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Forecasting coal-gas from re-mining work face of Getting coal mine in Jining coalfield, Shandong Province, China

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Abstract

Forecasting the gas from work faces has always been one of the basic studies on safety production of coal mines. In this article we take Geting Mine in Jining mining area as an example, dividing the coal field into five geological units with different characteristics according to the geologic features, and then using mathematic methods to analyze the gas emission volume from work face in different units. Then faults and burial depth are thought to be two of the dominant factors influencing the coal-gas emission volume. And the mathematic model is used to forecast the gas emission volume correctly. It is a good way to forecast the gas volume in the low gas mine.

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Keywords: geological block segments; faults; gas emission volume; geologic structure; Getting Mine

1. Introduction

According to the statistics, gas accidents account for more than 80% of all the accidents happening in coal production process in China, and the casualties of gas accidents make up 90% of the total casualties of serious accidents [1-5]. Jining mining area is an important coal production base in the west of Shandong province. It is located in the north of Jining coal fields. We have finished only a few studies on the gas in these mine areas because it's proved that there is only a small amount of gas here by the exploiting practices. But in recent years, the existence of gas exceptional points was found in some parts of this area, and in these points the amount of gas is high enough to affect the safety in production. Therefore, it is necessary to study the gas characteristics in this area for the safety in production and the future development of the mine. In this paper, we take Geting mine in the Jining mining area as an example. First, we analyze the geological conditions of this mine and find out the dominant factors of gas. The second step is forecasting the content of gas and the absolute gas emission rate. This study will provide

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valuable information for the forecasting of gas emission and the further studies on the geological characteristics of gas in low-gas mines in this area.

Getting mine is located in the north-west of Jining coal fields. Its Main target is the seams of Shanxi Formation. Its strata of Paleozoic era include Upper & Lower Shihezi Formation, Shanxi Formation, Taiyuan Formation, Benxi Formation. The main coal beds lies in Taiyuan and Shanxi formations.

2. Sampled and method

The sampling was conducted by choosing the zone of relative larger gas emission from different work face. And using the instruments to detect the gas density, combined with air volume, we worked out the absolute gas emission rate, sampling results in table 1 and samples sites in Figure 1. From the table 1, it is known that this mine belongs to gassy mine, but the regions of larger absolute gas emission rate still exist locally, such as the 1302 work face, etc.

Table.1 coal-gas emission volume statistical table of work face in Getting Mine

Work face	consistence / % (CH_4)	Air volume (m^3/min)	Absolute gas emission(m^3/min)	Work face	consistence / % (CH_4)	Air volume (m^3/min)	Absolute gas emission(m^3/min)
2306	0.09	659	0.59		0.06	561	0.34
	0.12	659	0.79		0.06	555	0.33
2326	0.05	542	0.27	2304	0.05	610	0.31
	0.04	428	0.17		0.06	573	0.34
2309	0.12	577	0.69		0.06	573	0.34
	0.11	577	0.63		0.12	603	0.72
	0.11	721	0.79	2310	0.09	618	0.56
2303	0.09	703	0.63		0.05	618	0.31
	0.13	703	0.91	2305	0.07	632	0.44
	0.07	594	0.42		0.06	626	0.38
2302	0.16	616	0.99		0.07	597	0.42
	0.2	616	1.23	2301	0.06	612	0.37
2313	0.04	662	0.26		0.07	612	0.43
2321	0.06	662	0.40		0.08	612	0.49
	0.05	662	0.33	1308	0.09	601	0.54
2324	0.05	561	0.28	1306	0.07	584	0.41
2322	0.04	550	0.22		0.07	584	0.41
	0.05	611	0.31		0.23	586	1.35
	0.04	616	0.25	1302	0.18	597	1.07
2312	0.11	616	0.68		0.13	597	0.78
	0.13	616	0.80		0.21	597	1.25
	0.13	699	0.91	1307	0.09	591	0.53
2319	0.05	619	0.31		0.1	602	0.60
	0.06	619	0.37		0.07	573	0.40
2307	0.07	654	0.46		0.06	573	0.34
	0.06	654	0.39	1303	0.16	582	0.93
2318	0.05	668	0.33		0.09	613	0.55
	0.06	668	0.40		0.07	613	0.43
1304	0.07	643	0.45	1305	0.09	584	0.53
	0.06	605	0.36		0.12	579	0.69
2311	0.05	561	0.28	1301	0.08	621	0.50
	0.05	553	0.28		0.07	621	0.43

Fig.1. the sampling location of work face and blocs division in the mine

3. Forecast of Gas Geology Regulations of Work faces

The faults of Mesozoic-Cenozoic in this area are developed. The major faults are near NS direction and there still exist faults in EW direction which are controlled by the EW structural belt near NS direction. Moreover, there are few faults in NW direction, with small dropping variance and short delaying. The NE-NEE fold of early time was controlled by the EW structural belt near NS direction which leds to the gas escaping, and affects the gas occurrence. Afterwards, they are controlled by the faults of NS direction. The shape of fold is not complete, which further affects gas occurrence. Research shows that (fig. 1), the faults in this area (F2, F3, F4 and F6 faults affecting gas occurrence greatly) divide the coalfield into 6 sub-areas from south to north. In each sub-area, except F3 and F29 (because F3 and F29 are closed), other regions near the fault have low gas occurrence, but the regions far away from the fault have high gas occurrence. Generally speaking, the north and south faults divide this area into 6 structure sub-areas. The occurrence regulation of each sub-area is that gas absolute emission was lower near fault, but the areas far away from the fault are on the contrary. In addition, the faults' spatial position is also influential to the gas preservation or escaping. In the mining area, the different faults cut the beds into no communicating block, which causes gas disappear massively.

