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SAVING ELECTRICAL ENERGY BY AUTOMATIZING THE OPERATING MODE OF THE ELECTRIC DRIVE OF THE SHAFT GAS SUPPORTING VENTILATION DEVICE

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Abstract
The article analyzes measures aimed at effective automation of the electric drive in the operating mode of mine ventilation fans. For this purpose, we are talking about the methods of operation of mine fans, the introduction of innovative equipment and automation systems for saving electricity and increasing energy efficiency. The article examines the importance of modernizing the electric drive, creating control and automatic control systems in mine conditions, as well as strengthening automation to ensure safety. At the same time, information will also be provided on the registration of fan operation, operating in optimal mode, and methods of effective control of air flows through fans. The article emphasizes the importance of promoting modern directions and practices for increasing the ecological and energy efficiency of mine production.

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Introduction

The accumulation of hazardous gases (mostly methane - CH4 and carbon monoxide - CO) in mine mines poses a direct threat to workers' lives. Powerful exhaust ventilation systems are used for the continuous removal of these gases. These systems often operate on the basis of high-power electric drives and account for a significant portion of the field's electricity consumption. In most cases, fans operate at maximum power throughout the entire operating period, which leads to excessive energy consumption. In fact, the need for ventilation varies depending on the gas concentration, so it will be possible to save electricity by automating this process. In this article, we will analyze, on a scientific and technical basis, the automation of the operating mode of the suction fan device, operating on the basis of an asynchronous electric drive with a power of 250 kW, and as a result, the saving of electricity. One of the most important elements of safety in mines is the constant supply of fresh air. The accumulation of gases in the mine increases the risk of explosion, especially when gases such as methane (CH4)

and carbon monoxide (CO) reach critical levels. Therefore, the presence of powerful and reliable ventilation systems in mines is mandatory. The main requirements of the ventilation system are: ensuring constant air circulation; automatic change of operating mode with an increase in gas concentration; optimization of electricity consumption.

Optimal operation of fans plays an important role in ensuring energy efficiency. Therefore, by automatically controlling it and activating it only as needed, it is possible to save a large amount of electricity. The operating condition of the fan unit is characterized by the following indicators: air pressure and its volume; temperature of the electric drive and fan rotor bearings; oil temperature in the electric drive spool and lubrication system; oil pressure and its amount. These indicators are constantly measured. The arrangement of measuring instruments used for their measurement is shown in Figure 1.

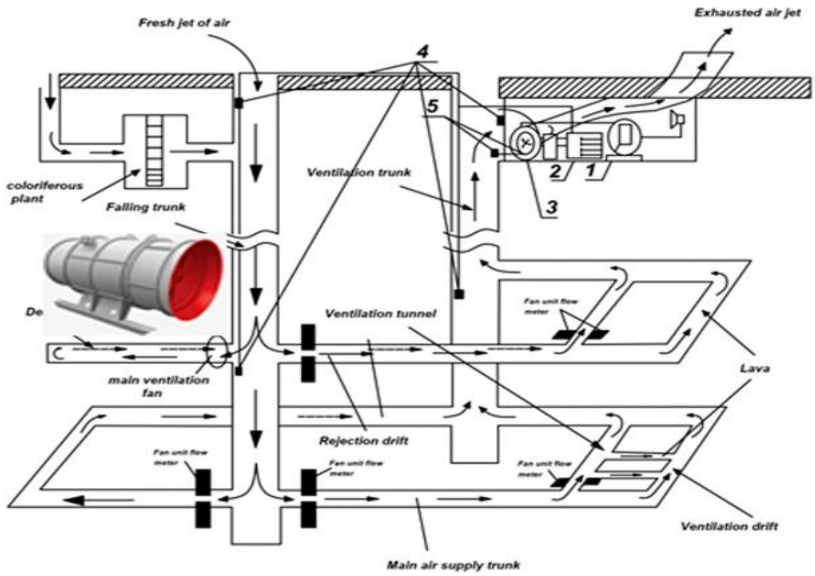

Fig-1. Diagram of the arrangement of instruments for monitoring the operation of the fan unit.

According to safety regulations, the productivity and load of ventilation equipment used in coal and shale mines must be measured in its normal and reverse operating conditions. For this purpose, in gas-free mines, a pressure gauge is installed, and in highly gaseous mines, a self-recording pressure gauge and an air flow meter (flow gauge) are used [10-25].

Ventilation devices with continuous monitoring of productivity and load and two self-recording depressometers (one in the fan and the other in the mine dispatcher room) are permitted to operate without a machinist. To automate their work, a complete set of CATC-2 automation tools is currently being used.

Technical information on measures for automating the operation mode of the mine ventilation fan's electric drive should primarily be aimed at ensuring maximum efficiency and energy saving of the fan's operation [10-25]. In this case, the main objectives of automating the fan operating mode are as follows:

1. Automatic control systems:

The activation and activation of the fan should be performed automatically based on the need for mine ventilation. For this purpose, monitoring of operating modes is carried out, and corresponding signals are received through various sensors and sensors. The operating parameters of the fan (for example, the air pressure and temperature necessary for operation) are controlled automatically, and in arbitrary cases, a shut-off or start-up mechanism is implemented.

2. Energy saving:

Fans should be able to automatically change their operating speed to save electrical energy. For example, depending on the change in the airflow in the mine, the fan's operating system should be able to switch to high or low speeds. The operating mode of the electric drive and fan is automated through a microcontroller or PLK (Programmable Logic Controller), thereby optimizing its operating mode.

