Study on Gas Occurrence Law in Xigou Coal Mine

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Abstract. The factors affecting the gas content occurrence and accumulation are quite complicated, in this paper, the gas occurrence law of Xigou Coal Mine is studied from the aspects of coal seam metamorphism, coal seam thickness, geological structure, surrounding rock lithology, burial depth and hydrogeological conditions, it provides guidance for safety production and gas development and utilization in later period.

1. Introduction
Coal is the main energy source in China, accounting for more than 70% of the primary energy. While ensuring the rapid economic growth of China, China's coal industry also deteriorates the mining conditions of coal, which are manifested in increasing mining depth, increasing gas pressure and gas content, complex geological structure conditions, and increasingly serious gas disasters. In order to guide the prevention and control of coal mine gas disaster scientifically and to predict gas disaster in advance, it is necessary to master the law of gas occurrence and gas emission in coal seam mining.

The study of the occurrence law of gas at the present stage has important guiding significance for preventing and controlling coal and gas outburst, predicting the gas distribution law at the next mining level and the gas outburst risk. At present, the gas content preserved in coal seam depends on the condition of gas migration to the surface and the performance of gas storage in coal seam. The occurrence of gas is closely related to geological structure, burial depth and coal seam thickness.

Gas generation Coal seam gas is produced by humic organic matter in the process of coal formation. Coal is a kind of combustible organic rock with high concentration of humus type organic matter. It is transformed from plant remains through complex biological, geochemical and physicochemical processes. There is a series of evolutionary processes from plant death and accumulation to coal conversion, which is called coal-forming process. Hydrocarbons, carbon dioxide, hydrogen and noble gases are produced throughout the coal-forming process. Combined with the coal-forming process, it can be roughly divided into two gas forming stages: Biochemical gas forming stage (this is the first stage of coal-forming, namely peatization or humification stage). This period started from the accumulation of primitive organic matter into coal in bog phase and triangular training phase environment. Under the condition of temperature not exceeding 65℃, the primitive matter into coal was decomposed by anaerobic microorganism to produce gas. (2) Coal-metamorphism gas stage (this is the second stage of coal-forming, that is, peat, sapropel under the action of pressure and temperature to change into coal process. At this stage, the upper overburden becomes thicker as the peat subsides. The pressure and temperature are also increased, and the chemical action of individual substances is gradually weakened until the end, entering the period of gas formation caused by coal metamorphism.
2. Geological background

2.1. Stratigraphic conditions
The xigou coal mine is located in the eastern part of the meso-cenozoic urumqi piedmont depression, on the north side of the bogda anticline. The regional stratigraphic division belongs to the northern xinjiang stratigraphic region, south junggar-north tianshan stratigraphic division, bounded by the F1 fault. The southern part of the fault belongs to the bogda stratigraphic district in the northern tianshan stratigraphic division, and the northern part belongs to the jimusar stratigraphic district in the northern part of the fault. The mine area is located in the south of the F1 fault and belongs to the bogda stratigraphic district. Within the mining area, the bedrock is well exposed, and the upper part of the second, third, fourth and third sections of the badaowan formation and the sangonghe formation are exposed on the surface.

2.2. Coal content
The coal-bearing strata are mainly lower Jurassic badaowan formation (J1b) and sangonghe formation (J1s). The sangonghe formation is divided into two sections (J1s1 and J1s2) from top to bottom. The thickness of the strata is revealed to be 251.18 ~ 378.31m, with an average thickness of 314.75m. The badaowan formation is divided into four coal-bearing sections (J1b4, J1b3, J1b2, and J1b1) from top to bottom. There are about 61 layers (groups) of coal in the four coal-bearing rock sections of badaowan formation, among which the minable coal seams are 23 layers (groups), and from top to bottom are A7, A8, A16, A20, A23, A26, A27, A28, A29, A31, A32, A41, A42, A43, A45, A46, A47, A48, A49, A50 and A51 coal seams (groups).

