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Development of a software package for optimizing the power supply system in order to minimize power and load losses

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Abstract

The article gives information on optimization of steady-state regimes of power supply systems in order to minimize power losses. The following tasks were set and solved: motor parameters were determined; the steady-state regime of PSS was calculated. Static characteristics of power losses in asynchronous and synchronous motors and transformers have been obtained. Researches have been carried out for ore mining and processing. On the basis of the obtained universal model, a software package has been designed to perform calculation and experimental researches to obtain static characteristics of power and load losses in PSS and to establish the patterns of variation of these characteristics.

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Keywords: power supply system; static characteristics; asynchronous and synchronous motors; transformer; load power; steady-state regime; power losses; software package

1. Introduction

It is well known that the energy intensity of the domestic industry significantly exceeds the analogous indicators of the developed economies of Western Europe, the USA and Japan. Therefore, currently much attention is paid to energy saving in the direction of optimizing the power consumption of individual electrical receivers and electrical

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systems, as well as reducing losses in the transmission, distribution and consumption of electricity [1−6]. At the same time, the efficiency of industrial enterprises is estimated, including by indicators Economical operation of the power supply system (PSS), which is especially important with the significant specific electricity consumption and high energy component in the structure of production costs [7]. In this regard, it is necessary to solve the problem of optimizing the operating regimes of power supply systems in order to minimize losses for transmission of energy from the power system to consumers.

The solution of the problem of minimization of electric power losses in electrical networks is expedient, first of all, at the stage of designing an industrial facility, when the parameters of the main electrical equipment are selected. This task is no less urgent in the process of operation of the PSS. However, in both cases, the problems of analyzing, calculating and optimizing the operating regimes of PSS are possible only on the basis of the application of special methods and means of computer technology. The development of methods of mathematical modeling aimed at solving these problems is undoubtedly relevant.

Design and operation of power supply schemes require the solution of various tasks characterized by increasing the reliability of consumer power supply and a multitude of parameters that determine the state of interrelated and interacting processes in synchronous and asynchronous motors, individual elements of the power supply system and the power system. The problems of analyzing, calculating and optimizing the operating regimes are solved on the basis of application of special methods and means of computer technology. The most widely used methods are mathematical modeling methods.

Despite a significant number of works in this field [6–11], the methods of modeling and optimizing shop-floor power supply systems, algorithms for calculating the characteristics of an asynchronous motor (AM) and a synchronous motor (SM), static load characteristics and power losses for calculating the normal operating conditions of large PSS and their practical implementation have not yet been properly developed. Most of the existing algorithms simplistically represent a circuit of shop-floor networks that is complex in structure and configuration, equivalent to most of the load at 380 V, don't fully take into account changes in the parameters of the equivalent circuit of AM and SM [12–16].

2. Methodology

Researches include a set of methods consisting of analysis and scientific generalization of scientific and technical and patent information, theoretical studies, methods of three-dimensional modeling and designing. The reliability of the results of scientific researches is confirmed by the development of models of the proposed devices [17].

To achieve this goal, the following theoretical and applied problems were solved in the paper:

- Development of the methodology and algorithms for calculating the parameters of the equivalent circuits for AM, SM with a massive smooth rotor and with poled-pole poles, according to the catalog data applicable to the determination of the static characteristics of power losses;
- The influence research of the deviation of real data standardized by the standards, the motors from the catalogs to the spread of the values of the parameters of the equivalent circuits;
- Completion of the software package for calculating the steady-state regimes of PSS with an electric motor load on the basis of the developed algorithms as applied to the determination of the static characteristics of power losses;
- Obtaining static characteristics of load and power losses for real industrial facilities and exploring the possibility of their use in the development of energy-saving measures.

The quality of industrial power supply system (IPSS) modeling is largely determined by the regime modeling method [18]. The regime modeling method should allow to display the entire variety of possible states of IPSS at the optimal expenditures of computer time and computer resources for calculations [19].

To simplify the calculation of IPSS regimes, it is expedient to distinguish three hierarchical levels [20].

The parameters of the IPSS regime at this level are determined by the Eq. (1):