Emergency Disposal Measures for Power-off of Non-intrinsically Safe Electrical Equipment during Abnormal Gas Emission in Working Face

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Abstract. Abnormal gas emission is a common gas phenomenon in coal mining face of gas mine. In order to prevent gas accidents, on the one hand, gas extraction measures are adopted to reduce or avoid abnormal gas emission; on the other hand, when abnormal gas emission is unavoidable, in order to prevent abnormal gas emission from occurring gas explosion accident by electric spark, non-cost cutting is adopted. Emergency measures such as power supply for quality and safety electrical equipment are taken as the second line of defense. Aiming at the abnormal gas emission phenomenon in East 102 coal face of Weijiadi Coal Mine, in order to avoid the gas explosion accident during the abnormal gas gushing period, the emergency measures for gas abnormal emission were expounded from the aspects of gas electric blockade, power cut and evacuation.

1. Introduction

During the period of abnormal gas emission in coal mine, the function of gas over-limit power cut of non-intrinsically safe electrical equipment in mining face is the most basic function of coal mine safety monitoring system, and the second line of defense to prevent gas explosion accidents and ensure gas safety. The Code for the Management of Coal Mine Safety Monitoring System and Testing Instruments (AQ1029-2007) stipulates that the non-intriniscly safety electrical equipment in working face must be controlled by power failure when methane sensor gas exceeds the limit. However, there are still some non-intrinsically safety electrical equipment in the air intake system of mining area and working face, which mainly rely on manual cut-off to achieve, which poses a serious threat to the safety of coal mine. Through continuous and real-time on-line monitoring of gas sensor in working face, setting gas alarm and power-off value, and implementing gas electric blocking function, it is of great significance to prevent and control gas power-off in coal mining face with abnormal gas emission.

Scholars at home and abroad have done a lot of research on the measures of gas power cut in safety monitoring and control system. He Qingsong[1] analyzed the necessity of gas over-limit and classified power cut in fully mechanized coal mining face, and carried out the design of coal mine monitoring and classified power cut. The results show that the power supply of high-level equipment can be cut off preferentially when the gas exceeds the set value, and the accident rate of gas explosion can be reduced. Liu Yiwu[2] aimed at the reverse wind flow caused by gas outburst, through the development of wind
direction sensor monitoring device and the use of methane sensor to monitor gas exceeding the limit, and docking with the power-off instrument of safety monitoring system, the advanced automatic classified power-off function of non-intrinsic safety electrical equipment in mining area has been realized, and good results have been achieved. Luo Zhengshi[3] discussed the blocking control function of the Counter-rotating Fan with the same power supply and the gas blocking control function of the coal mining face. The blocking function of the wind power and gas of the safety monitoring system provided guarantee for the management of "one ventilation and three prevention" in the mine, especially for the ventilation safety of the face with large gas emission and long-distance air supply. Zhang Jinhao[4] proposed a design scheme of fast power off in different places based on the mode of Ethernet + Fieldbus communication. Field tests show that the module is suitable for power off in different places of the existing safety monitoring system and can greatly reduce the time of power off in different places. Xue Jijun [5] elaborated the necessity of constructing perfect gas-electricity and wind-electricity blocking system in fully mechanized mining face, and analyzed the existing problems of the blocking system. After the targeted implementation of the transformation, the blocking system achieved good results.

Gas abnormal emission is a common gas phenomenon in gas coal mines. Because of the influence of many factors, it is difficult to prevent and control, which often poses a serious threat to the safety of mine production. In order to achieve the second line of defense for abnormal gas emission, this paper mainly focuses on the analysis and discussion of emergency measures for power cut during abnormal gas emission in East 102 working face of Weijiadi Coal Mine.

2. Overview of working face
The East 102 working face of Weijiadi Coal Mine is the first mining face of the East-First Mining Area. Its strike length is 920m, its inclination length is 135m, and the average thickness of the coal seam is 15.4m. It belongs to extra-thick coal seam mining. The average angle of the coal seam is 13 degrees, the structure of the coal seam is complex, and the gangue is 1-7 seams with thickness of 0.32-7.01m. It is located in the lower part of the coal seam. The original gas content of coal seam is 10.17 m$^3$/t, the gas pressure is 1.88 MPa, and the permeability coefficient is 2.13×10$^{-3}$ m$^3$/atm$^2$.d. The coefficient f of firmness is 0.31. Coal seam belongs to spontaneous combustion coal seam. The spontaneous combustion period is 4 to 6 months. U-shaped ventilation mode is adopted. Fresh air flow mainly enters the trough along the track of East-first mining area and transport up the hill. Polluted air mainly flows out through the return air in East-first mining area, and finally through 1260 return air lane, through the south wind well, and discharges the ground. Fully mechanized top coal caving technology is adopted in working face, and all caving method is used to manage roof. At present, the mine safety monitoring and control system is KJ95n, which carries out on-line monitoring 24 hours per day continuously to ensure that the monitoring is sensitive, reliable, accurate data, and escorts the safe production of the mine, the layout of East 102 is shown in Figure 1.
3. **Emergency disposal measures of gas abnormal emission and power cut**

In the mining process of East 102 working face, once abnormal gas emission occurs, emergency disposal measures are the first priority of the whole mine. Any other production activities must serve the purpose of emergency disposal. The emergency disposal of large area gas exceeding the limit should follow the principle of "first power outage, later evacuation, and then reporting", attach great importance to ideology, absolutely unified action, timely implementation of measures, reduce the scope of gas emission and expand disaster areas.

