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REALIZATION OF THE PROBLEMS RELATED TO CALCULATIONS AND ANALYSIS OF THE TECHNICAL-ECONOMIC INDICATORS OF THERMAL POWER STATIONS

The paper considers current problems related to the informational provision of automatic control systems of electric power stations as to calculations and analysis of the technical-economic indicators. Creation of such control systems must be based on the detailed analysis of the experience accumulated to date, taking into account their functional, informational, algorithmic as well as engineering provision for ensuring reliable operation of electric power stations. In the elaboration of basic information tasks attention was also given to determining energy characteristics of the equipment.

Key words: *electric power station, technical-economic indicators, automatic control system, generating unit, energy characteristics, error, power equipment, energy system.*

Introduction

Energy characteristics of generating units take on an important place in the basic information about the power equipment, which is necessary for its reliable functioning and for solving many tasks of operational-dispatching control. Estimation of energy characteristics is required for the system of power station and energy system mode optimization as well as for determining the impact of various disturbances in the normal mode of power equipment operation on its characteristics.

Consumption of energy, generated under the influence of various factors, varies continuously. This determines the necessity of constant changes in the power station operating mode, which in the integrated energy systems should be subordinated to the interests of such a system and established taking into account characteristics of the equipment, its economic efficiency, availability of the power reserves, etc. [1 – 3].

Due to the growth of daily and weekly unevenness of the operating mode, to maintain dispatching schedules, powerful generating units of the thermal power stations (TPS) are increasingly used for wide-range regulation of the energy system electric loads. In some energy systems with the most uneven schedules total load – from the night minimum to the morning maximum – increases 1.5 – 1.6 times, and on week-ends up to 50 % generating units have to be stopped [5].

Modern powerful generating unit of TPS is a combination of the following interrelated assemblies: steam generator, turbine and a great amount of auxiliary equipment. This combination is a complex control object. TPS generating unit is also an object with distributed parameters. Static and dynamic characteristics of its separate parts depend on the load, the type of fuel, the structure of the heat network and other factors related to the operating modes. Another characteristic feature is big amount of information that must be obtained, processed and realized to provide the power equipment control as well as its reliable and efficient operation under different operating modes.

Technical-economic indicators (TEI) characterize economic efficiency, failure-free operation and durability of the power equipment during its operation process [4]. Depending on their purpose, all the indicators are divided into operational, reporting and those registered during a work shift. Operational indicators are calculated within short time intervals (5 – 15 min.) and used for current control of the technological process. Work shift indicators are calculated within 8 hours and are required to evaluate the quality of the station personal performance as well as the equipment condition. Reporting indicators are calculated within the periods from daily ones to those of the calendar month [4]. Therefore, the conditions of optimal ES operation, which is the main task of the automatic control systems (ACS), are determined in the process of analyzing its technical and economic indicators [6].

Due to the complexity of the modern power equipment, characteristic features of its operation, big amount of experimental data as well as complexity of its mathematical processing, researchers face the problem of the necessity to register large volumes of initial information and to perform significant amount of rather labor-consuming computations for obtaining final results of the experiments. Much work is done manually, which leads to considerably longer periods, required for obtaining experimental results, does not ensure their accuracy and essentially reduces labor productivity of the employees who conduct the experiment [7 – 9].

It should be also noted that for obtaining the power equipment characteristics long-time experiments are usually required (4 – 24 hours and sometimes even longer). This is caused by the inertia of thermal processes and, as a result, time losses for the process of transition from one mode to another as well as by significant external and internal disturbances during operation.

The above circumstances complicate prompt use of the energy characteristics in order to ensure qualitative operation of the equipment and determine the practice of their computation only after capital repairs of the equipment or certain considerable work on its reconstruction, adopted at the majority of ES. This corresponds to the periodical renewal of the energy characteristics approximately once in every 1.5 – 2 years. It should be noted that such energy characteristics cannot be effectively used for implementing the tasks of ES ACS.

The above-mentioned shows that solution of the problems related to computation of TPS technical-economic indicators for ACS is relevant

and is of interest for the researchers.

The work aims at increasing accuracy of the analysis of the energy equipment technical-economic indicators, based on the improved algorithms of measuring information parameters for hardware/software packages of ACS of TPS technological process.

Research results

Application of the computation engineering means in ACS of generating units makes it possible to automate the process of experimental estimation of different energy equipment characteristics. During this process the plans of the experiments could be optimized as well as processing of their results [9, 10].

