Contrastive Analysis and Research on Negative Pressure Beam Tube System and Positive Pressure Beam Tube System for Mine Use

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Abstract. Against the technical defects of universally applicable beam tube monitoring system at present, such as air suction in the beam tube, line clogging, long sampling time, etc., the paper analyzes the current situation of the spontaneous combustion fire disaster forecast of mine in our country and these defects one by one. On this basis, the paper proposes a research thought that improving the positive pressure beam tube so as to substitute the negative pressure beam tube. Then, the paper introduces the beam tube monitoring system based on positive pressure technology through theoretical analysis and experiment. In the comparison with negative pressure beam tube, the paper concludes the advantage of the new system and draws the conclusion that the positive pressure beam tube is superior to the negative pressure beam tube system both in test result and test time. At last, the paper proposes prospect of the beam tube monitoring system based on positive pressure technology.

1. Introduction

With the enlargement of the coal mining strength, the spontaneous combustion fire disaster of coal bed occurs frequently, which restricts the development of coal mine seriously. Reflecting the coal bed situation in time is the emphasis of preventing spontaneous combustion fire disaster. The research data indicate that the coal temperature has close relationship with the composition of the surrounding gas. Detecting the pyrolytic gas product of coal and the component change of air can judge the spontaneous combustion fire disaster degree of the coal. At current stage, the gas monitoring of spontaneous combustion fire disaster usually adopts beam tube monitoring system. According to the installation position of the main engine, it is classified as main engine fixation above the well, main engine fixation under the well and mobile type. The above gas transportation of the system is negative pressure extraction mode at present, namely making the beam tube appear negative pressure state through the operation of the vacuum pump on the ground and extracting the gas in the detection area under the well for detection. Long-term practice indicates that the gas transmission in the negative pressure mode has many defects, such as air suction in the beam tube, line clogging, long sampling time, etc., which distorts the component and concentration of the tested gas. The beam tube monitoring system based on positive pressure technology starts to be applied in some mine, but the

overall system is to be improved. To further promote the development and application of beam tube monitoring technology, we must analyze the technical defect of the negative pressure beam tube comprehensively and improve the beam tube monitoring system based on positive pressure technology further.

2. Defect analysis of beam tube monitoring system based on negative pressure technology

The beam tube monitoring system diagram based on negative pressure technology is shown in Fig. 1

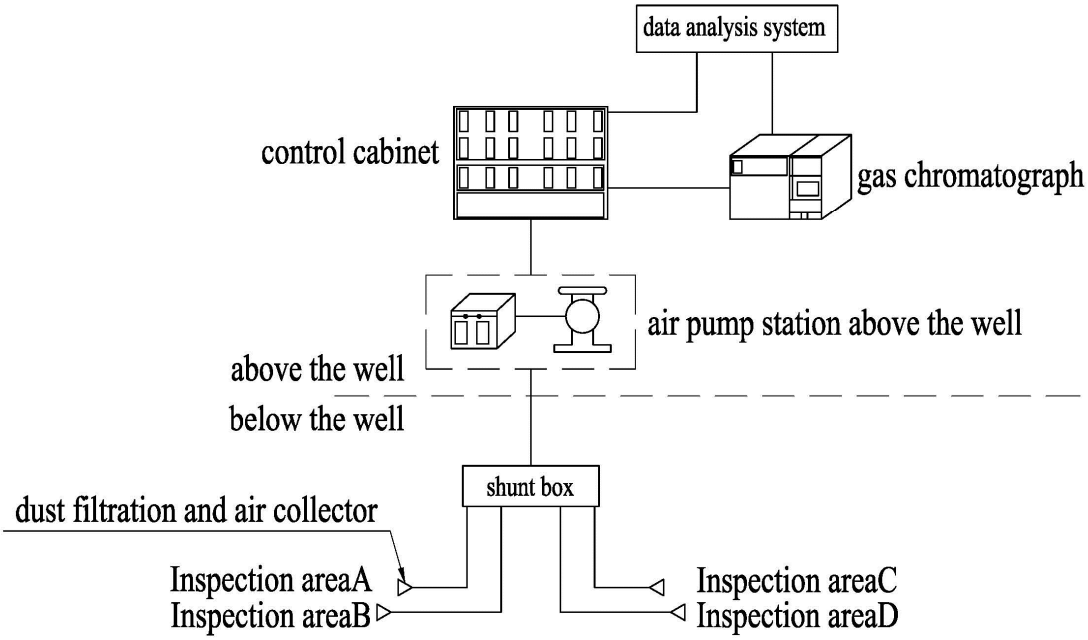

Fig. 1 Beam tube monitoring system based on negative pressure technology

The host of negative-pressure beam tube monitoring system is installed above the ground, the ground vacuum pump is connected to the beam tube, and another end of beam tube is in the inspection area under the well. The operation of vacuum pump makes the beam tube appear a negative pressure state. The gas in the inspection area under the well is pumped to the ground so that we obtain corresponding gas parameter under the united work of gas chromatograph and centralized control system for integrated analysis. A large quantity of practice indicates that the negative-pressure beam tube monitoring system has the following problems:

