Research of The Early Warning System of Coal and Gas Outburst

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Abstract. At present, accidents of coal and gas outburst are a big threat to safety production in coal enterprises and human lives in China. To date, the application of computer system in coal and gas outburst is not mature enough to meet the needs in early warning systems. In this study, we optimized the operating design for early warning systems and create a safety data base with the instant updating capacity. This early warning system demonstrated the abilities of safety monitoring and data analyzing, gas geology data analyzing, diagram drawing and aided designing, etc. Therefore it is able to analyze and evaluate the prediction and forecast of coal and gas outcast exactly, reduce accidents and it has great realistic significance to safety production in the coal enterprise.

Keywords: coal and gas outburst, computer network, early warning system

1. Introduction

As a very complicated gas dynamic phenomenon, coal and gas outburst can cast large quantities of coal，accompanying with an ejection of plenty of gas，by the tunnel through the excavation area or inside in an extremely short time, and it can fill up tunnels rapidly during the extraction and production course in the pit. Moreover, coal and gas outburst ,which is destructive and has immense impact,can destroy tunnel devices and ventilation equipment,even reverse wind direction and lead to many mine accidents such as explosion, gas suffocation and the burial of workers by coal floods, etc.It is a threat to the lives of workers in the pit and seriously impedes safety in coal production[1]. Therefore, it is necessery to develop a modern, reliable and practical early warning system of coal and gas outburst which is suitable for for coal enterprises.

With the development of computer network technology，computers are widely used in every area.Nowadays, computer network is widly applied in early warning systems, but the existing ones are unable to meet the requirements of early warning in terms of fuction.As a result, it is practically significant to develop a safe and reliable early warning system for safety production in thecoal enterprise [2].

2. Early Warning System of Coal and Gas Outburst

Early warning of coal and gas outburst mainly concerns that take fully advantadge of computer network technology, the coal mine safety monitoring system, existing outburst prevention technique and the power of information and technology to collect information of coal mine real-timly and dynamically under the guidance of accident theories, prevention theories of coal and gas outburst(especially outburst forecasting theories and regular patterns of outburst)and warning theories[3].The system can forecast, warn and evaluate dangerous outbursts and trends dynamically on every working surface in terms of space and time continuity after a comprehensive census and analysis. Therefore, it can help the person in charge be prepared in advance，reinforce anti-outburst systems and adopt effective anti-outburst measures to eliminate hidden dangers threatening safety in coal production.

Given the weaknesses of existing early warning systems, the early warning system has been optimized after a lot of practice on the existing basis.

Firstly, set up a dynamic safety information database in coal mines, which mainly saves coal seam hosting information, gas occurrence information, geology structure and distribution information, forecasting information about outburst dangerous areas, pit-collecting information, safety monitoring &controlling information, ventilation system information, routine safety- examination information and status information about anti-outburst measures, etc.

Secondly, set up forecasting and target-system models of early warning systems of coal and gas outburst combined with practical situation of the pit. Finally, comprehensive statistical analysis has been made towards the all kinds of dynamic information collected with the deepening of excavation space, therefore sending out early warning signals about hidden outburst dangers and trends, that is to say, it can provide person in charge with real-time information about early warning against coal and gas outburst[4].

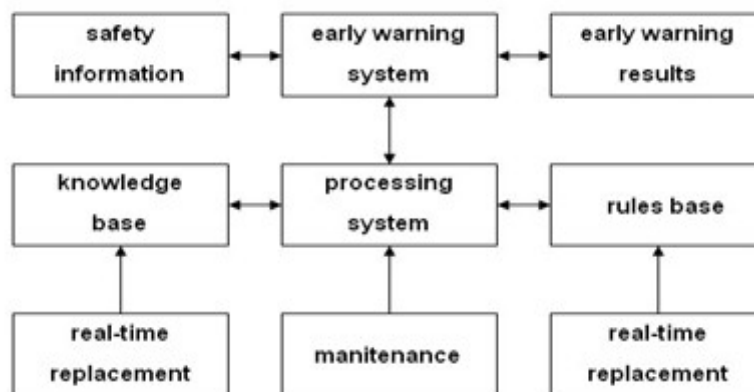The basic idea of an early warning system is listed in Fig.1.

Fig. 1: The basic idea of an early warning system of coal and gas outburst.

Fig. 1 shows that the data base can be updated automatically along with the new inputs. The regulation system is also optimized simultaneously, which subsequently processes the new data and reports back to the early warning sytem. Therefore, the newly-designed system demonstrates the desired applications in the early warning systems.

