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Research Article

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Research On the Source of Coal Gas and The Law of Gas Flow

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Abstract Coal seam gas is a common dangerous gas in coal mines, and its gushing amount is affected by many factors. The causes of coal seam gas mainly include the biochemical gas formation period and the coal metamorphism period. Sources of mine gas include gases in coal seams and surrounding rocks, gases from production processes, gases from biochemical reactions, and gases from the transformation of radioactive materials. In the coal body, gas exists in two forms: free gas and adsorbed gas, and there are vertical zoning characteristics. The law of coal seam gas flow includes the gas flow state and gas diffusion movement, and its gushing amount is very important for mine safety production. The study of gas emission is helpful to formulate a reasonable gas extraction plan and is related to the comprehensive utilization of coalbed methane resources. The amount of coal seam gas gushing is affected by many factors such as coal seam mining depth, surface pressure change, mining sequence and mining method, mining speed, production capacity and transportation method.

Keywords gas, gas flow law, gas emission mechanism, gas emission volume, mine safety

1. Introduction

This paper studies the flow of coal seam gas, first introduces where coal seam gas comes from, then introduces the form of gas in coal seams, then introduces how gas flows in coal seams, and finally introduces one of the quantities that measure coal seam gas flow: gas outflow.

The formation of gas mainly goes through the period of biochemical gas formation and coal metamorphism, and the gas components produced include methane, carbon dioxide, etc. Mine gas comes from a variety of sources, including gases contained in coal seams and surrounding rocks, gases produced during production, gases produced by chemical and biological reactions, and gases produced during the emission of radioactive materials. The existence state of gas in coal can be divided into two categories: free gas and adsorbed gas, and it shows different vertical zoning characteristics, which has an important impact on the flow law and distribution characteristics of coal seam gas. In addition, the flow state of gas in the working face and the gas diffusion movement also directly affect the safety production of coal mines. Accurately understanding the amount of gas emission and influencing factors is the key to ensure the safe production of coal mines and provides a reasonable gas extraction plan and the basis for the utilization of coalbed methane resources. In summary, the flow law and its gushing volume of coalbed seam gas are affected by many factors, and the study of these factors is of great significance for the safe production of coal mines and the effective utilization of coalbed methane resources.

2. Causes of Gas and Sources of Mine Gas

Causes of Gas

Gas is the gas emitted from the coal seam and the surrounding rock formations, and it is also a type of gas produced during mining. The causes of gas formation can be attributed to two main stages: the biochemical gasification period and the coalification metamorphism period.

In the biochemical gasification period, when there is no external oxygen and the temperature is not higher than 65 °C, organic matter is decomposed by anaerobic microorganisms into methane (CH_4), carbon dioxide (CO_2) and water (H_2O). This stage occurs during the peat period, when the gases formed are often infiltrated-diffused into the air due to the small burial depths, so the gases produced by biochemical reactions are usually not left in the coal seam.

In the coalification period, when the strata in the coal series settle, the pressure increases, the temperature increases, and the peat soil changes to lignite. In the environment of high temperature and high pressure, the organic matter undergoes metamorphism, the volatile matter decreases, and the carbon sequestration capacity is enhanced, forming a gas dominated by methane and CO_2.

Sources of Mine Gas

The source of mine gas can be divided into four main parts. First, gases such as methane (CH_4) and carbon dioxide (CO_2) contained in coal seams and surrounding rock can gush out of the mine. Secondly, the gases produced in the production process include gun smoke, internal combustion engine exhaust, rechargeable hydrogen, etc. In addition, chemical and biological reactions can also produce gases in mines, such as carbon monoxide (CO) from spontaneous combustion of coal, sulfur dioxide (SO_2) and hydrogen sulfide (H_2S) from mineral oxidation, and gas from decay of pit wood. Finally, gases such as radon (Rn) and helium (He) are produced during the metamorphosis of radioactive material. It is of great significance to fully understand and grasp the source of mine gas for in-depth study of the gas gushing mechanism in coal seams and surrounding rocks [1].

