drive of the CHP with allowance for the influence of the centrifugal load for specific mechanisms.

General methodology of research. The tasks have been solved on the basis of theoretical and practical analysis of the operation of pumping units with the use of fundamental concepts of the theory of automated electric drive, methods of mathematical modeling, numerical methods for solving problems of control and optimization of energy-saving VFDs.

Theme of the thesis is related to the state program with the priority direction of science development. Energy, priority, Heat and Power (increase of energy efficiency of operating thermal power plants in Kazakhstan), topic No. 2428 / ГФ3 "Increase of energy efficiency of operating thermal power plants of the RK due to energy saving in electric drives of the station's own needs" ME RK. **The thesis is executed independently** and testifies to the personal contribution of the author of the dissertation to science, in the field of application of energy-saving technologies in electric drives of mechanisms of own needs in operating TPP of the RK.

Has an internal unity, all sections and provisions of the dissertation are logically interrelated; scientific provisions obtained on the basis of practical studies of electric drives of ON at the operating power stations of the RK have been used to develop energy-saving technologies and recommendations in the process of modernization of TPPs and are consistent with the goals and objectives set in the dissertation. The proposed new solutions are reasoned and evaluated in comparison with the known solutions.

The scientific novelty of the studies carried out is that for the first time:

- a detailed survey of operating modes of electric drives of CHP TPP RK in the process of power generation

- Based on the comparative analysis, as an Frequency Converter (FC), for AM CP of the specific electric drives of the ON CHP of the RK, systems are proposed as the most economical and adapted to the peculiarities of the operating and electrical power supply modes;

- the mathematical and physical models of the electric drive of the CP have been developed, which allow to adequately study electromagnetic and electromechanical processes in the FC-AM system, the optimal parameters for regulating systems have been determined;

- methods and algorithms for calculating the parameters of the elements of the power circuit of electric drives, electromagnet processes and energy indicators are developed - the drive of the CP with respect to the new element base of the drive;

- Updated versions of the mathematical expression of the fan load on the motor shaft and the interdependencies of the parameters of the electric drive, pump and pipeline are proposed.

- recommendations on the use of energy-saving operating modes of electric drives were developed with the use of VFDs for specific mechanisms of ON at TPPs of the Republic of Kazakhstan.

The principle of reliability - the results of the thesis work were obtained using modern methods of scientific research and techniques for processing and interpreting data using computer technology. Theoretical conclusions, models, the revealed interrelations and patterns of use of the automated electric drive in energy-saving modes are proved and confirmed by experimental research, on the physical model and by means of mathematical modeling.

The practical value of the dissertation - in applied value, the scientific results obtained, confirmed by practical and theoretical studies at the existing TPPs of the Republic of Kazakhstan have practical and theoretical value, will be used in the planned modernization of the power plant of the Republic of Kazakhstan. Recommendations on the use of scientific conclusions of the thesis were transferred to Atyrau TPP for practical use.

The scientific results, regulations, recommendations and conclusions of the thesis are new, they will be used for energy saving in electric drives of ON with the purpose of reducing the cost of electricity at the operating power stations of the Republic of Kazakhstan;

scientifically based technical, technological, and economic solutions, the implementation of which makes a significant contribution to the development of the country's economy, in the use of energy-saving modes of electric drives of ON TPP.

The personal contribution of the applicant is:

- in the analysis and generalization of literary data;
- in the conduct of mathematical modeling;
- in planning, organizing and conducting experimental research, processing and generalization of results;

- in the development of the latest technical recommendations.

Approbation of the thesis results. The materials of the thesis were discussed and reported at international scientific and technical and scientific and practical conferences: 9th International Scientific and Technical Conference «Energy, Telecommunications and Higher Education in Modern Conditions» (Almaty, 2014), «INTERNATIONAL SCIENTIFIC AND TECHNICAL CONFERENCE OF YOUNG SCIENTISTS, ASPIRANTS AND STUDENTS» «Innovation is a vector for young people» , dedicated to the 60th anniversary of the Kyrgyz State Technical University. I.Razzakova (KR, Bishkek, 2014), correspondence International Scientific and Practical Conference "INNOVATIVE DEVELOPMENT OF CONTEMPORARY SCIENCE" (RF, Ufa, 2014), International Scientific and Practical Conference «Auezov Readings - 12:» The Role of the Regional University in development of innovative directions of science, education and culture »» (Shymkent), IX International Conference on Automated Electric Drive of AEP-2016 (Russian Federation, Perm 2016), annual conference of doctoral candidates, undergraduates and seminars of the Department «Electric Drive and Automation» of Almaty University Energy and Communications.

Publications. The main scientific results of the doctoral dissertation were published in 13 publications, including 4 publications in the publications recommended by Committee for Control in the Sphere of Education and Science (CCSES) ME RK, 2 publications included in the information database Scopus, in the foreign journal "International Journal of Pharmacy and Technology", in 5 international scientific and practical conferences, 2 conclusions on the grant of a patent for a utility model.

Structure and amount of work. The thesis consists of content, normative references, a list of abbreviations, an introduction, the main part of the four chapters and the conclusion. The volume of the thesis is 131 pages of computer kit, contains 34 drawings and 21 tables, a list of sources used and the application.