3. The Make-up of An Early Warning System

A comprehensive early-warning system of coal and gas outburst is an immense computer program which is the interaction of B/S and C/S of Geography Information System(GIS). It is mainly composed of an operation platform of gas early warning, a dynamic subsystem of gas geology analyzing technologies, a management subsystem of geology probing information and a subsystem of dynamic anti-outburst analysis and management, etc[5]. The logical construction of an early warning system of coal and gas outburst is a computer software system, which is made based on the logical working structures while software modules are working, on the core of space management database of early warning systems and operating and processing systems, and on the premise of geology probing management, dynamic anti-outburst information, gas outburst and geology analysis, and operation platforms of early warning information.

By adopting the information which is collected by the above-mentioned subsystems, an intelligent, real-time, dynamic and before-hand comprehensive early warning operation can be done. The early warning information was issued after analyzing. The results of early warning are divided into trend warning and state warning. The flow chart of the early warning system of coal and gas outburst is listed in Fig.2.

Fig. 2 shows that each subsystem has a specific task, such as the gas geology analysis system monitors only the dangerous outburst area or geological structure band. The instant detection results from all subsystems are then collected by the early warning system.
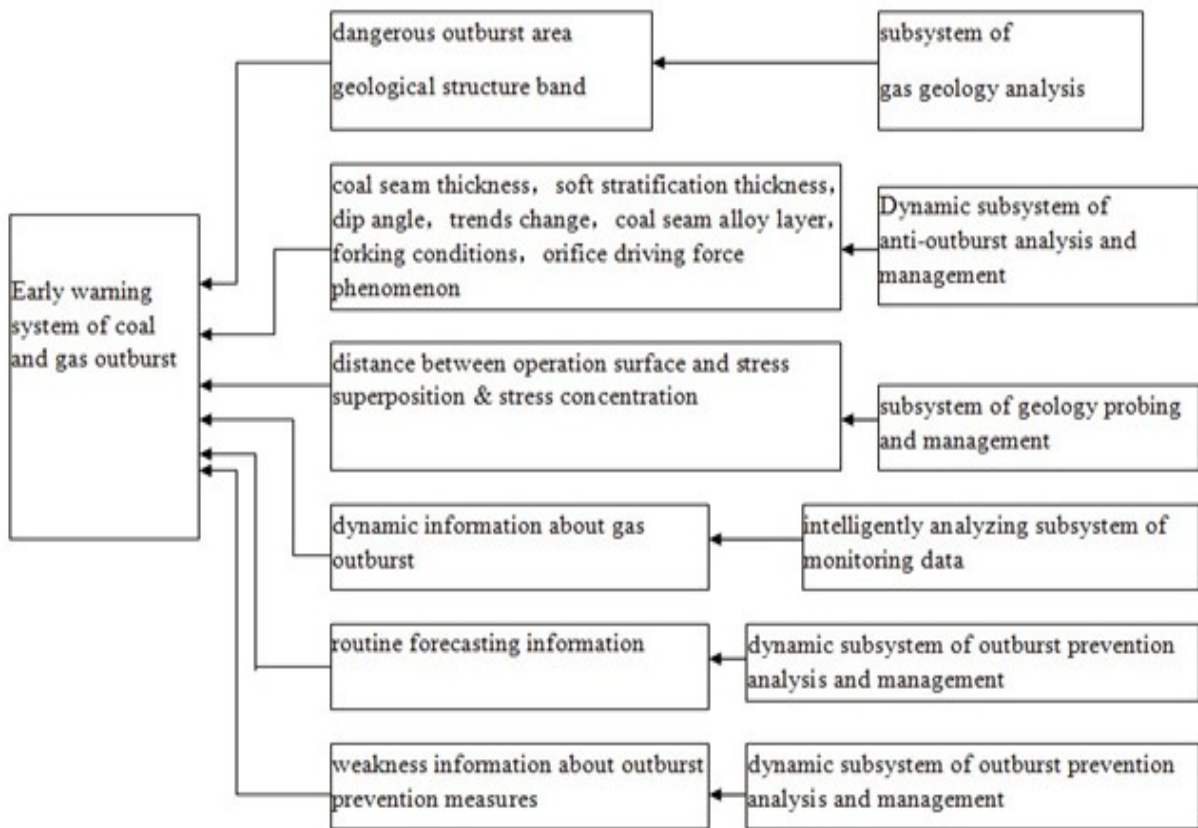
Fig. 2: Flow chart of the early warning system of coal and gas outburst.