Analysis of the work on conducting the experiments using the computation systems enables determination of the following functions of the experiment automation system in ACS of ES:

– collection and registration of the data coming from the object;

– saving and express-analysis of the experimental data;

– implementation of the experiment planning algorithms;

– automatic control of the experimental processes;

– processing and interpretation of the experimental results;

– accumulation of the data obtained from a number of experiments and its statistical processing;

– providing the possibility of the researcher direct communication with the research object;

– presenting and outputting the results of the experimental data processing in the form, convenient for further use.

Energy characteristics of the equipment are necessary for implementation of the following tasks:

1. For optimizing the modes of the generating units:

– compiling optimal-mode charts of the generating unit operation, i. e. of the dependence of control actions on the controlled technological process parameters;

– establishing the terms of preventive and capital repairs;

– evaluating the effect from the organizational and technical measures.

2 . For optimizing the modes of electric power station (energy system):

– distribution of the active and reactive load between the units with the choice of main equipment composition;

– distribution of the fuel types between the units;
– optimization of maintaining the vacuum;
– optimization of the schedule of organizational-technical measures to be taken, of revisions and capital repairs, etc.

It should be stressed that any experiment always involves participation of a human operator [11, 12]. Besides, the use of inaccurate consumption characteristics during the active load distribution by the method of equal specific increments can lead to overburning of the fuel. It should be also noted that some problems related to receiving and processing of the output information about the generating unit operation have not been solved because not all of the required unified sensors, having the necessary precision and providing the corresponding information, are available.

Fig. 1 presents a structural diagram of the general problem of determining energy characteristics in relation to TPS generating unit. Arrows show the information path and the order of actions during registration of the characteristics.

When the plans of experiments are elaborated, the problem is divided into two parts (Fig. 1): planning single-factor and multifactor experiments. This traditional division is connected with different types of mathematical apparatus used at the planning stage and at the stage of initial processing of the results. Multifactor experiment is necessary for determination and correction of the input data, which should be brought to the nominal conditions.

Statistical processing of the results includes: initial processing of the obtained data, sorting out in order to reveal evident failures and mode violations, evaluation of the main approximation parameters, approximation accuracy estimation and comparison of the results obtained.

The longest experience of automatic computation and analysis of TPS is accumulated at Zmiyivska and Zaporizhya TPS, where these tasks are the main ones for ACS of the technological process (TP) of the three generating units with the power of 800 MW each [8].

Computation problems are distributed between unit and group subsystems. Unit subsystems realize collection and initial processing of the information, determination and analysis of TPS characteristics within 15-minute intervals as well as preparation of the information for solving the group subsystem problems. In the group subsystem TPS characteristics are determined and analyzed for each unit and group within the work shift in total and within the reporting intervals as well as the equipment condition is controlled.

