ACTUALITY OF CENTRALIZED HEAT SUPPLY SYSTEMS AUTOMATED PROCESS CONTROL SYSTEMS MODERNIZATION

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Abstract

The article discusses the existing problems of centralized heat supply and considers the forecast of the urban consumers' needs of the Republic of Kazakhstan for the next decade. An economic method for solving problems by applying complex automation process is presented. A list of competitive suppliers of full-scale automated process control systems based on modern software and hardware systems is given; a recommendation is made on their choice. The advantages of using the Program Technical Complex "Krug" and the use of industrial controllers DevLink-C1000 at the control objects (central heating stations, boiler rooms, pumping stations, etc.) are described. Russian-made industrial controllers DevLink-C1000 are designed to create "light" and "medium" automated process control systems, as well as used as part of large, complex systems. In combination with DevLink A10 In / Out modules, the DevLink C1000 controller is able to interrogate various sensors and devices (thermocouples, thermoresistors, devices with a unified current output, etc.) and generate control actions. PLCs can interrogate many different devices and read archives. A high-performance 32-bit processor based on the ARM9 architecture (with a frequency of 400 MHz) in combination with fast memory and a controller's real-time system (SRVK) specially optimized for this platform allow achieving a high level of performance.

Key words: combined heat and power plant, centralized heat supply, automated process control system, controllers, software and hardware complex.

INTRODUCTION

More than 70% of residents use the services of centralized heat supply (CHS) in the cities of Kazakhstan. This method of heat supply which does not require intervention from the consumer is quite comfortable and convenient for most residents. Centralized heat supply is a complex consisting of: a heat source (combined heat and power plant (CHPP) or district boiler house), heating networks and heat consumption systems. The main problems in all existing CHS are: moral and physical depreciation of fixed assets in all parts of the system, high emissions of pollutants in environment, the high cost of reconstruction as well as a reduced level of automation which is one of the most important indicators of efficiency and competitiveness of heat and energy production.

MATERIALS AND METHODS

Theoretical analysis

By 2030, the demand for heat energy in Kazakhstan will increase by 25.4 million Gcal (20%):

- the share of CHPP in providing urban consumers will increase from 45% to 54% (Fig. 1);

- the expected increase in heat consumption in cities will require the modernization of CHPP and heating networks [1].

In the conditions of insufficient investment in this industry one should look for the least costly but giving quick effect methods to solve at least part of the existing problems. One of these methods is the integrated automation of CHS. At a relatively low cost regarding the replacement of technological equipment, automation gives a quick economic effect.

