Study on laws of gas occurrence and emission of deep coal seam in Yaoqiao Coal Mine

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Abstract: To grasp the gas occurrence and emission laws of Yaoqiao deep coal mining area (West ten mining area and the second central mining area) in No.7 Coal Seam, the neural network is used to analyze the relationship and degree of influence factors between gas occurrence and gas content. We construct a prediction model of gas content to predict the gas content of the corresponding position and draw contour map of the gas content. We combine gas geological data of Yaoqiao coal mine and summarize the law of gas occurrence and emission to guide the work of gas prevention and control and enhance the prevention level of gas disaster.

Introduction

Coal seam gas control is a worldwide problem and China is one of the world's gas accident-prone countries. With the increase of mining depth, significant changes in mining conditions and natural environment have come. The phenomenon of highland stress, high gas, non-uniformity, low permeability and low intensity of coal appear. More and more serious gas even makes grade of gas a fundamental change. Original high gas coal mine and even in parts of mines of a small amount of gas began to appear mine dynamic[1]..

The geological data of Yaoqiao coal mine shows the presence of gas abnormal area in deep mining area. And its adjacent mine, such as Cuizhuang, Gaozhuang and Fucun all exist high gas coal mine areas. Some places even reached the critical value of gas outburst[5].

Laws of gas occurrence and main influencing factors

Laws of gas occurrence Looking for the law of gas occurrence requires a lot of gas data, but if all is measured, the quantity is big, cycle is long, and cost is high. Therefore, we must use the measured gas content and the factors of gas occurrence to analyze the relationship between the two. Then we can apply this relationship to unknown area and according to the factors of gas occurrence to predict gas content. At last we can increase the gas data and analyzes the law of gas occurrence. We can use active measurement method of gas pressure in underground coal seam and face drilling cinder analytic method to measure the date of gas content. Using neural network to further analyze the nonlinear relationship between various factors of gas occurrence and the gas content, we build prediction model and use geological parameters within the study area to predict gas parameters. The measured data are shown in table 1[6].

Table 1 Gas content determination results

Serial number	Position	Buried depth	Gas content	Serial number	Position	Buried depth	Gas content
1	7011A down pipe	865	2.10	11		855	1.96
2	Road	865	2.28	12	7011CDown pipe Road	855	1.89
3	West ten coal exploration down 50m	877	2.46	13		860	1.83
4		877	2.38	14		860	1.78
5	West ten coal exploration downhill 200m	925	2.68	15	Central mining area roadway drainage	875	1.52
6		925	2.76	16		885	1.64
7	-850 West Lane	855	2.54	17	7620 Material Road	715	1.36
8		855	2.48	18		720	1.42
9	Back to wind down the West Kowloon	855	2.18	19	Fall down the central mining area	875	1.50
10		855	2.06	20		865	1.48

Through the prediction model of gas content, we predict the gas content of other parts of the study area. Predicted data are shown in table 2

Table 2 Prediction of gas content in coal seam

Serial number	thickness of roof mudstone	thickness of floor mudstone	Buried depth	Distance from the nearest fault	Fault throw	Seam thickness	Gas content
1	0.8	1.3	905	15	7	3.60	1.367
2	1.1	2.1	925	20	13	3.74	1.433
3	1.8	2.0	960	160	42	4.49	1.713
4	0.9	1.4	910	60	6	3.44	1.365
5	1.6	2.8	970	50	20	3.38	2.371
6	1.9	3.3	960	20	25	3.80	2.731
7	2.2	3.4	1010	50	15	4.44	2.657
8	2.1	4.2	1035	100	13	4.28	2.693
9	2.4	4.8	1115	25	5	4.36	2.748

