USING SENSORS TO MONITOR THE CONDITION AND SAFETY OF ELECTRICAL EQUIPMENT

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Abstract

The article explores the important role that modern sensors play in ensuring the safety and efficient operation of electrical equipment. Advances in sensor technologies make it possible to effectively monitor the condition of equipment, identify potential problems and prevent accidents. The article examines the principles of operation of sensors, their diversity and application in various areas of the electric power industry. Particular attention is paid to predictive maintenance technologies, which allow optimizing resources and increasing the reliability of electrical equipment. Ultimately, the use of sensors to monitor the condition and safety of electrical equipment leads to reduced risk of accidents and increased efficiency of electrical power systems.

Keywords: sensor, vibration, electrical equipment monitoring.

I. Introduction

In the modern world, the electric power industry plays a key role in meeting the energy needs of society. However, as the complexity of electrical power systems increases, their requirements for reliability and safety increase. Failures and accidents in electrical equipment can lead to serious consequences for both electricity consumers and the environment. In this context, the use of modern sensors to monitor the condition and safety of electrical equipment becomes a necessity.

Sensors play an important role in ensuring the efficient and safe operation of electrical equipment. They allow you to continuously monitor various parameters such as temperature, humidity, pressure, vibration and electrical parameters, allowing you to quickly identify any anomalies or deviations from the norm [1-3]. Thanks to modern technologies for collecting and analyzing data, the information obtained can be used to predict the likelihood of equipment failure and take appropriate measures to maintain or replace it.

The purpose of this article is to consider the role of sensors in ensuring the safety and efficiency of electrical equipment. We will discuss how sensors work, their variety and application in various applications in the power industry, as well as the benefits they bring in predictive maintenance and optimization of power systems. As a result, we will be able to understand how the use of sensors helps improve the safety and reliability of electrical equipment, as well as reduce the risks of emergency situations.

II. Formulation of the problem

Technical diagnostics are intended to improve the quality, reliability and increase the service life of mechanisms, machines and equipment. The need to use technical diagnostics is caused by the constant increase in complexity and increase in the level of automation of modern enterprises, factories, plants, thermal and nuclear power plants, sea, air, railway and other modes of transport, etc.

According to the international confederation IMECO, the introduction of continuous technical diagnostics into rotary equipment of companies reduces labor intensity and repair time by more than 40%, reduces fuel consumption of energy companies by 4% and increases the technical utilization rate of equipment by more than 12%. Experience in operating similar systems at a nuclear power plant at the end of the 1990s. allowed to reduce costs by 3 million US dollars within one year and generate additional income in the amount of 19 million by reducing equipment downtime.

Taken together, the introduction of technical diagnostic tools allows:

- prevent accidents;
- prevent and increase the reliability of machinery and equipment;
- increase their durability, reliability and service life;
- increase productivity and production volume;
- predict residual life;
- reduce the duration of downtime with the assessment of additional profits;
- reduce time spent on repair work;
- reduce operating costs;
- reduce the number of service personnel;
- optimize the number of spare parts;
- reduce insurance costs.

The sensors themselves are practically useless - they simply collect huge amounts of information. To store this data, structure, process, analyze and use it for production management, you need special software. It can be installed on company servers or deployed in the cloud.

Examples of standard production monitoring software would be:

1. MES systems. These are production process control systems. They monitor production capacity utilization, help track defects, and alert personnel to production problems, such as material shortages or production process irregularities.

2. Scada. This is software that collects and visualizes information about the operation of equipment. With its help, you can monitor the performance of individual machines or the entire workshop as a whole, control equipment remotely and create reports for management and analysts.

There are also other platforms with additional features that can replace or complement MES and Scada. For example, VK Cloud (formerly MCS) has a ready-made platform for building an equipment monitoring system. It is deployed in the cloud and allows you to rent any capacity needed for monitoring, as well as develop your own solutions to optimize production. The platform can collect and store information from sensors, visualize data and notify about events [8-11] .

With the development of microelectronics, small-sized measuring and diagnostic systems, integrated and installed directly into equipment, have developed. Work in this area is carried out by the world's leading companies: Schneider Electric, Siemens, General Electric, BALLUFF BCM, etc.

III. Problem solution

In production, especially in mechanical engineering, there are extremely many points where monitoring of wear or contamination of components is required. Indicators of these parameters are usually vibration and temperature.

It is difficult to implement a system for precise control of vibration and temperature with 100% coverage of all points. There is a need for inexpensive mass indicators that can identify points that require close attention.

At the same time, there is a need for a convenient presentation of a large amount of data for further analysis. The BALLUFF company has a solution in this direction.

Objective information about the degree of wear and contamination of components is important for optimal planning of equipment maintenance, as well as preventing unscheduled shutdowns.

Measuring vibration and temperature parameters in this case does not require high absolute accuracy, which today is provided by modern highly specialized vibration control systems.

Such control often comes together with temperature control. With a large number of control points, problems arise with the placement of sensors and wiring of sensors. Then the task of miniaturizing sensors and optimizing signal transmission lines arises.

Vibration control involves measuring about 20 parameters that require additional processing to be analyzed. Usually this function is performed by an external controller, which also complicates the solution.

BALLUFF has brought to market a revolutionary solution by combining vibration and temperature, humidity and atmospheric pressure measurement, as well as a microprocessor in one package. All this is represented by a series of BCM sensors.

The BCM sensor is a complex device that includes individual parameter monitoring modules.

