Design of control and frequency conversion speed regulation system for mine fan

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Abstract. In order to improve the accuracy and stability of the control system of mine fan, the control and frequency conversion speed regulation system of mine fan was developed based on PLC. Based on the analysis on control technology for mine fan, puts forward the inverter, soft start double mode control strategy, combined with the design of PLC control system hardware circuit and software program, the realization of mine fan starting and soft start, reasonable speed regulating, stop running process control, at the same time have the parameters such as voltage, current detection and fault protection function.

1. Introduction

Coal mine ventilation system is an important part of coal mine safety production. The normal operation of coal mine ventilation system is closely related to the working environment conditions, production efficiency and safety. Mine main ventilator equipment adopt modern technology and management methods to replace the traditional management mode, has become to measure a mine's modernization and the important symbol of the levels of standardization, each bureau of mines in take measures, efforts to improve the comprehensive operation efficiency of mine main ventilator, particularly to solve the fan and wind network do not match, fan control technology backwardness, "big mara car" and the operating problems such as inefficient. With the continuous strengthening of safety supervision of all walks of life by the Chinese government, especially the higher and higher requirements for coal mine safety production, it is imperative to carry out technical transformation on the coal mine ventilation system to improve its operation stability, reliability, energy saving and consumption reduction.

At present, most of the coal mine ventilation system still adopts relay and contactor control system, but this control system has many defects, such as large volume, many mechanical contacts, complex wiring, low reliability and trouble shooting. Because the working ventilator has been running at high speed, the standby ventilator stops, and it cannot work in rotation, which is easy to cause fault of the working ventilator and reduce the service life. In view of this series of problems, this system combines PLC and frequency converter organically, adopts the mine air pressure pressure as the main control parameter, realizes the effective control of the motor's working process and running speed, makes the centrifugal ventilator used in the mine ventilate efficiently and safely, achieves the obvious energy-saving effect. The project carries out the technology of frequency conversion control system for mine
fan, studies the theory of fan control, data acquisition and control technology, and provides a new way for the energy-saving technical transformation of mine ventilation system.

2. Mine fan
Mine fan is a large coal mine explosion-proof shaft flow fan successfully developed by combining with the ventilation network parameters of China's coal mines. It has the advantages of high efficiency, energy saving and low noise. The static pressure efficiency of the highest device of the product is over 86%, reaching the leading level of China's mine main fan. Mine fan adopts opposite rotating structure, the impellers of the two machines rotate in reverse to each other, eliminating the intermediate guide vane and reducing the loss of the intermediate guide vane, improving the fan efficiency, suitable for the resistance requirements of the mine ventilation network. Adopting the type of direct connection between motor and impeller, it can avoid the damage accident of transmission device, eliminate the energy loss of transmission device, and improve the efficiency of fan device. Motor are installed in the fan main ram inside airtight cover, airtight cover has certain pressure resistance, can make the motor and fan cut off gas bearing gas in the flow channel, also has certain heat dissipation effect, airtight cover is equipped with two rows of streamlining the wind pipe, through the main ram atmosphere are interlinked, with the ground in the fresh air into the airtight cover, at the same time can make the cover in the fan operation mediator positive pressure air in state. The blade mounting Angle of the impeller of the mine fan can be adjusted and the blade Angle can be adjusted according to the production requirements. The fan is specially designed, with no hump in the performance curve and stable operation under any network resistance.

![Fig.1 Physical drawing of mine fan](image)

3. Control system design
The control and speed regulation system of mine fan can realize the starting, running and stopping control of mine fan, and has the function of current and voltage detection. The control and speed regulation system of mine fan is mainly composed of distribution cabinet, frequency conversion soft start and switch cabinet, frequency conversion speed regulation cabinet, soft start and speed regulation cabinet, parameter monitoring module, data processing module, display unit, control panel, etc. The system structure is shown in figure 1. Siemens s7-200 smart PLC is selected as the control core for the control and speed regulation system of mine fan. The control signal is sent out by buttons and conversion switches on the operating table panel, and the action instructions are given by PLC to realize the fan frequency conversion start and soft start control, as well as the monitoring and storage of operation parameters. The main power supply system of mine fan control and speed regulation system is composed of power distribution cabinet, frequency conversion soft start switch cabinet, frequency conversion speed regulation cabinet and soft start speed regulation cabinet, providing power supply for mine fan operation, and realizing short circuit, overcurrent, overload and phase fault detection and protection. The protection time and current multiple can be set flexibly according to the demand. The display unit is kunlun tongtai TPC1570Gi touch screen, which is equipped with frequency conversion operation display, soft start operation display, fault display, three-phase input
voltage, three-phase input current, frequency conversion operation frequency, frequency conversion operation current, soft start operation current, etc.

The control and speed control system of mine fan is programmed by the special programming software of s7-200 smart. The software interface includes menu bar, project tree, command area, programming area, etc. Most menus and functions are selected in the menu bar. Project tree is an overview of the project, we open this project include the configuration of the hardware in trees, and some of the wizard selection, program state is STEP 7 - MicroWIN SMART - 200 series PLC programming software more convenient point of novel design, can choose our CPU, signal board, extension module, etc., can also to our input and output I/O point set, such as the setting for the input pulse capture, etc., are to be carried out in this setting. Instructions area is used in programming, such as instruction, transfer instructions, timer, counter, etc., STEP 7 - MicroWIN SMART in instruction area is more than 200 library instruction, although there are 200 library instruction, but need to write the library files, and STEP 7 - MicroWIN SMART system is integrated with several commonly used library instruction directly, such as modbus communication library, USS communication library, etc., the use of more convenient for the user. The control system software flow is shown in figure 3.
The touch screen adopts MgsPro configuration software for screen configuration. The configuration screen of the touch screen is composed of main screen, status monitoring, instrument display, parameter setting, real-time curve, history curve, XY curve, alarm browsing, storage browsing and after-sales service. FIG. 4 shows the interface between the control and speed regulation system of the mine fan.

![Fig4 State monitoring interface](image)

4. Conclusion
The hardware circuit and software program of the control and speed regulation system of the mine fan are developed. The system can switch the starting mode of the mine fan, adjust the speed with frequency conversion and stop, and has the function of fault detection and protection.

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