Through the neural network prediction model and the corresponding geological parameters to predict gas parameters, but the gas parameters are messy. It is very difficult to judge gas distribution parameter intuitive. Using mathematics software, measured data and gas prediction, we map the gas content contour map of west 10 mining area and the second central mining area. Respectively as shown in figure 2 and figure 3[6]..
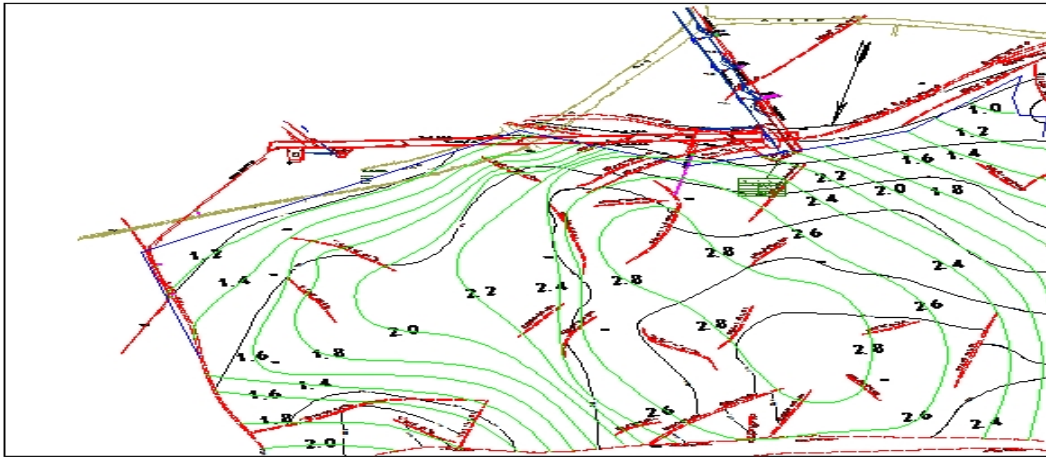
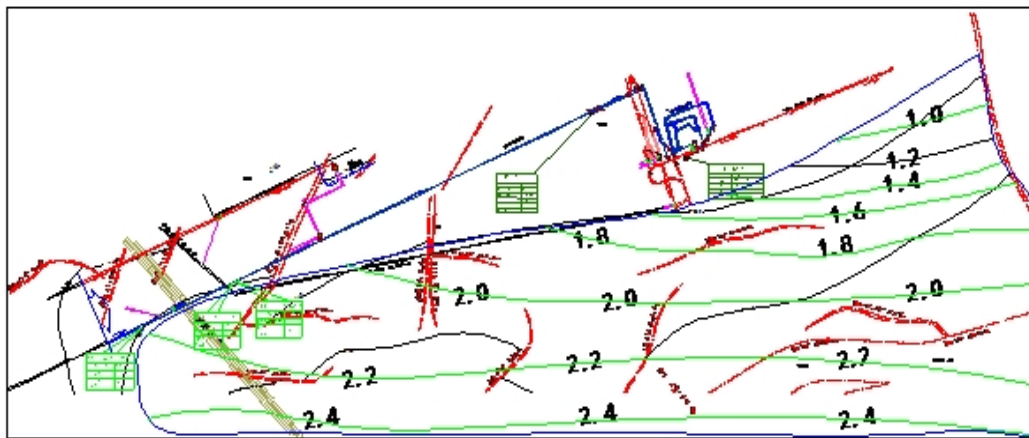Figure 2 The gas content in the West ten mining area

Figure 3 The gas content in the second central mining area

From the contour map of gas content in west ten mining area and the second central mining area, it can be seen that the local area is relatively high in the vicinity of the fault. Respectively, between the fault f298 and the fault f320, nearby faults f431, faults f349. Coal seam permeability of these areas is generally poor.

In the second central mining area, gas content rises with increasing mining depth, the law of occurrence is relatively simple. Gas content rises also with increasing depth of mining in ten mining area, but gas content is relatively low in ten west mining area, and the gas gradient is bigger[3]..

The main influencing factors For the study area of coal seam, the gas parameter is affected by many factors, such as the buried depth of coal seam, surrounding rock permeability, geological structure and so on. These factors have different impacts on gas occurrence. There are main control factors and secondary control factors.

Use computers to analyze the influence factors of gas parameters with neural network, specific data as shown in table 3.