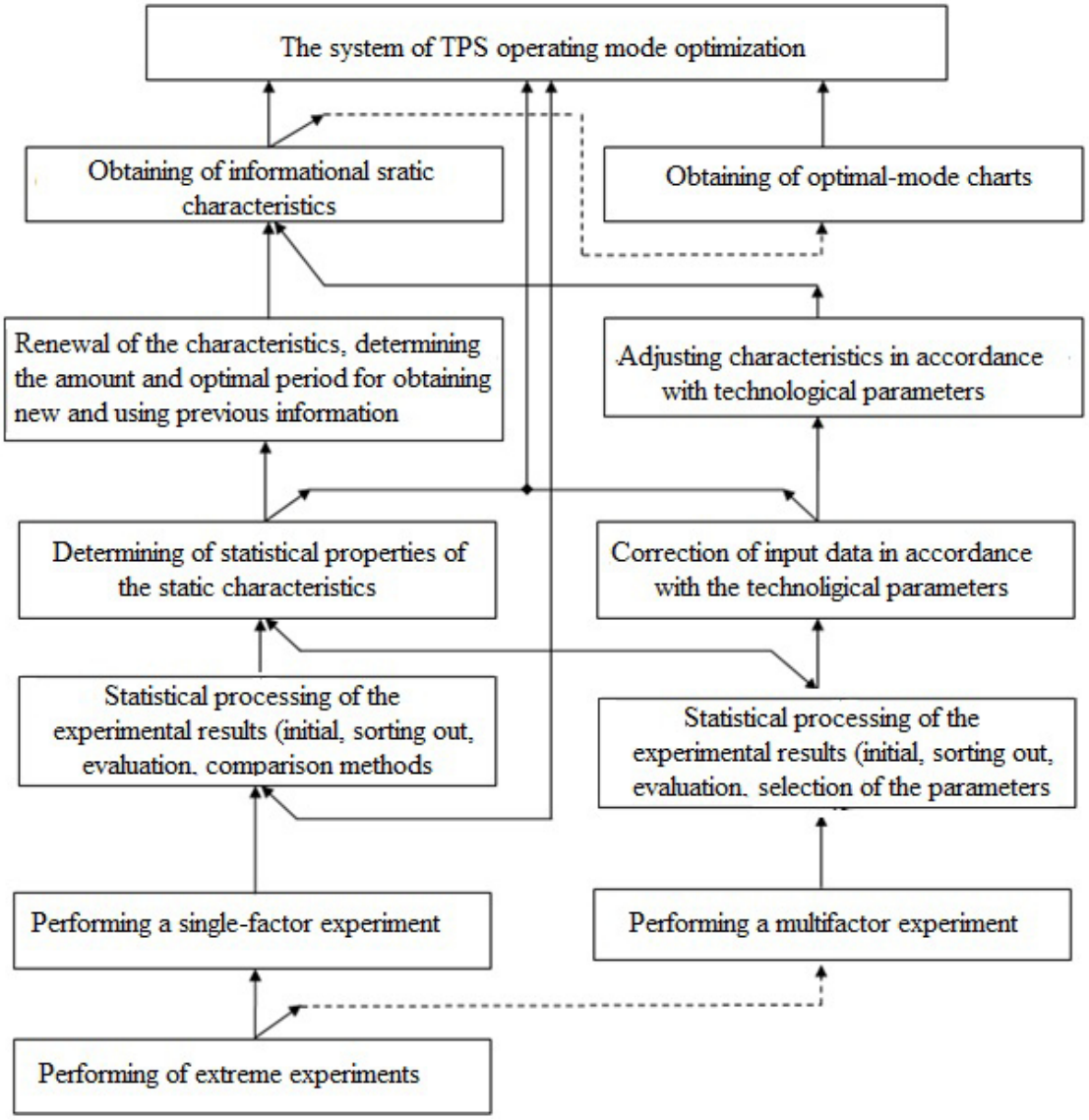

Fig.1. The diagram of using the results of experimental estimation of TPS generating unit energy characteristics

To analyze TPS, normative indicators and fuel overconsumption at the operational interval are also determined. Set of indicators to be calculated at the operational interval is determined by the usefulness of their application for operational control. Information concentration in all the units of the group subsystem makes it possible to perform full-scale TPS calculations for each unit and their group, beginning from the 8-hour interval.

Before the analysis of unit TPS, the algorithm of calculation and distribution of the total (for all the units) heat and electricity consumption between the units for their own needs is realized.

The procedure of calculating the indicators is the same at all reported intervals (daily, weekly, monthly). Initial and absolute secondary indicators are determined by averaging the corresponding quantities, obtained at 8-hour intervals. Relative and normative indicators for all intervals are determined again, normative indicators being determined by the reverse method (according to the fuel overconsumption and to the actual indicator value).

Apart from through calculations of the reported TPS, estimation of the indicators within the work shifts is required for the analysis of the personnel performance. The equipment control problems are required for evaluating the condition of separate unit elements (regeneration heaters, the turbine cylinders, heated surfaces of the steam generator, etc.). These problems are solved periodically in accordance with the data supplied after initial processing before the group subsystem is analyzed.

Initial processing involves 150 parameters for each unit. It is convenient to use reference data of

the parameters in the form of passports. This enables prompt changing of the validity control algorithms and their setting parameters as well as scaling factors when sensors are replaced. Information is displayed at the indication device and printers, installed at the unit control panel, by groups according to the operator request. Recently, input of the information about general measurements (for all units) into the group subsystem through the subsystems of separate units has been implemented. This has created the conditions for comprehensive solution of the problems related to processing non-operational information for the entire group of 800 MW units of Zaporizhya TPS.

Conclusions

1. TPS analysis should be based on the comparison of actual and normative indicators in order to provide the most expedient mode of the energy system operation, under which the consumers continuously receive energy of the acceptable quality with the least expenses for its generation, transmission and distribution.

2. The scheme of using the results of the experiments on determination of energy equipment characteristics has been developed. Connections between its separate parts indicate the current tasks of electric power station mode optimization.

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