The vibration measurement is made using a microelectromechanical system (MEMS) element, a technology now widely used, including in smartphones, industrial inclination sensors and accelerometers. Microelectronic technologies have also been applied to measure other parameters, making it possible to combine all measurements into one miniature device.

Data processing is carried out by a built-in processor, which creates a data array convenient for analysis and transmission. In addition to the values of certain parameters, this array also includes the event log.

The problem of transferring a large amount of data from one sensor was solved within the framework of the standard IO-Link digital interface, which is gaining momentum in mechanical engineering, designed to connect sensors to a master module in a point-to-point manner (Fig. 1). Communication between the master module and upper-level equipment is carried out using industrial network interfaces, such as, for example, Ethernet/IP and Profinet.

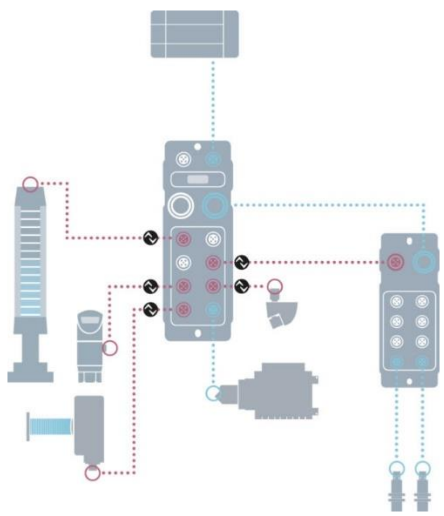

Figure 1: *Connecting equipment with IO-Link interface*

Using the BCM sensor, monitoring an increase in the average values of vibration parameters over a period of time will tell you when it is necessary to replace a bearing or change the oil in a critical mechanical unit; temperature will indicate a possible malfunction of the cooling systems or the presence of parasitic friction; relative humidity will indicate the need to make changes to the technical process for which it may be important. Today, an equipment condition monitoring system can be effectively used in almost every production facility.

Thus, in addition to the transparency of production processes (Fig. 2), a reduction in downtime is achieved both for manual inspection of critical components and for performing repair work.

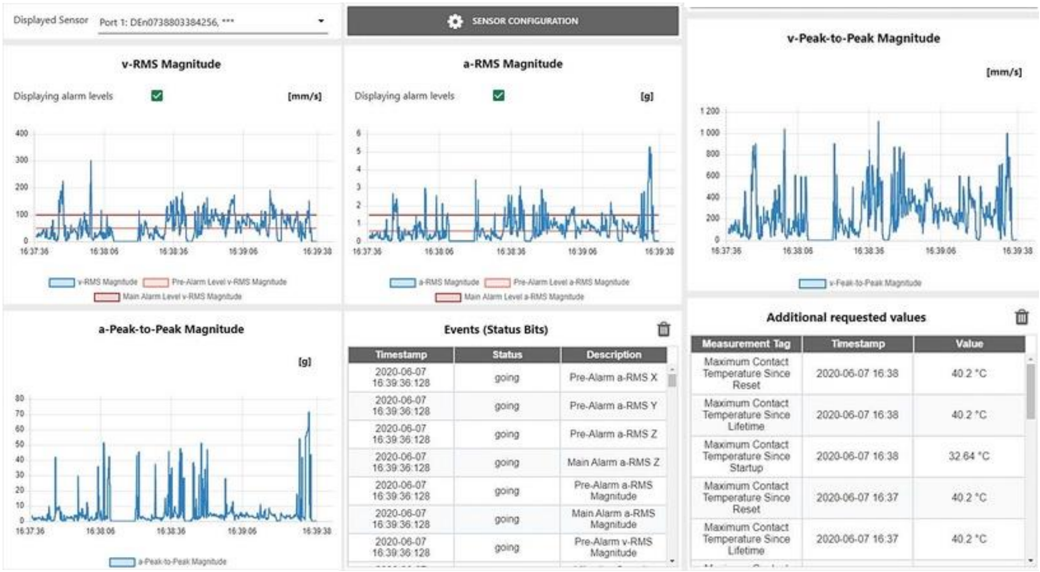

Figure 2: *Visualization of equipment condition monitoring*

Sharp changes in certain parameters or cumulative trends in increasing values can not be analyzed in the control system, but a corresponding logical alarm signal of two levels (conditional "yellow" and "red" alarm) can be received from the BCM sensor, thereby optimizing the program code of the monitoring system and ensuring convenience for the operator, who can quickly make decisions about the need to intervene in the technical process.

Thus, in addition to the transparency of production processes, a reduction in downtime is achieved both for manual inspection of critical components and for repair work.

In addition, there is the possibility of implementing a completely autonomous condition monitoring system, which can automatically create a schedule of repair and maintenance work based on sensor readings and thereby simplify and optimize the work of relevant specialists and departments at enterprises.

IV. Conclusions

In conclusion, we can emphasize the importance of using sensors to monitor the condition and safety of electrical equipment in the modern power industry. Our analysis showed that modern sensor technologies make it possible to quickly monitor various parameters of equipment operation, which in turn helps prevent accidents and failures, increase system efficiency and reduce maintenance and repair costs.

In addition, the use of sensors also contributes to the development of the concept of predictive maintenance, which allows optimizing the process of equipment maintenance and repair, reducing the time and financial costs of its maintenance.

Overall, the use of sensors to monitor the condition and safety of electrical equipment is an important step towards improving the reliability and efficiency of electrical power systems, which is key to ensuring the stable functioning of energy infrastructure and meeting the needs of modern society.

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