3.1. The gas emission characteristics in the east re-mining work faces of F35, F37, F43 faults

1) Gas emission analysis of the tectonic medium block that is far away from F29 fault

We can conclude that the gas emission volume goes up with the depth, and the gradient of the gas emission is 0.0059m^3/(min·m), as showed in Figure 2-(a).

2) Analysis of Gas emission volume within block which is close to F29 fault and the structure is medium

Block near F29 fault appears partly gas abnormal, and we gather statistics from 4 work faces near F29 fault this time. Roof lithology near F29 fault was mudstone, whose structure is complex, and where gas emission volume tends to be large, with the highest to be 1.60m³/min. We find the gas emission volume appears positive correlation with the buried depth near by the faults block. Gas emission volume gradient is larger than the former, which is 0.01 m³/ (min·m). Compared with the former, we find that even the absolute gas emission volume increased near the F29 fault, it still has something to do with bottom buried depth, which explains that gas emission volume is controlled by structure and bottom buried depth. Through the research, the reason why the gas emission volume is so high is probably the faults are closed, forming gas enrichment belt, and thus causing the increase of the absolute gas emission volume around, as showed in Figure 2-(b).

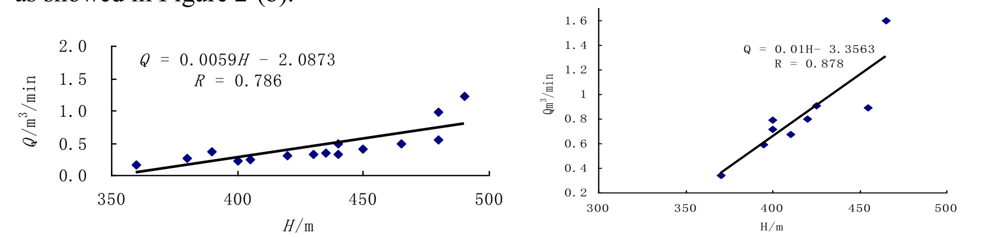

Fig2.(a)The relation between gas emission and buried depth in structure of moderate complexity far away from the east of F35, F37,F43 belt; (b)The relation between gas emission and buried depth in structure of complexity near F29 to the east of F35, F37, F43 belt

3.2. The gas emission characteristics in re-mining work faces of F6、F35、F37 and F43 faults block

1) The characteristics of gas emission volume of work face near DF35 fault.

This geological unit is near by DF35, which develops large faults in three directions, with mudstone to be the roof of coal seam which has poor permeability, and its structure is complex. Because of the openness of the fault, it goes against with the preserve of gas, and it causes low gas emission volume in this area. It has 3 work faces here, which are 2309、2311、2313. Its absolute gas emission volume appears positive correlation with buried depth, and the gas emission volume gradient is 0.0068 m³/ (min·m). As showed in Figure 3-(a).

2) The characteristics of gas emission volume of 2303 and 2301 work face far away from DF35.

This geological unit is located near by the north area which has igneous rock invading. Through the linear regression analysis we can find the gas emission volume and its buried depth appears linear correlation, and regression gradient is 0.0051 m³/ (min·m). Regression elevation takes positive number, reflecting positive correlation between gas emission and elevation in this area. The whole gas volume tends to be low, all bellow 0.5 m³/min, since fault activity leads to gas absence. As showed in Figure 3-(b).

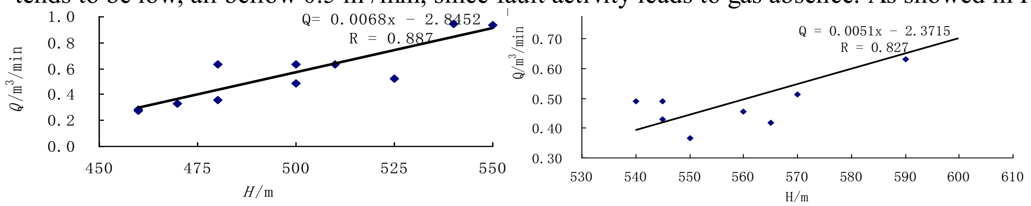

Fig.3. (a) The characteristics of gas emission volume of work faces in F6, F35, F37, F43 belt (b)The characteristics of gas emission volume of 2303,2301 work faces far from DF35 belt

3.3. The gas emission characteristics in re-mining work faces between F6 fault and F4 fault

It is a simple structure area in the minefield between F6 fault and F4 fault. The lithology of its roof is mudstone, which has bad permeability, and the northern part is influenced by igneous rock. There are two mining areas including 2321 and 2319, which are mainly located close to F6 fault. Through the linear regression analysis of the re-mining work face, we can find that gas emission volume is positively related with the increase of its buried depth, the gas discharge volume gradient is 0.0015 $m^3/(min \cdot m)$, and the regression elevation takes positive. The gas emission volume of this area is low in the mass, under 0.5 m^3 /min, and mainly because of the F6 fault making gas absence. As showed in Figure 4-(a).