2.1. Air Suction Problem of Beam Tube

The beam tube of negative-pressure beam tube monitoring system appears a negative pressure state. When air leakage occurs for beam tube, the surrounding air pressure is larger than that in the tube, and the outside gas is extremely easy to enter the beam tube and transmitted together with the original gas, which causes mixed gas pollution and affects the true concentration and composition of the detected gas. In the situation of outside gas mixed, data analysis system still analyzes the gas transmitted to the analysis center, but cannot determine the gas source, so the obtained data cannot reflect the truth of gas in the inspection area or judge whether fault occurs in the beam tube.

2.2. Beam Tube Clogging Problem

The diameter of beam tube is extremely small. When the negative pressure in the tube is high, it has the risk of being depressed by its own negative pressure, reduces the flow of gas passed per unit area, and affects the efficiency of gas transmission. The temperature difference between the surface and underground is obvious. When encountering high temperature section in the gas transmission, vapor is

easy to liquefied to water and stays on the tube wall. In serious situation, it clogs the pipeline totally and obstructs the gas transmission.

2.3. Time Lag Problem

The length of beam tube under the well varies between 5km and 15km according to the difference of mine. In the negative-pressure air exhaust mode, the transmission pressure of gas is lower than a barometric pressure. On the condition of low pressure, long-distance beam tube is very difficult to overcome the resistance of gas transmission pipeline and results in slow motion of gas. We need to pressurize so as to enter the monitoring device. In this way, the time of monitoring gas increases and the obtained result is not the current state of monitoring point. thus, the time lag problem is difficult to solve in the negative pressure mode.

3. Introduction of beam tube monitoring system based on positive pressure technology

The research is investigation and data organization and analysis oriented. The positive-pressure beam tube monitoring system is studied and developed using theoretical analysis, field investigation, indoor experiment, numerical computation, and physical simulation on a basis of research on the design and modification of positive-pressure gas transmission unit in the beam tube monitoring system and moving pump station above the well to under the well so as to establish a perfect beam tube system stated in the research.

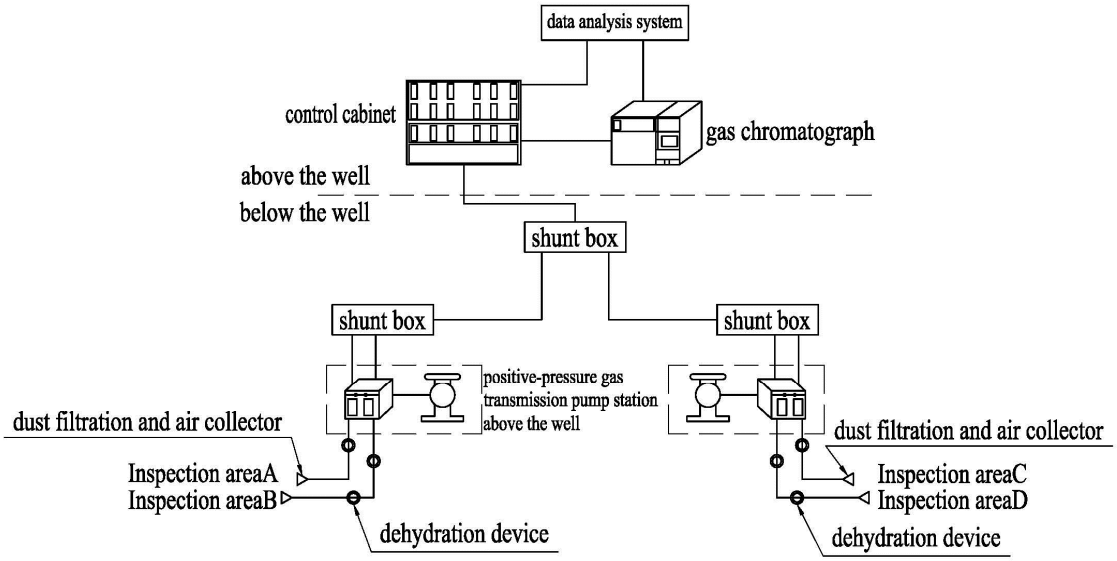

Fig. 2 The beam tube monitoring system diagram based on positive pressure technology is shown in

