Study on the occurrence law of gas in Fukang mining area

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Abstract. Fukang mining area consists of three sections: Urumqi He-Sigong He, Sigong He-Baiyang He and Baiyang He-Dahuangshan. Typical high-gas mines are taken in the three sections to measure the content of coal seam gas, analyze the occurrence law of gas in Fukang mining area, predict the amount of gas in mining period, and provide the basis for the prevention and control of mine gas.

1. Introduction
Fukang mining area is located in the low mountain to hilly area of bogda Mountain in the southeast margin of Junggar Basin. Fukang mining area is divided into three blocks: Urumqi He-Sigong He, Sigong He-Baiyang He and Baiyang He-Dahuangshan. Typical high-gas mines are taken from the three blocks for the determination of basic parameters of gas and the study of gas content. Wulong Coal Mine and No. 1 well of Coking Coal Group (original Shenlong coal Mine) were selected for the Urumqi He-Sigong Coal Mine section, Xinlong coal Mine and Skungmine for the Sigong He-Baiyanghe coal Mine section, and No. 1 well of Dahuangshan Coal Mine and Xigou coal mine for the Baiyanghe-Dahuangshan Coal Mine section.

2. Data Measurement

2.1. Basic data of coal seam
The basic parameters of coal samples of different coal seams in Wugong Coal mine, No. 1 well of Coking-coal Group and Xinlong coal Mine were collected and tested on site. See Table 1 for specific data.

| Coal seam                | moisture (%) | ash (%) | Bulk density (m³/t) | Gas pressure (MPa) | Porosity of coal (m³/m³) |
|--------------------------|--------------|---------|--------------------|--------------------|--------------------------|
| Xigou Coal Mine A3 coal seam | 0.74         | 10.72   | 0.781              | 1.05               | 0.0179                  |
| Xigou Coal Mine A5 coal seam | 0.76         | 7.33    | 0.794              | 1.05               | 0.0185                  |
| Xigou Coal Mine A7 coal seam | 1.32         | 4.97    | 0.775              | 0.68               | 0.0215                  |
| Dahuangshan Coal Mine No. 1 well Large trough coal seam, | 1.32         | 5.04    | 0.775              | 0.98               | 0.0271                  |
| West wing of Wugong Coal Mine SA3 coal seam | 1.36         | 2.26    | 0.763              | 0.67               | 0.0412                  |
West wing of Wugong Coal Mine SA5 coal seam  1.46  2.16  0.781  0.72  0.0588  
East wing of Wugong Coal Mine SA3 coal seam  1.38  2.36  0.752  0.67  0.0453  
East wing of Wugong Coal Mine SA5 coal seam  1.36  2.26  0.775  0.72  0.0582  
Coking Coal Group Well 1 A2 coal seam  1.28  10.98  0.758  0.82  0.0712  

2.2. Determination of adsorption constants

Gas adsorption constants measured in the laboratory are given in Table 2. Gas adsorption curves are given in Figure 1 ~ 9.
FIG. 3 Gas adsorption curve of Xigou Coal Mine A7 coal seam

FIG. 4 Gas adsorption curve of Dahuangshan Coal Mine No. 1 well Large trough coal seam

FIG. 5 Gas adsorption curve of West wing of Wugong Coal Mine SA3 coal seam
FIG. 6 Gas adsorption curve of West wing of Wugong Coal Mine SA5 coal seam

FIG. 7 Gas adsorption curve of East wing of Wugong Coal Mine SA3 coal seam

FIG. 8 Gas adsorption curve of East wing of Wugong Coal Mine SA5 coal seam
FIG. 9 Gas adsorption curve of Coking Coal Group Well 1 A2 coal seam