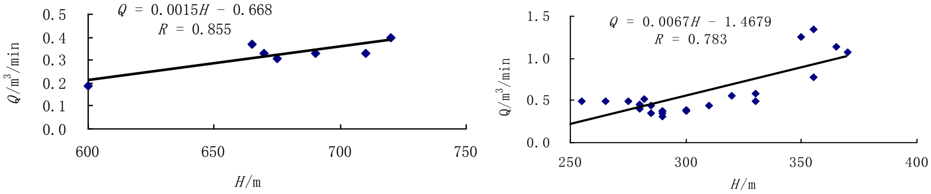

Fig.4. (a) Analysis of gas emission volume from 2321, 2319 work faces; (b) Regression analysis of gas emission volume from work face between F2 and F3.

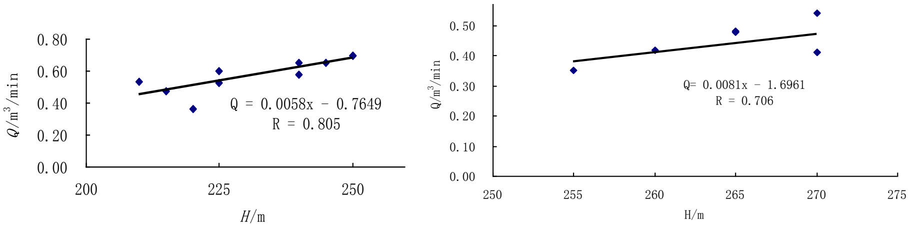

Fig.5. (a) Linear regression analysis of gas emission volume from 1306, 1308 work faces ;(b)Regression analysis of gas emission volume from 1306, 1308 work faces.

3.4. The gas emission characteristics in re-mining work faces between F2 fault and F3 fault

There are four re-mining work faces between F2 fault and F3 fault, the roof of coal seam in the geological unit is mudstone, sandy mudstone as the direct roof, with good resistance, simple geological structure, a few small faults. Through the regression analysis of gas emission volume over the years on the re-mining work faces, it shows that gas emission volume is positively related with the increase of the gas buried depth, the gas emission volume gradient is 0.783$m^3/(min \cdot m)$. As showed in Figure 4-(b). The highest gas emission volume mainly concentrated in the eastern region of the 1302 work face , since this area is located in the axis of whole syncline, and the closure is better. Therefore, gas occurrence conditions are good.

3.5. The gas emission characteristics in re-mining work face between F2 fault and DF1 fault

This block is located in the western field .There are four main re-mining work faces. According to the field structure degree of complexity, it can be classified into two secondary tectonic units: 1306 and northern area of 1308; 1305 and southern area of 1307.

1) Work faces of 1306 and 1308 in the northern area

This region is simple in structure. The roof of coal seam is mainly mudstone, with good resistance. According to the gas emission volume over the years, a linear regression analysis is conducted (fig.5-a), and the regression elevation takes positive. We can find that gas emission volume is positively related with its burial depth , which shows gas emission volume has a direct connection with the depth of bottom floor. The gas emission volume gradient is 0.0058 $m^3/ (min \cdot m)$.

2) Work faces 1306 and 1308 in the southern area

The structure is more complex in this region with many small faults, and the lithology of its roof is mainly mudstone. By the analysis of gas emission volume over the years, we find that the gas content is low in this region; mainly because of complicated structure. A regression analysis (fig. 5-b) is conducted and a positive relation between gas discharge volume and burial depth is found. The gas emission volume gradient is 0.706 m^3/ (min·m).

4. Conclusions

1) Gas in coal mines is dominated by many geological factors, and each of these factors has different effects on the distribution and emission of gas. Generally, the occurrence and emission of gas are mainly affected by the tectonic factors. Because of tectonic cuttings, the geological characteristics of gas in different sections of the same district can be different. Whereas under similar geological conditions, the dominant factors of gas are often alike. Therefore, to forecast the characteristics of gas accurately, we should find out the geological conditions and the dominant factors of gas.

2) We forecast the absolute gas emission rate with a model built on the base of the analysis of the statistics. As a result, high gas emission rate sections lie nearby the F3 and F29 faults. According to the statistics, the distribution of the absolute gas emission rate is controlled by the geological structures, the north-south faults especially. By building data model in every geological section divided by the faults through analyzing the statistics of different re-mining work faces, we find that the dominant factor of the distribution of gas is faults and the next is the depth.

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