Intelligent Upgrade and Application Effect Analysis of Ventilation System in Yannan Coal Mine

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Abstract: *In view of the shortcomings of the ventilation system of Yannan Coal Mine, such as poor wind control performance, low wind measurement accuracy and difficult air regulation, technology and equipment upgrading were carried out from the aspects of ventilation parameters, ventilation power and ventilation facilities. Meanwhile, personnel positioning, monitoring and monitoring, beam tube monitoring and other systems were integrated to establish a centralized management and control platform for the ventilation system to achieve static and dynamic calculation of the ventilation network and air supply on demand. Through application analysis, the upgraded ventilation system improves the convenience of daily ventilation management, reduces the work intensity of wind measurement personnel and related air conditioning personnel, and realizes the integrated monitoring of ventilation network, which can detect ventilation system faults in time, and greatly improves the automation, information and intelligence level of Yannan Coal Mine.*

Keywords: Yannan Coal Mine; Ventilation system; upgrade

1. Introduction

Mine ventilation system is one of the necessary auxiliary systems in mining. The ventilation system plays an important role in delivering fresh air to the underground workers, diluting and removing toxic and harmful gases, and optimizing the working environment of the working face. Not only that, when there is a disaster in the underground, the ventilation system can be timely regulated, the air flow can be guided, the disaster can be steadily controlled in time, the disaster can be avoided, and the disaster prevention and resistance of the mine production system can be enhanced. With the development of information technology, control technology and computer technology, the domestic coal industry has put forward the construction goal of smart mine.

Intelligent mine ventilation is an important part of the smart mine construction system. It monitors the operation status parameters of the whole mine ventilation network, monitors the effective air volume, wind speed and wind quality under the mine, automatically establishes the relevant measurement data account, uses the monitoring data to automatically analyze and judge the problems and faults of the ventilation system, and puts forward the corresponding improvement measures. It also realizes the simulation and calculation of mine ventilation network and main fan working conditions, automatic control and remote control of various air doors, automatic underground air regulation, on-demand air supply and other functions, and integrates safety monitoring and fire prevention monitoring, comprehensive linkage and dynamic analysis of various data to ensure real-time and accuracy of ventilation management [1-3].

Based on the actual conditions of Yannan Coal Mine and the existing scientific and technological equipment, this paper carries out technical upgrading and application research on the intelligent ventilation system.

2. Ventilation system overview

2.1 Basic information

The coal seam of Yannan Coal Mine is prone to spontaneous combustion, the coal dust is explosive, the gas grade is low gas, and the approved production capacity is 2.1 million tons/year. The mine adopts multi-horizontal shaft development mode, the ventilation mode is zonal ventilation, and the ventilation

method is extraction type, that is, the main shaft, the auxiliary shaft and the second west shaft enter the air, and the second north shaft and the third west shaft return the air. The total inlet air volume of the mine is 6334m^3/min and the total return air volume of the mine is 6537m^3/min. There are two mining areas in Yannan Coal mine, namely the North second mining area and the West third mining area. At present, the North second mining area has one fully mechanized mining face and one preparation mining face, and the West third mining area is in the stage of infrastructure construction.

In addition to the six major mine systems, Yannan Coal Mine is equipped with safety monitoring and monitoring system, personnel positioning system, video surveillance system, emergency avoidance system, pressure and wind self-rescue system, water supply rescue system and communication and liaison system. The ventilation system is mainly responsible by the ventilation prevention Office and the ventilation team, and the specific work contents include wind measurement, wind regulation, ventilation resistance measurement, wind back experiment, and the construction and management of wind doors and Windows.

2.2 Existing shortcomings

Yannan Coal Mine is a modern mine. Since its initial construction, it has achieved certain results in the construction and management of the ventilation system, but there are still some deficiencies, as follows:

1) The local ventilator currently used has insufficient noise, poor control performance and low efficiency;

2) The wind gauge is used by the wind gauge to measure the wind speed, and its measurement results are of low accuracy, inconvenient to carry, and the wind speed data collection is not continuous;

3) The measurement of ventilation resistance is tedious, labor intensity is high, and the effect is poor;

4) The damper installed in the important traffic connection lane has low traffic efficiency and does not have the function of disaster wind control;

5) The mine adopts the plug-in type air window, which has a complex air adjustment form and does not have the function of automatic air distribution.

3. Intelligent upgrade of ventilation system

Aiming at intelligent ventilation, the technology and equipment of air doors and Windows, local ventilation fans, wind measuring devices, ventilation resistance monitoring and ventilation centralized control platform of Yannan Coal Mine are upgraded.

3.1 Doors and windows

As an important ventilation facility in the ventilation system, the air door and window are mainly used for the passage of personnel and goods, as well as the control of wind flow and the adjustment of air volume. According to the ventilation network, the ventilation door window of the important ventilation connection lane of the mine is selected to be upgraded, and the "remote", "automatic" and "manual" control of the ventilation door window is realized. At the same time, a high-definition camera is installed to obtain the working status of the damper and window in real time.

1) The damper automatically opens and closes. The power of the damper comes from 0.4~0.8MPa compressed gas. Through the control of PLC, the conduction and closure of the gas path are realized, and the telescopic movement of the cylinder is formed, and the opening and closing of the damper are finally realized. Infrared sensors are installed on both sides of the damper. When pedestrians or vehicles need to pass through, the infrared rays outside the door should be blocked to trigger the door opening instruction. After pedestrians or cars pass, infrared rays will be blocked and the door will be closed.

