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Practice of Gas Pressure Measurement in $M7_{lower}$ Coal Seam of Yuka No.1 Coal Mine

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Abstract: *No gas pressure measurement has ever been carried out in the M7 $_{lower}$ seam of Yuka No.1 coal mine and only the gas level appraisal has been carried out in the whole mine. With the continuous extension of the mining depth of the M7 $_{lowe}$r coal seam, the problem of predicting gas disaster has gradually appeared. In order to prevent gas accidents from occurring in the deep mining process, the gas pressure of the M7$_{lower}$ coal seam was measured. The technical process of gas determination is introduced, and the maximum gas pressure is 0.41MPa through on-site determination, and the buried depth of the measurement point is 689.72m, which is comprehensively analyzed, and the gas disaster is gradually revealed with the increasing mining depth.*

Keywords: *gas pressure; direct measurement; pressure measurement process*

1. Introduction

The accuracy of gas pressure measurement in the original coal seam directly affects the design of safety facilities in the later stage of mine construction, and accurate gas pressure measurement results can provide more reliable safety guarantee for mine gas disaster management. At present, the gas pressure measurement technology is mainly a direct measurement method, through the measurement of gas pressure for herniation risk prediction, gas extraction radius investigation. Regarding the determination of gas pressure in mines, experts and scholars in China have carried out a lot of research, Wang Lei, Xue Weichao [1] for II_1 coal seam in the west wind shaft area of a mine to carry out protruding danger prediction process for the determination of gas pressure, through the determination of the integrated parameters to predict the protruding danger of coal seams, the use of "two plugging and one injection" technology for pressure measurement, and achieved good results; Xu Zhaohua[2] examined the extraction radius of 3306 working face through layer drilling holes, examined the gas pressure as an important index, proposed to improve the sealing length to strengthen the quality of sealing holes, and did not appear the phenomenon of abnormal unloading of drilling holes in the process of measuring the gas pressure, and the effect of pressure measurement is good;Tang Hua and Huang Wenpin [3] carried out special pressure measurement operations during the investigation of gas storage characteristics in Hengtai coal mine, and introduced the pressure measurement process of drilling holes through and along the layers, and the results of the research have a certain guiding significance for pressure measurement operations in other mines. Other experts and scholars have presented different research results on gas pressure measurement in different areas of gas disaster management[4-6]. The gas pressure of the coal seam under M7 in the No.1 well of Yuqa was not measured, because the coal mine is located in the plateau area, and the research work on gas management is less. In order to further improve the gas disaster management of this coal mine, the gas pressure of the coal seam under M7 was measured and researched.

2. Project Information

Yuka No.1 coal mine can be mined coal seams totaling 4 layers, respectively, M5, M7 $_{upper}$, M7 $_{middle}$ and M7 $_{lower}$ coal seams. Among them, the average thickness of M5 coal seam is 5.12m, the coal seam structure is simple, and the whole area can be mined; the average thickness of M7 upper coal seam is 10.18m, the coal seam structure is complex, and most of it can be mined; the average thickness of M7 $_{middle}$ coal seam is 13.92m, the coal seam structure is complex, and the whole area can be mined; the average thickness of M7 $_{lower}$ coal seam is 19.47m, the coal seam structure is complex and the whole

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area can be mined, and the coal seam is dominated by long bituminous coal, and the top plate is mudstone, the bottom plate is mudstone, and the top plate is mudstone. The average thickness of $M7_{lower}$ seam is 19.47m, the whole area can be mined; the average thickness of $M7_{lower}$ seam is 19.47m, the whole area can be mined. According to the appraisal result of the mine's gas level, the mine is a low-gas mine, and the maximum gas outflow in the past three years is 12.98m3/min. No work has been done to measure the basic parameters of the mine's gas and gas pressure. Since the $M7_{lower}$ seam is a deeper seam, it is predicted that the problem of gas hazards will become more pronounced, so it is necessary to accurately measure the gas pressure in this seam.

3. Gas Pressure Measurement Technology

Currently, gas pressure measurement methods include direct measurement and indirect measurement, in which the indirect measurement method is mainly based on the existing coal seam permeability coefficient, gas extraction attenuation coefficient, gas desorption parameters and other back calculations to derive the gas pressure. The direct measurement method is based on drilling holes into the designed coal measuring points, installing galvanized steel tubes for pressure measurement inside the holes, tying cotton yarn and other materials to the inner end of the tubes to prevent coal chips from falling into the tubes and blocking the tubes, installing pressure gauges to the outer end of the tubes, and sealing the holes with the "two plugs and one injection" process. According to the relevant research, the direct measurement method is more reliable. Therefore, the direct measurement method was adopted to investigate the $M7_{lower}$ coal seam.