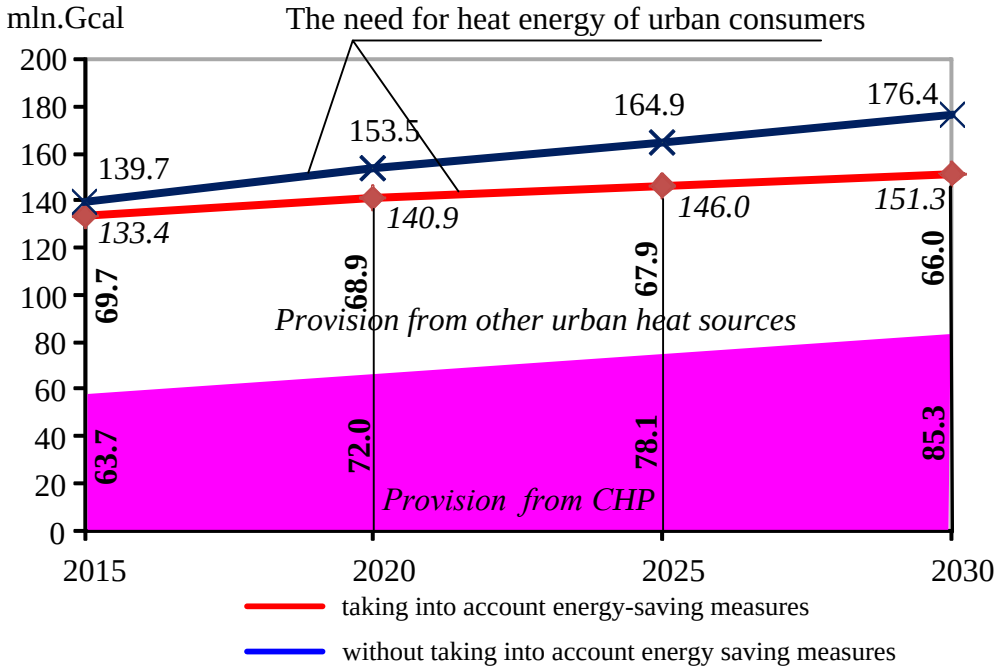

Fig. 1. Forecast of the need for heat energy of urban consumers of the Republic of Kazakhstan for the period 2015 - 2030.

The level of automatic process control systems of most CHPP no longer provides for the competitiveness of heat and energy in terms of reliability, quality of technical equipment, volume of functions and level of information content. Modern automated process control systems (APCS) can significantly improve the accuracy of regulation of the equipment parameters that determine the efficiency of the operating mode and the quality of the process which in turn increases the service life of the equipment. After the introduction of modern control systems, the range of tasks to be solved significantly expands in comparison with traditional equipment. Thus, it becomes possible to calculate technical and economic indicators (TEI) of equipment operation in the “on-line” mode. Another important option of the modern generation of industrial control systems is the analysis of technological protections which allows increasing their reliability.

Modern, more ergonomic means of providing information on the progress of the technological process can significantly reduce the errors of the heat supply systems operating personnel. Further operation of obsolete equipment is accompanied by an increase in operating costs for spare parts and repairs. In addition, an increase in the number of failures in the control equipment inevitably leads to faster deterioration of the main power equipment and often to emergency situations which can entail large financial losses. The next not

unimportant argument in favor of modern industrial control systems is the ability to bring the training of operational personnel to a qualitatively new level by creating simulators based on the operating program and technical complex (PTC) [2,3].

A brief overview of modern process control systems based on PTC. Currently, the Kazakhstan market of services for the energy sector has a fairly wide range of various Russian and foreign manufacturers of the modern generation of APCS based on the PTC which, with one or another success, can solve the problems energy specialists face in the conditions of the functioning of the energy and power market. A full-fledged software and hardware complex should provide:

• providing operational personnel with sufficient, reliable and timely information on the flow of technological processes, on the status of equipment and technical means of industrial control systems;

• automated control of technological equipment in normal, transient, emergency and special operating modes;

• optimal process control in order to obtain thermal and electric energy of a given quality and quantity;

• reduction in operating costs and an increase in the overhaul period due to a decrease in the number of serviced equipment (compared to traditional tools), a minimum recovery time, and also to facilitate changes and build-up of functions during further reconstruction;

• automatic maintenance of operational documentation;

• performing TEI calculations.

Far from all of the APCS based on PTC advertised, created and implemented at the present time meet the above requirements (Table 1).

Table 1. List of competitive suppliers of full-scale APCS for power units based on modern PTC

Company	Country	Name of PTC
Westinghouse	USA	WDPF-2
Westinghouse	USA	Ovation
ABB	Germany	PROCONTROL-P
ABB	Germany	Freelance 2000
Siemens	Germany	Teleperm XP-R, ME
PTC «Krug»	RF	SIC «Круг»

RESULTS AND DISCUSSION

The weak point of the control systems of foreign countries manufacturers which should be taken into account when choosing a PTC is the need to constantly resort to the costly services of companies involved in their implementation. Our analysis shows that the operated equipment of most of the existing CHPP built in the 60-80s of the last century is Russian-made, and therefore the introduction of RF systems would be justified and economical.

Characteristics PTC "Circle". The KRUG Company is a developer of the KRUG-2000 software and hardware complex [4]. The solutions developed on the basis of PTC KRUG-2000 have a number of advantages that distinguish them from the products of competitors:

1. An integrated approach and the construction of a system on the basis of unified, deeply integrated software and hardware tools.