3 Occurrence of Gas in Coal

The Occurrence State of Gas in The Coal Body

According to the existence state of gas in coal, it can be divided into two categories: free gas and adsorbed gas. Free gas exists in large fractures, pores and cavities in coal or surrounding rock, accounting for about 10%-20% of the total gas content. Adsorbed gas can be further divided into adsorption state and absorption state. Among them, the adsorption state refers to the adsorption of gas molecules on the inner wall of pores by the molecular attraction on the surface of the solid phase of the particles.

The adsorption state reflects the movement of gas molecules in the structure of coal particles and interacts with solid molecules. Moreover, adsorbed gas and free gas are in a state of dynamic equilibrium. When the external pressure and temperature change, the original equilibrium state will be destroyed, resulting in the transformation of gas from the adsorption state to the free state, a process called desorption. Conversely, if the gas shifts from a free state to an adsorption state, it is called adsorption [2].

The friction produced by the fluid in the fluid is mainly due to the exchange of momentum between the fluids and the cohesion inside the fluid. When the viscosity of the liquid decreases with increasing temperature, the viscosity of the fluid decreases with increasing temperature, but the exchange of momentum has little effect on the viscosity of the fluid. The viscosity of a gas is determined by the exchange of momentum between molecules, and as the temperature increases, so does the viscosity coefficient of the gas.

Vertical Zoning of Coal Seam Gas Occurrence

When studying the gas fluidity, the vertical zoning characteristics of coal seam gas are factors that need to be considered. The gas in the coal seam is usually distributed in different rock layers and coal seams of different depths, and there is a vertical transfer between these coal seams of different depths. Therefore, the vertical zonation characteristics of coal seam gas can affect the flow law and distribution characteristics of gas in coal seams. The gas weathering zone is of great significance for coal mining [3]. It can improve safety and reduce the risk of coal mine gas explosion accidents; Realize the efficient utilization of coalbed methane resources and provide sustainable energy support.

4. The Basic Law of Coal Seam Gas Flow

General Introduction

The extent of the gas flow space in the coal seam is called the flow field. In a flow field, a gas behaves as a flow field with direction, velocity, and a gradient of gas pressure or concentration. The flow field of gas in the coal seam is divided according to space and time. The change of gas flow direction is divided into unidirectional

flow, radial flow and spherical flow. According to the change of the flow field in time, it is divided into stable flow and unsteady flow.

Unidirectional flow, radial flow and spherical flow are common terms to describe the flow law of coal seam gas in three-dimensional space. Among them, taking the coal wall of the coal roadway and the mining face in the thin and medium-thick coal seams as an example, the two cases are analyzed, and only one fluid velocity is analyzed, while the other fluid velocity is 0. For thick coal seams with large thickness, if the thickness cannot be fully revealed, the vertical velocity will not be zero, so it should not be a one-way flow. The radial flow refers to the partial velocity in two directions in three directions, and the partial velocity in the other direction is 0, such as the gas flow at the coal wall when the stone gate, vertical shaft, borehole and so on penetrate vertically into the coal seam. In this case, the isogas pressure line and the coal wall are basically concentric circles. When there is a partial velocity in all three directions, such as in the coal wall of the coal roadway excavation face in the thick coal seam, when the coal is drilled or the stone gate is entered, or when the coal is ejected from the mined coal, the spherical flow will occur.

Steady flow and unsteady flow are common terms to describe the response characteristics of coal seam gas flow field to time variation. Stable flow refers to a situation in which the gas flow velocity, flow direction and gas pressure do not change over time after long-term emissions (more than 150 days), so as to tend to a stable situation. The unstable flow refers to the fact that the speed, direction and pressure of the gas will change with time in the initial stage of gas gushing, and it is unstable. Therefore, it is of great significance to conduct in-depth research on the flow law of coalbed gas, including the source, occurrence state, flow characteristics and gushing amount of coalbed gas, so as to formulate scientific gas prevention and control measures, improve the safety production level of the mine and realize the efficient utilization of coalbed methane resources.