3.1. Drill hole arrangement

In order to ensure the accuracy of the gas pressure measurement results, the measurement points were uniformly arranged in the $M7_{lower}$ coal seam endowment area. The construction of the drill holes at the pressure measurement points is shown in Table 1.

Table 1: $M7_{lower}$ coal seam gas pressure measurement point drilling parameter table.

Drilling number	Drilling position	azimuth(°)	dip angle(°)	depth of hole(m)	Drilling type
$M7_{lowe}$1-1	2400 Extended depth 3# contact lane	130	32	50	Upward layer drilling
$M7_{lowe}$1-2		130	32	50	Upward layer drilling
$M7_{lowe}$2-1	2400 Level 1 Extended Depth Downhill Chamber 4	137	32	50	Upward layer drilling
$M7_{lowe}$2-2		180	32	50	Upward layer drilling
$M7_{lowe}$3-1	2400 Level #2 Sub-shaft Track Downhill (Chamber 13)	180	32	50	Upward layer drilling
$M7_{lowe}$3-2		180	30	22	Upward layer drilling
$M7_{lowe}$6-1	2400 Level #2 Sub-shaft Track Downhill (Chamber 8)	125	27	26	Upward layer drilling
$M7_{lowe}$6-2		113	18	42	Upward drilling through layers
$M7_{lowe}$7-1	2750 West Alley 1400m	90	11	32	Upward drilling through layers
$M7_{lowe}$7-2		26	-24	46	Upward drilling through layers
$M7_{lowe}$8-1	2750 West Alley 1150m	119	-18	46	Upward drilling through layers
$M7_{lowe}$8-2		123	-16	33	Upward drilling through layers

3.2. Pressure measurement process

Due to the construction of the borehole has upward and downward holes, downward holes there is a risk of water accumulation, so the construction of the borehole construction process must be real-time observation of whether there is water in the borehole, if there is an abnormal phenomenon of water influx in the borehole must take relevant measures. The construction process of pressure measurement drilling is shown in Figure 1. The two ends of the sealing section are installed with polyurethane, which will expand after installation to form the central cavity section, which is the grouting section, and the grouting section is installed with grouting pipe and return pipe, from which expanding cement slurry is injected, and the sealing of the hole is completed when cement slurry starts to spill out of the return pipe. As the cement slurry is expansive, it can fill the sealing section well after solidification, effectively preventing the occurrence of air leakage and significantly improving the quality of pressure measurement.

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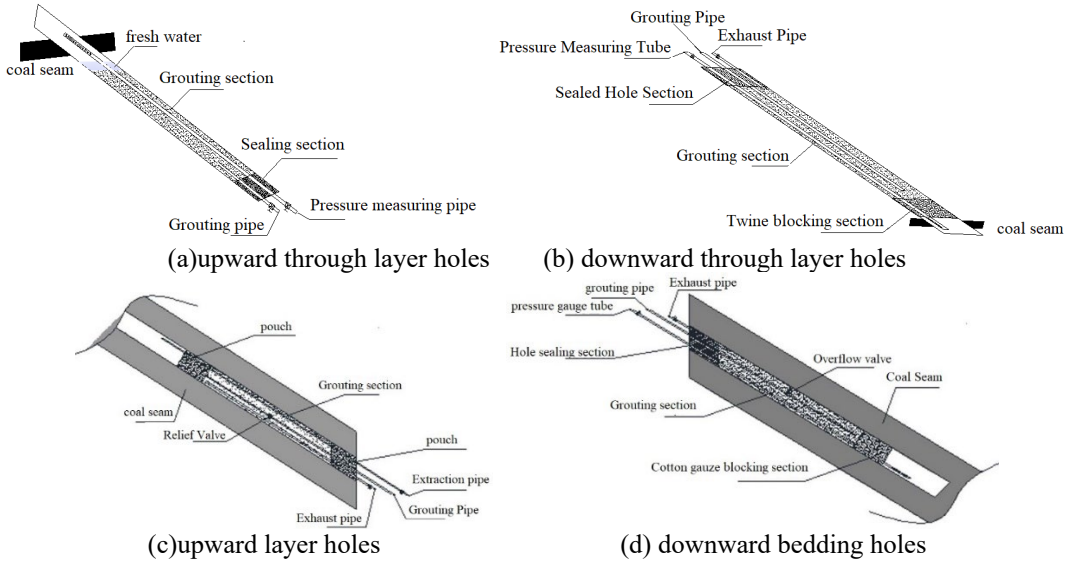

(a)upward through layer holes (b) downward through layer holes

(c)upward layer holes (d) downward bedding holes

Figure 1:Schematic diagram of pressure measurement for grouting and sealing holes.