Table 2 Gas adsorption constants of each coal seam

| Coal seam                                           | Adsorption constant |
|-----------------------------------------------------|---------------------|
|                                                     | a (m³/t) | b (MPa⁻¹) |
| Xigou Coal Mine A3 coal seam                        | 22.5205   | 0.7901    |
| Xigou Coal Mine A5 coal seam                        | 21.9871   | 0.6583    |
| Xigou Coal Mine A7 coal seam                        | 18.4942   | 1.3505    |
| Dahuangshan Coal Mine No. 1 well Large trough coal  | 24.4485   | 1.5083    |
| Dahuangshan Coal Mine No. 1 well Large trough coal  | 24.4485   | 1.5083    |
| West wing of Wugong Coal Mine SA3 coal seam         | 36.0263   | 1.1224    |
| West wing of Wugong Coal Mine SA5 coal seam         | 41.1788   | 1.3059    |
| East wing of Wugong Coal Mine SA3 coal seam         | 25.4856   | 0.8728    |
| East wing of Wugong Coal Mine SA5 coal seam         | 33.7842   | 0.7826    |
| Coking Coal Group Well 1 A2 coal seam               | 25.9253   | 0.7833    |

It can be seen from the data that the gas content in the east and west wings of Fukang mining area is relatively high, while that in the middle is relatively low, which is caused by the shallower mining in the middle coal seam and the more outcrops in the coal seam. With the increase of mining depth, the gas content will also increase.

3. Cause Analysis

3.1 Sealing property of surrounding rock of coal seam

The lithologic assemblage of coal seam roof and floor is classified into two categories: coarse clastic rock, fine clastic rock, conglomerate and various sandstones, siltstone, mudstone, shale and their interbedded beds are classified as fine clastic rock.

In this work, the lithology of the roof and floor of the 2-3 layers of the main coal seams with the largest thickness in the Two coal bearing groups of Jurassic Xishan Kiln formation and Badaowan
formation is calculated according to coarse clastic rocks and fine clastic rocks, and the statistical results are shown in Table 3.

| Session name               | Statistical points | Roof lithologic | Floor lithologic |
|----------------------------|--------------------|-----------------|------------------|
|                            |                    | Fine clastic    | Coarse clastic   | Fine clastic    | Coarse clastic   |
|                            |                    | rock %          | rock %           | rock %          | rock %           |
| Urumuqi He-Sigong He       | 31                 | 84              | 16               | 100             | 0                |
| Sigong He-Baiyang He       | 9                  | 69              | 31               | 73              | 27               |
| Baiyang He-Dahuangshan     | 10                 | 68              | 32               | 74              | 26               |

It can be seen from the statistical results that the top and bottom of the whole region are dominated by fine clastic rocks, and the top and bottom of the fine clastic rocks account for over 60%. From the above results, it can be seen that the lithology of the roof and floor of coal seam in all districts is mainly fine clastic rock. Therefore, from the perspective of lithology alone, it is favorable for the preservation of gas.

3.2. Sealing conditions of coal measure strata

Geological history shows that in Jurassic in Junggar basin experienced early settlement, medium coal, the geological evolution of the uplifting process, settlement period after the humid climate, built large deposits of coal bearing, the Jurassic coal-bearing strata in south of up to 2500 m or so commonly, LiuHuangGou district, urumqi hedong mining area coal bearing strata thickness increases gradually from east to west, from alluvial facies, sedimentary environment to make the transition to fluvial facies, lacustrine facies, sedimentary from coarse to fine granularity from west to east.

Vertically, the coal-bearing strata of Badaowan Formation are generally more than 800 meters thick, with coarse clastic rocks accounting for 53.6%, concentrated in the lower part of the formation, and fine clastic rocks of 46.1% developed in the upper part. The Sangonghe Formation is 580 meters thick, with coarse clastic rocks accounting for 48.6%, fine clastic rocks for 51.4%, and coarse grain in the lower part and fine grain in the upper part. The coal bearing strata of Xishan Kiln formation are more than 900 meters thick, with coarse clastic rocks accounting for 35.6% and fine clastic rocks for 57.3%.

The lithologic variation trend of the coal measure strata in the above three sections is consistent with the lithologic statistical results of the roof and floor of the previous target coal seam. Xishan Kiln formation is located in the upper part of the coal measure, with a high proportion of fine clastic rocks and the best sealing property.

Vertically sedimentary lithology change, 3 coal measures strata group for 3 from coarse to fine water into a sequence of sedimentary, eight bay the lake from the group of the fan delta and delta sedimentary system, water stable, small water body of kinetic energy, form the thicker fine clastic coal bearing strata, has played an important role in blocking of the gas.