3. Conditional signaling and auxiliary systems:

In case of any disproportion in the operation of the fan (for example, overload of the fan, news), the automatic alarm system must be activated and provide an auxiliary signal to the mine personnel. Automatic systems work with safety measures and various auxiliary elimination methods in various situations (for example, situations that interfere with the operation of the ventilation system) [1-20].

4. Sensors and monitoring:

Air parameters in mines are constantly monitored through sensors for air pressure, temperature, humidity, and gases (methane, oxides). If the air parameters in the mine exceed the norm, alarm systems are activated to detect and detect imbalances in the ventilation system.

5. Automated auxiliary systems:

To support the fan, pumps and other auxiliary systems in the electric drive are automatically directed to work. These factors contribute to the stable and efficient operation of the mine ventilation system, while also being aimed at energy saving, ensuring safety, and optimizing the operating system. Measures for automating the operation mode of the mine ventilation fan's electric drive also include the following factors.

6. Automatic explanation of operating conditions:

The automation system allows for the selection of modes (for example, standard mode, emergency mode, general mode) depending on various operating conditions for the mine. Fans automatically receive signals for restarting or disconnecting equipment depending on the operating condition [1-25]. If unexpected changes in air conditions occur in the mine, the automation system allows automatically changing the modes and, if necessary, determining the fan operating speed.

7. Automated diagnostics and prevention:

During the operation of the fan, technical defects and faults are monitored. If technical errors or anomalies are observed in the system, the automatic diagnostic system may activate and stop the operation of auxiliary systems or require their verification. During the operation of the fan and other electric drive equipment, preventive inspections are carried out, which are performed automatically and at certain intervals. During this time, leaks, impacts, or maximum movement times are detected, increasing the efficiency of fan operation.

Monitoring of the operating conditions of fans and other systems, as well as the pre-air condition in the mine in real time. With the help of these simulation methods, maximum efficiency and energy savings can be achieved. To ensure a harmless impact on mine air and atmosphere, the environmental indicators of ventilation systems (e.g., gas emissions into the atmosphere) are monitored. Also, to reduce energy consumption, the maximum efficiency of fans is monitored.

The ventilator operating mode automation system should be integrated with other engineering systems in the mine (for example, auxiliary pumps, heat exchangers, etc.). This ensures balanced control based on the full performance of the mine air and ventilation system. With the help of modern technologies, fans in mines can communicate with each other through IT and adapt to changing conditions. For example, data on various air parameters and indicators in the mine are directed to centralized platforms, which helps to coordinate and evaluate work. Information about the fan's operation, including operating time, speed, temperature, and air pressure, is continuously collected and archived. This information is used in the preparation of technical reports necessary for the operation and maintenance of the mine.

Automated systems, using forecasting systems based on the operating parameters of the mine environment, help to take into account future needs. This, in turn, allows obtaining the necessary reports for efficient and effective management of mine resources. These factors are important for increasing the efficiency of the electric drive of the mine ventilation fan, energy saving, ensuring safety, and minimizing the impact on the environment. Automation systems facilitate mine operations and allow quick adaptation to changing conditions. When developing a complete mathematical model for automatic control of the electric drive speed of the mine ventilation fan in Python, it is important to take into account each detail and consider the development of movements. Below is a program for more complete control of the mathematical model [1-25].

1. Traditional operation (without automation):

$$1600\,kW \times 8000\,soat = 12800000\,kWh/\,year$$

Automated operation (average 70% power)

$$1600\,kW \times 8000\,soat \times 0.7 = 8960000\,kWh/\,year$$

Annual electricity savings

$$12800000\,kW - 8960000\,soat = 3840000\,kWh/\,year$$

Save money (1 kWt electricity costs $0.08)

$$3840000\,kWh \times 0{,}08 = 307200\$/\text{year}$$

Automatically change the fan operating speed, monitor the operating mode, and achieve maximum efficiency. This ensures efficient use of electrical energy in the mine. Constant monitoring of fan operation is carried out, based on which automatic system alarms and alerts are activated in case of technical errors and anomalies. This ensures the safety of workers in the mine. The condition and operation of the fans are automatically checked, which contributes to the improvement of the system as a result of maintenance and preventive maintenance. Constant analysis of mine air, monitoring of fan operation through various sensors, correct automatic reaction to the appearance of high or low pressures.

Conclusion

Measures for automating the operating mode of the mine ventilation fan electric drive are largely aimed at efficient and safe mine operation, reducing energy consumption, and improving the environmental situation. These processes are aimed at the following main goals. The importance of ventilation systems in ensuring the effective removal of gases from mines and the safety of workers is invaluable. Due to the constant operation of such systems, the energy consumption of the electric drives installed in them is very high. Therefore, equipping asynchronous electric drives with a power of 250 kW or more (for example, 1600 kW) with automated control systems allows for significant energy savings.

According to the calculations presented in the article, automation for a 1600 kW fan electric drive will save 3.84 million kWh of electricity per year, which is equivalent to 307 thousand US dollars. Such efficiency not only brings great economic benefits, but also serves to reduce environmental damage and increase mine safety. Therefore, automation of ventilation systems in mines based on modern sensors, the PLC system, and frequency converters is one of the most optimal and effective solutions.

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