4. Measurement results analysis

After the completion of the pressure measurement borehole sealing needs to be left for 24h, when the cement slurry solidification is completed after the installation of the pressure gauge for pressure measurement, the detection cycle is 20 ~ 30d, the frequency of observation is 3 times / day, until the pressure is stabilized to stop the observation, statistical data. When there is water in the borehole, relevant corrections need to be made, and the correction formula is as follows:

1) Horizontal and downward pressure measurement borehole correction equation:

$$P' = P_1$$

In the formula:

P′—— corrected measured pressure gauge reading, MPa;

P1—— measured pressure gauge reading, MPa.

2) For upward drilling, if there is no water proceed according to the following formula, otherwise the correction method is as follows.

(1) When V>V1 and V-V1<V2:

$$P' = P_1 - 0.01l\sin\theta - 0.01\frac{4(V - V_1)}{\pi D^2}\sin\theta$$

In the formula:

V - the volume of water flowing out of the pressure measuring borehole, m^3;

V_1 - volume of the space inside the pressure measuring tube pipe, m^3;

V_2 - volume of the air chamber reserved for the borehole, m^3;

l - length of the pressure measuring tube, m.

(2) When V > V1 and V - V1 ≥ V2.

$$P' = P_1 - 0.01L\sin\theta$$

In the formula:

L - length of the pressure measuring borehole, m.

(3) When 0<V≤V1.

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$$P' = P_1 - 0.01\frac{4V}{\pi d^2}sin\,\theta$$

In the formula:

d —— diameter of the pressure measuring tube, 0.015m.

Statistical analysis to obtain the pressure in the region is shown in Table 2.

Table 2: Measurement results of gas pressure in the M7 $_{lower}$ coal seam.

Drilling number	Drilling position	survey point elevation(m)	burial depth (m)	gas pressure(gauge pressure)/MPa)	Volume of water removed from meter(L)	Corrected gauge pressure(MPa)
M7$_{lower}$1-1	2400 Extended depth 3# contact lane	2671.89	559.27	0.31	4.08	0.20
M7$_{lowe}$1-2		2664.85	566.20	0.37	8.16	0.29
M7$_{lowe}$2-1	2400 Level 1 Extended Depth Downhill Chamber 4	2657.41	589.25	0.37	0.00	0.37
M7$_{lowe}$2-2		2662.00	584.66	0.35	0.00	0.35
M7$_{lowe}$3-1	2400 Level #2 Sub-shaft Track Downhill (Chamber 13)	2595.70	689.72	0.41	0.00	0.41
M7$_{lowe}$3-2		2789.90	693.40	0.39	0.00	0.39
M7$_{lowe}$4-1	2400 Level #2 Sub-shaft Track Downhill (Chamber 8)	2670.16	618.32	0.33	0.00	0.33
M7$_{lowe}$4-2		2681.78	606.70	0.29	0.00	0.29
M7$_{lowe}$5-1	2750 West Alley 1400m	2844.98	361.90	0.49	6.12	0.23
M7$_{lowe}$5-2		2841.31	365.57	0.50	4.08	0.30
M7$_{lowe}$6-1	2750 West Alley 1150m	2826.11	388.93	0.45	2.04	0.31
M7$_{lowe}$6-2		2821.32	393.72	0.41	2.04	0.33

Through the correction, the maximum gas pressure in the area is 0.41MPa, the minimum gas pressure is 0.23MPa, the maximum gas pressure measurement point is located in the 2400 level 2# sub-well track downhill, the area of the buried depth is large, up to 689.72m, a comprehensive analysis, with the mining depth is not short of the extension of the gas pressure gradually increased, the gas problem is gradually appeared.

5. Conclusion

The data related to gas in Yuka No.1 well is only available in the annual gas level appraisal report, and with the continuous extension of the mining depth, it is predicted that the gas problem will gradually appear, in order to prevent the gas disaster problem in the process of deep mining of the M7$_{lower}$ coal seam, the gas pressure of the seam was measured, and the following conclusions were obtained:

(1) Comprehensive analysis shows that the mining value of M7$_{lower}$ coal seam is high, but the burial depth gradually increases, so there is a risk of gas disaster;

(2) Measuring points are evenly arranged in the mining area of M7$_{lower}$ coal seam, and the pressure measurement process is elaborated in detail;

(3) The maximum gas pressure in the mining area of M7$_{lower}$ coal seam is 0.41MPa, and the depth of this measuring point is relatively large, so it is predicted that the gas disaster problem will appear gradually in the deep mining process of M7$_{lower}$ coal seam.

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