2. High reliability of equipment in combination with the possibility of organizing various redundancy schemes make it possible to build APCS on the basis of “uninhabited technologies”.

3. Organization of communication of local APCS (central heating, pumping, boiler rooms) via slow and unreliable communication channels (modem wired channels, GSM) with the possibility of their reservation.

4. The ability to gradually increase the functionality and scale the system.

5. Implementation of all tasks of the water software and hardware complex (accounting, control, management, analysis).

6. Availability of drivers for numerous metering devices used at heating facilities, a comprehensive solution to the problems of technical and commercial metering of water, gas, electricity and heat carrier.

7. Developed standard technical solutions for various heating systems.

These advantages are due to a number of features of the basic software (the modular SCADA system KRUG-2000®) and the DevLink®-C1000 industrial controllers used in the PTC. The capabilities of SCADA KRUG-2000 to create systems with a distributed database are well suited for the construction of multi-level dispatch systems, where there may be several levels of data collection and storage in the form of a central dispatch center and dispatch branches.

The SCADA KRUG-2000 arsenal contains the majority of generally accepted protocols that allow the exchange of information with third-party systems and controllers of third-party manufacturers. This makes it a universal means of integrating equipment already existing at heating facilities into a single system. For example, the described software and hardware ensure integration with the video surveillance, security and fire alarm subsystems into a single complex.

Nevertheless, the greatest effect is achieved when industrial controllers DevLink-C1000 are used at the control objects (central heating, boiler, pump, etc.). In this case, a specialized exchange protocol is used to exchange information between the SCADA system and the controllers which allows working on slow and unreliable communication channels. This protocol not only supports operation in an unstable environment but also restores archived information on the system’s database servers when communication with the DevLink-C100 controllers breaks by reading archives stored on the controllers. Thus, after communication is restored, the dispatcher has complete information about the events that occurred at the facility during its absence. Special software modules provide work with both static and dynamic IP addresses with support for traffic encryption. Software Firewall protects DevLink-C1000 from malicious programs which are important when working on open Internet networks. The presence of a GSM module with two SIM cards as a part of the controllers allows organizing reservation of communication channels with controllers in various combinations (GSM/GSM, GSM/Ethernet, Ethernet/HDSL, etc.) without additional communication equipment in the automation cabinet.

Special modifications of DevLink-C1000 incorporate up to 4 RS-485 interface channels, which together with an extensive library of drivers for various devices (electricity meters, heat meters, gas meters, etc.) make them centers of integration of equipment available on heating system facility. DevLink-A10 I/O modules allow monitoring and control using almost the entire set of existing unified signals. Despite the fact that the DevLink-C1000 controllers are a budget solution designed specifically for dispatching tasks, their software is

similar to the software used as part of the KRUG-2000 PTC for automating the most complex and dangerous production of the oil and energy industries. Accordingly, it has a complete set of tools for creating the most complex control algorithms. The DevLink-C1000 controllers allow organizing various redundancy schemes that increase their reliability and have been in the most difficult operating conditions. Do not forget about the presence of a unified programming environment SCADA CIRCLE-2000 and DevLink-C1000 controllers, as well as a single once-dialed and consistent database system which greatly facilitates the engineering, commissioning and operation of the system.

The modularity and scalability of the PTC KRUG-2000 fully ensure the implementation of an integrated approach to creating a dispatch system for heating networks (Fig. 2). The customer has the opportunity to buy software modules and increase information capacity as the system expands.

The experience of introducing PTC KRUG-2000 on the heating networks of enterprises of the Russian Federation has allowed us to create a number of standard solutions. Among them are standard solutions for the automation of various individual heating units (ITU), central heating stations of pumping stations, boiler houses, typical solutions for the creation of control centers and energy metering systems. The use of standard solutions gives a number of advantages, such as reducing the time and cost of design, reducing the cost of engineering, commissioning and maintenance, ample opportunities to expand and scale the system. As a result, the use of standard solutions developed by KRUG SIC (Scientific Industrial Company) reduces the total cost owning the automation system as a whole and reducing the payback period of the system.