Generally speaking, there are many coal seams in the study area and the thickness of coal seam is large. The thickness and lithology of the roof and floor of the target coal seam as well as the coal measure strata are mainly fine clastic rocks, which is conducive to the preservation of gas in this area.

3.3. Sealing conditions of coal seam itself

In this area, the metamorphism of coal seam is low and the gas content is low, but the relatively thick coal seam is very advantageous to the sealing of gas. The gas generated from these thick coal seams is deposited on the pore surface of coal, which is not easy to transport under normal circumstances, and constitutes a favorable place for gas preservation.

From the development degree of coal seams in this area, the coal layers are numerous and thick, which form multi-layer sealing in the vertical direction, reducing and delaying the gas loss.
In addition, the coal in this area is of low metamorphism, high porosity and low generative multi-
storage type. Coal has low gas content, high porosity and relatively strong adsorption capacity. The gas
generated from coal seam is stored locally in the pores of coal.

4. Analyzable gas quantity prediction
Coal seam gas content refers to the amount of gas contained in coal per unit mass or volume under
natural conditions according to the following formula.

\[ W = \frac{abP}{1 + bP} \times \frac{100 - A_d \cdot M_{ad}}{100} \times \frac{1 + 0.31M_{ad}}{100} + \frac{10\pi P}{\gamma} \]

where:
- \( W \) is the coal seam gas content, m³/t;
- \( P \) is the absolute gas pressure of coal seam, MPa;
- \( a, b \) are adsorption constants;
- \( A_d \) is the ash content in coal, %;
- \( M_{ad} \) is the moisture content in coal, %;
- \( \pi \) is the porosity of coal, m³/m³;
- \( \gamma \) is the bulk density (false specific gravity) of coal, m³/t.

The amount of analytic gas is calculated as follows:

\[ W_j = W - W_c \]

where:
- \( W_j \) is the resolvable gas volume of coal, m³/t;
- \( W_c \) is the residual gas content of coal at standard atmospheric pressure, m³/t, calculated by pressing
the button below.

\[ W_c = \frac{0.1ab}{1 + 0.1b} \times \frac{100 - A_d \cdot M_{ad}}{100} \times \frac{1}{1 + 0.31M_{ad}} + \frac{\pi}{\gamma} \]

Table 4 shows the calculated gas content of coal seam, residual gas content of coal seam and analytic
gas amount during production.

| Coal seam                          | Gas content (m³/t) | Residual gas content (m³/t) | Gas resolution (m³/t) |
|------------------------------------|-------------------|-----------------------------|-----------------------|
| Xigou Coal Mine A3 coal seam       | 7.594903          | 1.210549                    | 6.384354              |
| Xigou Coal Mine A5 coal seam       | 6.92912           | 1.033456                    | 5.895664              |
| Xigou Coal Mine A7 coal seam       | 6.076089          | 1.491025                    | 4.585064              |
| Dahuangshan Coal Mine No. 1 well Large trough coal seam | 10.03282 | 2.164173                    | 7.868647              |
| West wing of Wugong Coal Mine SA3 coal seam | 10.84551 | 2.518778                    | 8.326732              |
| West wing of Wugong Coal Mine SA5 coal seam | 13.78243 | 3.23116                     | 10.55127              |
| East wing of Wugong Coal Mine SA3 coal seam | 6.743688 | 1.439501                    | 5.304187              |
| East wing of Wugong Coal Mine SA5 coal seam | 8.795474 | 1.737512                    | 7.057962              |
| Coking Coal Group Well 1 A2 coal seam | 7.139294 | 1.276874                    | 5.86242               |
5. Conclusion
Through field investigation and testing, it is found that the roof and floor of the coal seam in Fukang mining area are mainly composed of fine clastic rocks, with many layers and large thickness of coal, which plays a natural shielding role in gas preservation; The lithology of the roof and floor of the target coal seam is mostly fine clastic rock, which can account for about 60%.

Gas content of each coal seam, residual gas content of coal seam and analytic gas amount is obtained, which provides basic data for coal mine drainage method and drainage system selection, and provides guidance for coal mine gas prevention and control work.

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