The beam tube monitoring system based on positive pressure technology is composed of gas collection part of gas to be inspected under the well, beam tube transportation part of the transmission gas, and gas analysis about the processing data above the well. The specific working process is firstly dividing the inspection area under the well and setting up dust filtration and gas collector and connecting beam tube in the inspection area. When the gas in the inspection area passes the dust filter, enters the negative-pressure air exhaust end of beam tube, is transmitted to the positive-pressure gas transmission pump station, and processed by the shunt box, the gas in the inspection area is output by the positive-pressure gas transmission end of the gas transmission pump station, transmitted to the shunt box near the ground via beam tube, processed by the shunt box, and transmitted to the control cabinet above the ground. After the multipath gas passes the control cabinet, it is shifted according to the stated sequence and time so that it enters the gas chromatograph as per the requirement. The result

obtained from gas chromatograph is analyzed through gas analysis system. At last, the computer system processes data, outputs the result and forecasts the situation of the inspection area. In addition, according to the specific situation of mine, dehydration unit is set up in the high-temperature and wateriness section of beam tube transportation so as to solve water blocking problem.

4. Advantage analysis of beam tube monitoring system based on positive pressure technology

4.1. Definite Gas Source

The beam tube monitoring system based on positive pressure technology sets up inspection area in many places under the well. The detection scope is more extensive than negative pressure beam tube. Vacuum pump is set up above the ground. It transmits gas through positive pressure mode. In the gas transmission process, the air pressure of the outside world is lower than that in the beam tube, so when slight destruction happens to beam tube, low-pressure gas in the outside world cannot enter the beam tube and thus ensure the concentration of component of gas distortion less and the source definite. Then, we set up final pressure range. On the premise of considering the resistance in the tube, when the final pressure of gas is greatly different form the initial pressure fed by the vacuum pump, we can judge the beam tube is serious damaged. In this way, the beam tube damage is controlled and repaired in time.

4.2. The Line Is not Easy to Be Clogged

The gas pressure in the beam tube is higher than a barometric pressure, so the beam tube is not depressed by the air pressure of outside world. In the positive pressure transmission process, the maximum transmission pressure is not restricted by the vacuum degree and it is higher than the ambient pressure, so the inhibition effect of the air resistance and friction force of tube wall on gas transmission is obviously smaller than that of negative pressure beam tube and the gas flow is smooth in the pipeline. The beam tube monitoring system based on positive pressure technology especially considers water blocking problem in the gas transmission process, so we propose setting up automatic dehydration unit in many places. Setting up dehydration unit in high-temperature section and frequently occurred section of water blocking of coal mine can realize automatic dehydration and thus solves water blocking problem.

4.3. High Efficiency of Gas Transmission

The driving force of positive pressure beam tube is obviously greater than that of negative pressure beam tube. It can transmit the gas to the above well place with great pressure. The gas flow rate is high, enhances the monitoring speed obviously and realizes fast gas transmission. In the positive-pressure gas transmission process, it is unnecessary to pressurize before entering the monitoring unit. Thus, it simplifies the original process, reduces the operation time and enhances the gas transmission efficiency.

4.4. Broad Development Prospect

As is shown by the data, spontaneous combustion accidents of working face happen to about 400 coal mines in our country every year. Through investigation of current coal mines in our country, it is found, the beam tube monitoring system of above half of coal mine cannot work normally and fails to develop its due function, which is caused by the technological defects of beam tube monitoring system based on negative pressure technology universal at current stage. The exploitation scope of mine is enlarged with the increasing of the mine exploitation term, and the length of beam tube to be laid is also increased day by day, rising from 8km to 10km and even 15km. the longer the beam tube is, the advantage and disadvantage of positive-pressure beam tube and negative-pressure beam tube are shown more obviously. The fault occurs frequently for negative-pressure beam tube, the maintenance expense is high, and the obtained result fails to reflect the truth, so it is inapplicable to the forecast of spontaneous combustion fire disaster any longer. The beam tube monitoring system based on positive

pressure technology in the research is designed and modified based on analyzing the defect of current negative-pressure beam tube comprehensively. It can solve the major problem we face, and it is designed conveniently and operated simply, so it is applicable to most mines at present and has broad development prospect.

5. Conclusion

The paper analyses the difference between positive pressure and negative pressure beam tube monitoring system based on multi-disciplinary theoretical knowledge. The beam tube monitoring system formulated based on positive pressure technology using theoretical analysis, site investigation, indoor experiment, numerical computation, physical simulation can solve the beam tube leakage problem, ensure the purity and concentration of the tested gas, solve the line clogging problem, make the beam tube not easy to be clogged or frozen through high positive pressure, prevent the deformation of beam tube, realize high purity of gas transmitted by the positive pressure beam tube and accurate forecast of coal spontaneous combustion under the well, implement fast gas transmission, high flow rate of positive pressure gas and enhance the monitoring speed obviously. Such monitoring system has broad development prospect and has very important significance on the prevention and forecast of the fire disaster of mine well.

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