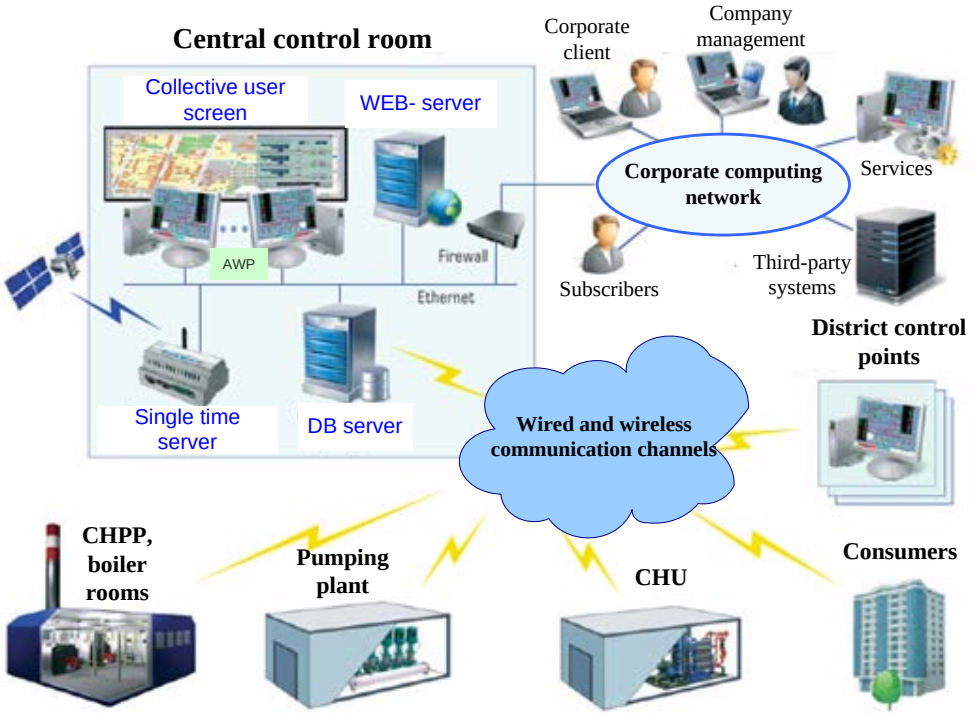

Fig. 2. Automated dispatch control system of a heat supply company

CONCLUSION

Thus, PTC KRUG-2000 has the whole set of necessary tools for implementing projects for the automation of heating networks, is the most effective means to increase the efficiency of heat supply and allows for the phased implementation of the policy of heat and power economy modernization with the preservation of investments.

REFERENCES

1 Sostoyanie i perspektivy` razvitiya czentralizovannogo teplosnabzheniya v Kazaxstane [State and prospects of development of district heating in Kazakhstan]. Astana, LPP «KazNIPIEnergoprom», 2013. 26 p.
2 Rabenko V. S, Moshkarin A. V. Povy`shenie bezopasnosti, nadyozhnosti, e`konomichnosti i prodlenie sroka sluzhby` oborudovaniya predpriyatij teplovoj e`nergetiki sredstvami novy`x komp`yuterny`x texnologij podgotovki operativnogo personala [Improving safety, reliability, efficiency and extending the life of equipment of thermal energy enterprises using new computer technologies for training operational personnel]. E`nergosberezhenie i vodopodgotovka - Energy saving and water treatment, 2002, no. 2, pp. 31 - 39.
3 Proshin A.I., Shekhtman M.B., Ladugin D.V. Kompleksnaya avtomatizacziya teplovy`x setej kak naibolee rezul`tativny`j instrument povy`sheniya effektivnosti teplosnabzheniya [Integrated automation of heating networks as the most effective tool for improving the efficiency of heat supply]. Avtomatizacziya i IT v e`nergetike – Automation and IT in the energy sector, 2017, no. 4(93), pp. 2-6.
4 Scientific Production Company «KRUG». Available at: www.krug2000.ru (accessed 12 February 2020).