3. Analysis of gas occurrence rule

3.1. Degree of metamorphism
The degree of coal metamorphism is closely related to the coal seam gas content. Along with the coal seam gas generation in the whole coal forming process, the methane content generated in the coal metamorphism process increases with the increase of the metamorphism degree. Due to tectonic movement, coal-bearing strata in this region were uplifted, and coal seams entered into the weathered zone and exposed to the earth's surface. Then, after tectonic movement, the overlying deposits of coal seam gradually thickened, and according to hilt's law, the coal quality evolved to the stage of high metamorphism, followed by the generation of gaseous products. The largest coal vitrinite reflectance is between 0.40 ~ 4.62% between, variable qualitative stage is 0, I, II, III, IV, V, VII, VIII, IX, X class, comprehensive superposition of different metamorphism type, causes the coal metamorphic grade, the low degree of metamorphic bituminous coal, metamorphic degree of coal in the highest degree of metamorphic bituminous coal were appeared, reflects the have generated gas of each seam need enough maturity.

3.2. Coal seam dip Angle and outcrop
This mining area experienced the yanshan movement and the Himalayan movement, from the cretaceous period, under the pressure, the coal seam began to tilt upward. Due to weathering and denudation, the strata between cretaceous and pleistocene were missing in the region, and a large amount of gas was released in the shallow part. In the middle Jurassic, the strata were mostly settled and deposited, and the sedimentary thickness was very large and became the covering layer of the coal measures, which provided a good burial condition for the coal measures and was conducive to the occurrence of gas.

The gas content is closely related to coal seam dip Angle and outcrop. Dip Angle of coal seam in the mining area: south of the F4 fault, the high Angle is 60° ~ 87°; north of the fault, the gentle Angle is 20° ~ 60°. The dip Angle of coal seam varies greatly. When the dip Angle of coal seam is large, the gas can be moved upward and discharged along some strata with good permeability, resulting in low gas content in these sections. The upper part of coal seam A45 and A44 has very little gas and has been discharged.
completely. The lower A43 and A42 coal seams contain some gas. Although the thickness of A42 coal seam is large, the content of gas in these two layers is still low. On the contrary, when the dip Angle of coal seam is small, some strata with poor permeability play the role of sealing gas, which is conducive to the preservation of coal seam gas content. Coal seam outcrop is the outlet of gas discharge to the ground, the longer the outcrop exists, the more gas discharge. The large dip Angle of coal seam and continuous outcrop are conducive to gas discharge. The existence of coal seam outcrop is the main reason for the low overall gas content of A16 coal seam.

### 3.3. Thickness of coal seam

The thickness of coal seam is the internal factor that determines the amount of coal seam gas and adsorption, and it is also the main index that measures whether the coal seam has industrial mining value. In general, the thicker the coal seam is, the stronger the ability to absorb gas and the higher the gas content is. As can be seen from figure 1, the thick gas content of A43 coal seam is high, while the thick gas content of A44 and A45 coal seams is successively thinner and the gas content is also reduced. As can be seen from figure 1, there is a layer of gangue in coal seam A45 of drill hole ZK508, but the thickness is large and the gas content is high. The thickness of A46 coal seam is nearly half smaller than that of A45 coal seam, and the gas content is lower. The thickness difference between upper and lower layers of A47 coal seam is not large, but the structure of the lower layer coal seam is simple and the gas content is slightly higher. The structure of the upper layer coal seam is complex, and the thickness of the two-layer gangue is small, so the gas content is relatively small. The coal seam is not only an important gas source rock, but also an important reservoir.
3.4. Geological structure
This mining area is influenced by regional structure, and the overall structural features are dominated by east-west linear structure, mainly composed of monoclinal structure and inverse inferred layer, which belongs to the category of tianshan giant east-west structural system. Mine mainly monoclinal structure, but the secondary fold structure, the inverse inference layer on both sides of the common small drag fold (figure 2), mine fault development, a series of high Angle thrust fault, more intensive distribution, south, north west to normal fault, and development of coal bed gas storage to save the weight will be used. It can be seen from figure 2 that the coal seam of borehole A26 of ZK311 is located on the syncline wing, and the gas is basically dispersed under the influence of F7 thrust fault. Although the coal seam is thick, the methane composition and content are small. Because the coal seam of ZK311J drilling hole A26 is located at the top of the anticline, the coal seam is of large thickness and developed by structural compression fractures. The roof is of fine sandstone, which is conducive to gas dispersion and low gas content. On the contrary, the coal seam in the anticline wing is slightly less compressed, which is conducive to the preservation of gas. For example, the gas in the coal seam A16 and ZK312 drilled by ZK311J is larger. At the same time, we can also see that the normal fault is an open fault, which is not conducive to the preservation of gas content. Therefore, the gas content of the coal seam along the fault is relatively low, resulting in the low gas content in the deeply buried part. For the reverse fault, it is of poor air permeability. In the north, there are a number of reverse faults crossing and forming a relatively stable and closed fault-block structure. The gas content in the fault block structure is high, which plays a good sealing role in gas occurrence and is conducive to gas preservation. In the course of geological history, structural movement has produced many cracks in coal seams, especially in the tensile stress area. The cracks generated by the structure have increased the gas storage space on the one hand, and the permeability of coal seams on the other hand. Therefore, the influence of the structure on the occurrence of coal seam gas and the outburst of coal and gas is complex and uncertain.