Table 3 Influence Factors of coal seam gas parameters

Parameter	thickness of Roof and floor mudstone	Depth	Fault	thickness of coal seam
Gas content	0.409（0.162 and 0.247）	0.204	0.238（0.187 and 0.051）	0.149

According to table 3, the main controlling factors of the coal seam gas parameters in the study area

are the fault and the thickness of roof and floor mudstone, the depth and thickness of coal seam is in a secondary position.

Gas emission laws

According to the appraisal data of mine gas level, the project team collected the gas emission data from the partial mining face.

Table 4 Data sheet of Gas emission in coal mining face

Serial number	Face	Relative gas emission quantity（m^3/t）			Mining depth（m）
1	7717 Face	Methane	0.0007	0.0491	435
		Carbon dioxide	0.0484		
2	7521 Face	Methane	0.0031	0.1578	635
		Carbon dioxide	0.1547		
3	7541 Face	Methane	0.0073	0.3081	685
		Carbon dioxide	0.3728		
4	7011 Face	Methane	0.0031	0.6545	835
		Carbon dioxide	0.6514		

Table 5 Data sheet of Gas emission in heading face

Serial number	Face	Relative gas emission quantity（m^3/t）			Mining depth（m）
1	7707 heading face	Methane	0.0034	0.1597	285
		Carbon dioxide	0.1563		
2	7502 heading face	Methane	0.0092	0.5830	335
		Carbon dioxide	0.7196		
3	7011 heading face	Methane	0.0310	1.1265	835
		Carbon dioxide	1.0955		

From table, it can be seen that the relative gas emission is relatively small, which is far lower than the minimum critical value of the high gas coal mine 10m^3/t. To show more clearly relationship between gas emission quantity and mining depth, we use mining depth as dependent variable and gas emission quantity as the independent variables. At last we analyze the data of table 4 and draw the following relationship:

$$y=0.0015x-0.6714 \qquad\qquad （1）$$

We can calculate the R_2=0.8693 and indicate a good correlation.

In the same way, the relationship between the quantity of relative gas emission of Y and the depth of

X is also available:

$$y=0.0015x-0.0976 \qquad\qquad （2）$$

We can calculate the R_2=0.8695 and indicate a good correlation.

From (1) and (2) coal seam gradient of the relative gas emission can be calculated as 0.15 (m^3/t)/hm. When the mining depth increases 100m, the relative gas emission increases 0.15 m^3/t. It shows that the coal seam gradient of relative gas emission is small.

According to the "2014 gas level identification report of Yaoiao coal mine ", the relative gas emission rate of the mine is Q_{CH4}=0.0049m^3/t, Q_{CO2} =0.6191m3/t; The absolute amount of mine gas emission is Q_{CH4} = 0.0453m3/min, Q_{CO2}=5.7360m3/min. So the grade of mine is gas coal mine.

The amount of gas emission in coal mining face is 0.01382m^3/min; the amount of gas emission in heading face is 0.0027m^3/min; the amount of gas emission in goaf is 0.02618m^3/min. Analyzing the source of the whole mine gas emission, we can know that mine gas emission is mainly from goaf; coal mining working face, heading face, and goaf respectively account for 32.32%, 6.32% and 61.36%.

Conclusion

(1) Using the neural network to analyze the relationship between gas content and the various geological parameters, through sample training, Yaoqiao coal gas content prediction model is established. According to the parts of the geological parameters, we predict the gas content in certain region successfully. Based on measuring and predicting gas data, we draw the contour map of gas content in second mining area and ten mining area.

(2) Gas content of the deep area in Yaoqiao coal is generally not high, and the relationship with the buried depth of coal seam is positively correlated. But near the fault, the gas content is high. The main controlling factors of gas content is fault and the thickness of roof and floor mudstone, and the depth of coal seam and the thickness is in a secondary position.

(3) According to actual situation and the requirement of "coal mine gas drainage standards interim provisions", it is suggested that the gas treatment of the mine should be dominated by ventilation, and may be appropriate with the pumping technology.

Acknowledgement

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