2) Automatic air volume regulation. The air volume of connecting alley can be adjusted only by adjusting the opening Angle of the shutter by transforming the panel air window into louver type air window. The regulating wind window device is composed of an outer frame, a fan blade, a connecting rod and a pneumatic motor. Through the transmission of the connecting rod, the rotating motion is transformed into a linear motion to promote the rotation of the louver. Adjusting the wind window can realize 0~90° rotation of louvers, and adjust the wind area in a large width.

3.2 Local ventilator

As an important ventilation power facility of driving face, the stable and reliable operation of local fan is of great significance to the safe operation of driving roadway[4]. Through the application of modern control technology, the local fan remote control, automatic rewind, independent frequency modulation and other functions, but also the integration of condition monitoring, the fan running status assessment, fault analysis, improve the fan maintenance efficiency.

According to the excavation plan and mining speed of Yannan Coal Mine, it is decided to install three new local fans and control systems in the mine, and connect the fan controller to the underground ring network system to achieve the following functions:

1) Online monitoring of duct air volume. By monitoring the actual wind speed of the local ventilator and the working face, combining the information of the size and length of the ventilator, the air volume and air leakage rate are calculated in real time.

2) Air supply on the working face as required. According to the wind demand of the driving face, combined with the feedback of the air volume of the front face, the speed of the fan is dynamically regulated.

3) Remote centralized control. The fan controller is connected to the industrial ring network to realize the functions of remote start and stop, speed regulation and rewind of the fan.

4) Fan operation safety evaluation. The fan is equipped with vibration sensor and temperature sensor. At the same time, the change of current and voltage of the fan is analyzed to evaluate the safety of the fan's operating state.

3.3 Ventilation resistance monitoring

The monitoring of ventilation resistance is of great significance to the state of ventilation network and efficient ventilation. Based on the ventilation theory, according to the mine ventilation system diagram and mining deployment situation, and aiming at the intelligent decision-making needs of ventilation, the key ventilation routes of the mine are optimized and selected. Along the pre-selected ventilation resistance measurement route, wind speed sensors are installed at the smooth flow of the roadway and multi-parameter sensors are installed at the tunnel nodes to obtain real-time wind speed, temperature, humidity and atmospheric pressure for resistance measurement. At the same time, an automatic wind measuring device is arranged in the wind measuring station to realize unmanned wind measurement and continuous wind measurement.

The wind measuring device is installed in the YFC15 coal mine anemometer based on ultrasonic wind measurement, which is mainly installed in the main rail transportation lane, 04 down the trough, return air down the mountain and other places to monitor the change of air volume and control the state of the ventilation network.

3.4 Ventilation system centralized control platform

The integrated control platform of the intelligent ventilation system of Yannan Coal Mine integrates ventilation network monitoring, video monitoring, ventilation power and ventilation facility control. At the same time, it shares data with monitoring, personnel positioning, beam tube monitoring and other systems to realize all-round environmental basic data collection and analysis of the mine, real-time analysis of mining surface wind supply capacity and ventilation resistance. Comprehensively and comprehensively control the safe operation of the ventilation network.

(1) Ventilation parameter monitoring and air network calculation

According to the ventilation resistance monitoring route, wind speed sensors, environmental multi-parameter sensors and pressure difference sensors are arranged, and combined with the safety monitoring system, data such as wind speed, wind pressure, temperature, humidity and atmospheric pressure of key nodes of the underground ventilation network are obtained in real time. The wind network is solved by using analysis software, and then data transmission and display are carried out.

(2) Integrated management of ventilation network

According to the three-dimensional model of underground roadway, the ventilation network is modeled to realize the display of all elements of underground roadway nodes, key ventilation facilities

and each connecting roadway. Improve the hidden danger identification degree and safety management level of ventilation network.

(3) Ventilation network warning

The information of wind speed, wind pressure and resistance of each roadway can be displayed in real time on one diagram of ventilation network. If there is an anomaly, such as excessive wind speed, insufficient situation, timely alarm, prompt the relevant staff to deal with. At the same time, according to the characteristics of the ventilation network and the abnormal changes of parameters, the hidden dangers of the ventilation network can be analyzed to ensure the safe operation of the mine ventilation network.

(4) Air flow identification

According to the calculation of ventilation network, the state of air flow can be displayed dynamically, and the inlet air, return air and used air can be distinguished by color. When there is a disaster and emergency wind control is needed, the status of air flow can be updated by regulating ventilation facilities.

(5) Centralized control

The underground wind measuring device, automatic air door, wind window and ventilator are connected to the underground ring network system, which can realize remote control on the centralized control platform of the ventilation system and improve the management efficiency of the ventilation network.

4. Summary

Starting from the actual situation and aiming at intelligent mine construction, Yannan Coal Mine fully draws advanced management experience and technology related to intelligent ventilation, integrates multiple systems such as safety monitoring and personnel positioning, realizes comprehensive linkage and dynamic analysis of various data, provides effective decision-making for mine safety production, and upgrades the hardware basis of ventilation system. It has improved the automatic management level of daily ventilation, realized the distribution of underground air volume according to demand, accurate ventilation network regulation and emergency wind control during disasters, promoted the further upgrade and optimization of the intelligent ventilation system of Yannan Coal Mine, and provided an effective reference for the development of mine intelligence.

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