3.1. **Setting up of power cut, evacuation and warning in abnormal gas emission area**

(1) When $T_1$ reaches 1.5% in East 102 working face and $T_2$ reaches 0.8% in return air lane, all non-intrinsically safe electrical equipment in the working face and its return air lane should be cut off immediately. All workers must be withdrawn to the entry air lane of the working face. When the gas concentration of $T_1$ and $T_2$ is still elevated, the workers should be withdrawn to 1150 East-middle lane, and be in the air inlet of East 102 locomotive, East-first car yard, 1240 car yard and East-first total return air. Warning shall be set at the joint gateway.

(2) When the gas concentration at the shearer of East 102 working face reaches 1.5%, the power supply of the shearer must be cut off.

(3) When the gas concentration of the head $T_7$ and tail $T_6$ of the rear scraper conveyor in 102 working face reaches 1.0%, the alarm must be given; when the gas concentration reaches 1.5%, the power supply of shearers, transporters, front and rear scraper conveyors, working face lighting and all non-intrinsically safe electrical equipment in the return air lane must be cut off.

(4) When $CH_4$ reaches 0.7% in 1260 east-middle roadway, cut off the special battery locomotive power supply in the roadway, and cut off the power supply in the upper section of East-first mining area and West-first mining area. East 102 area, 1310 area, 1115 area working face, 1260 middle lane personnel withdraw to 1070 level air intake lane, and set a warning in West-first track up the mountain, belt up the mountain, 1070 East lane.

(5) When $CH_4$ reaches 0.75% in the wellbore of the South and north air wells, all the workers in the East and west mining areas evacuate, cut off all power supply, evacuate to 1070 level air intake lane, and stop operation in the West Second Mining area; when $CH_4$ is still on the rise, the workers evacuate to the ground, and personnel are strictly prohibited from entering underground.
3.2. Implementing Procedures of Power-off Range in Abnormal Gas Emission

(1) When the gas concentration of T_0, T_1, T_4 and T_6 gas sensors in East 102 working face reaches 1.5%, cut off the power supply of all non-intrinsically safe electrical equipment in East 102 fully mechanized caving face and its intake and return air lanes.

Cut off six combination front scraper conveyor, coal machine control switching power supply → cut off four combination rear scraper conveyor control switching power supply → cut off the signal of East 102 air inlet lane, lighting comprehensive protection → cut off the feed switching power supply of East 102 air return lane.

(2) When the gas concentration of T_2 and T_5 gas sensors in East 102 working face reaches 1%, cut off all non-intrinsically safe power supply of electrical equipment in East 102 fully mechanized caving face and its return air lane.

Cut off six combinations of front scraper conveyor, shearer control switching power supply → cut off four combinations of rear scraper conveyor control switching power supply → cut off the signal of East 102 air inlet lane, lighting comprehensive protection power supply → cut off East 102 air return feeding switching power supply.

(3) When the gas concentration of T_3 gas sensor in East 102 working face reaches 0.5%, cut off all non-intrinsically safe power supply of electrical equipment in the intake lane of East 102 fully mechanized caving face.

Cut off the switching power supply of East 102 intake lane and return air feeder → manually cut off the No. 7 switching power supply of Xishang Substation → manually cut off the No. 4 switching power supply of Xishang Substation → manually cut off the No. 10 switching power supply of Xishang Substation.

(4) When the gas concentration of T_7 gas sensor in the motor of back scraper conveyor reaches 1% in East 102 fully mechanized caving face, cut off the power supply of front and rear scraper conveyor, shearer, transporter and lighting signal of working face.

Cut off six combinations of front scraper conveyor and shearer control switching power supply in East 102 air inlet Lane → cut off the power supply of rear scraper conveyor control switch in East 102 air inlet Lane power supply of transporter control switch → manually cut off of signal in East 102 air inlet lane and comprehensive lighting protection power supply.

(5) When the gas concentration value of gas sensor in East 102 fully mechanized caving face reaches 0.5%, cut off the power supply of double-loop gas pump.

Cut off the primary circuit feed switch power supply of East 102 fully mechanized caving face gas pumping station → cut off the secondary circuit feed switch power supply of East 102 fully mechanized caving face gas pumping station.

(6) When the gas concentration in 1260 east-middle roadway reaches 1.0%, cut off all non-intrinsically safe electrical equipment power supply in East-First and West-first mining areas.

Cut off the feed switching power supply of East 102 intake and return air lanes → manually cut off the 7 switching power supply of Xixia Substation → manually cut off the 04 switching power supply of Xishang Substation → manually cut off the 10 switching power supply of Xishang Substation → manually cut off the 08 switching power supply of Xishang Substation → manually cut off the 2 switching power supply of Xishang Substation → manually cut off the 3 switching power supply of Xishang Substation No. 5 switching power supply for substation.

(7) When the gas concentration in the wellbore of South and North Air wells reaches 0.75%, the power supply of all non-intrinsically safe underground electrical equipment is cut off artificially, cut off the load switching power supply of each mining area working face and driving face → cut off the feed switching power supply of each mining area working face and driving face → cut off the switching power supply of each mining area substation → cut off the low switching power supply of central substation and the low switching power supply of No. 01, No. 02, No. 03 and No. 04.
4. Conclusion
Through gas data of different levels monitored by sensors in different working faces, the power supply of non-intrinsically safe electrical equipment in this area is cut off, the personnel are withdrawn, the work is stopped, and the safety of mine production is ensured.

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