4. Technological Features of an Early Warning System

4.1. Collecting-Distributing structure system

The latest Collecting-Distributing structure system has been used in the comprehensive system of gas monitoring in the early warning system. It has some unique advantages. If something goes wrong with the main engine or with the communication tunnel connecting an operation centre with a substation, the system in various stations won't stop working but continue to operate according to the given constant values.When a certain device in substation doesn't work, the system will still move and operate properly.

4.2. strong software function

From the above-mentioned information, the early warning system is a computer software system with strong functions and friendly users' interface, which includes the following 3 aspects:

(1) It involves a perfect and advanced alarm management system. Once the gas concentration goes beyond the limit in a monitoring point, the operating platform and corresponding warning light will flash, accompanied with alarms. It is easy to locate the exact warning point and ventilate in time with the help of warning operation pictures. Meanwhile, the computer program will recalculate according to the warning position and distribute the ventilation volume reasonably.

(2) It has strong display function of early warning trend. The warning-trend display can generally be divided into: current-trend and past-trend display.The parameters concerned, such as blowing rate and wind pressure, etc,can be shown in one trend-displaying picture, providing the workers with real-time accident analyzing information.

(3) It can edit and print report forms freely. The function of editing users'report forms freely is compiled into the system. A report form is edited according to the practical working conditions of the system; and the needed data such as current value, maximum value and minimum value can enter into the corresponding position in a report form. Automatic report printation has two fuctions of printing center table layout in normal print report and printing incident report.

5. Main Functions of Early Warning System

(1) Analysis of gas geology information

A dynamic analysis of parameters about coal seam occurrence (mainly about thickness, strike, dip angle, burial depth and soft stratification thickness, etc.), an intelligent analysis of gas occurrence parameters(edition of parameters such as gas concentration, pressure and content)，the statistics of bulge of resettlement, research of geological structure and the fields it can influence, intelligently-divided and forecast dangerous outburst areas, all of these analysis constitute a geological gas structure schematic finally.

(2) Analysis of safety-monitoring and controlling data

Provide data references for needed dynamic warning indexes by reorganizing and analyzing past and real-time data dealing with safety monitoring and controlling systems.

(3) Analysis of dynamic information about excavated tunnels

With the deep-going of coal excavation,it is necessary to analyze the dynamic parameters of three-dimension space in a specific operating point of every acting surface realtimly, as well as such parameters as the distance between acting surface and dangerous outburst areas,the distance between acting surface and geological structure,tunnel distribution around an acting surface and the distance between cross-hole acting surface and coal beds.

 (4)A census and detailed analysis of outburst prediction data

On the basis of collected real-time information,the system will statistic the outburst forecasting data in terms of distribution law of time and space and give a detailed anaylysis, to lay a foundation for displaying regular distribution patterns of outburst data exactly and planning potentially dangerous outburst areas.

(5) Mine–picture drawing and aided design

By implementing a three-dimensional, intelligent and digital processing of geological structure, conditions of coal beds,all tunnels in the pit, a mine picture-drawing system can be formed, which can meet the requirements of accident-warning networks. Combined with the perfect space processing capacity of GIS, it can give an aided design for coal excavation, replacing CAD drawing-picture software in terms of designing and filling ,etc.

(6) Real-time search of mine safety information

This warning-network system can inquire into all the safety information about coal anti-outburst systems flexibly, such as real-time search for information about tunnel distribution, geological structure of acting surface and situation of coal bed, gas storage and ventilation conditions,etc.It also makes it possible to search online for reasons of outburst forecast, results and effects of anti-outburst measures, query results of safety information, distribution of mine personnel, management regulations and verifying steps of anti-outburst examining, information about an outburst accident and about anti-outburst rewarding and punishing,etc.

Other functions are also included such as the evaluation about safety,reliability and stability of ventilation systems in the coal pit. Besides, it also can give a dynamic final estimate of ventilation network system.

6. Summaries

More coal and gas outburst accidents have been happened in China. Regular patterns of outburst and medium structures are very complex. To meet the needs of safety production and life safety of the staff, this paper develops a comprehensive warning system of coal and gas outburst on the basis of the computer network. After a comprehensive analysis of gas ejection, gas geology structure, influence of excavation on outburst, enforcement and effects of anti-outburst measures, etc, a real-time evaluation and warning against dangers of acting surface and their trends has been realized. This system is modern, reliable and practical and is able to analyze and forecast safety parameters exactly. Make the outburst work more targeted, and it has a broad prospect of application in safe production in coal.

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8. References

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