3.5. Surrounding rock permeability
The surrounding rocks of most coal seams in this mining area are low-permeability mudstone, carbonaceous mudstone, siltstone and sandy mudstone. Most of these surrounding rocks are compact rocks, which play a good sealing role in gas preservation. The surrounding rock of a few coal seams is fine sandstone and medium sandstone with good permeability, which is not conducive to gas preservation. For coal seams with small inclination in the north, the role of surrounding rock is more important. If the surrounding rock is less permeable and the coal seam is thick, it is conducive to the preservation of coal seam gas; otherwise, it is not conducive to the preservation of gas.

3.6. Burial depth
With the increase of the buried depth of coal seam, the gas content of coal seam increases gradually. The increase of the buried depth of coal seam not only increases the in-situ stress and makes the permeability of coal seam and rock stratum worse, but also increases the distance of gas migration to the surface. Therefore, the deeper the buried coal seam is, the more favorable it is for gas preservation.

3.7. Hydrogeological conditions
Hydrogeological conditions can affect and control the occurrence and migration of coal seam gas, and play a very important role in the accumulation and exploitation of coal seam gas. The mining area of the mine water inflow in is 240 m³ / d + 763 m, 698 m + level is 360 m³ / d, the largest up to 1700 m³ / d, belongs to the weak of groundwater recharge, recharge, formed one and a half closed hydrogeological period, groundwater recharge, runoff, give priority to with static reserves, in favor of preservation of gas in coal seam, the mining area coal bed gas content is one reason local save good.

4. conclusion
Through the previous analysis, the factors affecting the occurrence and accumulation of gas content are quite complex, and are also related to the coal seam structure, ash value, coal and rock components, etc.,
and the coal seam gas content is the result of the combined action of various geological conditions. At present, the coal seam gas pre-drainage in the mine is used as a regional outburst prevention measure, which is also feasible. By pre-drainage of gas, the gas pressure and gas content of the outburst dangerous coal seam can be reduced, so that the coal body loses or weakens the possibility of outburst. Mineral resources belong to non-renewable resources. Comprehensive exploitation and utilization of coal mine associated mineral resources and scientific and rational comprehensive exploitation and utilization of coalbed methane are very necessary for the construction of a conservation-oriented society and the development of circular economy. It is suggested to carry out parameter well and production well test of CBM for coal seam, so as to have a detailed understanding of the parameters of coal reservoir permeability, gas bearing capacity, drainage and mining test, etc., and to develop and utilize CBM by means of short drainage and mining time and simultaneous well pumping up and down, so as to solve the purpose of CBM extraction and utilization.

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