The Flow State of Gas in The Working Face

The flow state of gas in the working face will directly affect the safety of coal mine safety production, so it is necessary to study the flow state of gas in the working face in depth. There are two main types of gas flow states in the working face: one is the static state, that is, the gas stays in a fixed position; The other is a dynamic state, that is, the gas moves with time. There is a certain connection between these 2 states. In the dynamic state, the gas will continue to diffuse to the surrounding area and form a stable distribution area [4]. At the same time, due to the high density and viscosity of gas, it will form droplets or clumps under certain conditions, thus hindering its own flow. These factors determine the flow state of the gas in the working face. In order to better understand the flow state of gas in the working face, it is necessary to analyze its motion law. Generally speaking, the flow velocity of gas in the working face is affected by a variety of factors, including the quality, concentration, and temperature of the gas itself, as well as the topography and geological structure [5].

The transport of gas within the pore-fissure system can be divided into two categories: one is the diffusion movement, which obeys West's law, and the second is the osmotic movement, which obeys Dafic's law.

5 Gas Outflow

Introduction to Gas Emission

Studying the amount of gas emitted is crucial in mining. First of all, it ensures the safe production of the mine. By assessing the amount of gas emitted, it is possible to determine whether the production of gas in the mine exceeds the standard and take timely safety measures to ensure the safety of miners and mine equipment. Secondly, the study of gas emission is helpful to formulate a reasonable gas extraction plan. Understanding the distribution characteristics and gushing law of gas can control the amount of gas gushing, reduce the risk of gas accumulation, and ensure the safe production of mines. In addition, the study of gas emission is also related to the comprehensive utilization of coalbed methane resources. By evaluating the gas emission volume, the potential and exploitability of coalbed methane resources can be evaluated, which provides a basis for the rational development and utilization of coalbed methane. Therefore, studying the gas emission can not only ensure the safety of the mine, but also promote the effective utilization of coalbed methane resources. This is essential for the sustainable development of mining.

Gas is one of the common risk factors in fully mechanized coal mining faces. The gas gushing mechanism refers to the process of gas flowing from the ore body to the surface. The main causes of gas gushing include changes in pore structure, hydraulic action and pressure changes. Among them, the change of pore structure is one of the

most important factors. When the stone in the ore body is damaged or cracks are formed, it will cause the pore structure to change, allowing gas to escape. In addition, water flow can also affect the ore body, introducing groundwater into the ore body through infiltration, which in turn causes gas gushing. When the pressure inside the ore body increases or the pressure inside the ore body decreases, gas gushes out[6].

According to its spatial and temporal distribution characteristics, it can be divided into conventional extraction and special extraction. General outflow refers to the outward discharge that is uniform and uninterrupted in space and time, such as along the coal wall and goaf. "Special outflow" refers to the spatiotemporal non-uniform and discontinuous outflow of goaf gas, which is mainly manifested by the old roof to press down the goaf gas surge, coal fall, gas surge, gas eruption and protrusion, etc.

In order to solve the problem of mine gas gushing, it needs to be predicted. At present, the most commonly used method is the source prediction method.

The basic idea of the sub-source prediction method is that according to different sources, the gas emission of the two working faces of mining and excavation is multiplied by the emission coefficient of the goaf to obtain the gas emission of the mine. Through the analysis of mine gas emission, the mine gas emission can be accurately predicted, so as to provide a theoretical basis for mine safety production and safety management.

Factors Influencing Gas Outflow

The amount of coal seam gas is affected by the mining depth, surface pressure change, mining sequence and mining method, mining speed and production technology, mining technology and mining technology. The effect of mining depth on gas emission under different distribution states is different. The surface atmospheric pressure only has an impact on the gas escape in confined spaces such as goafs and closed old empty areas of the working face. The effect of a change in atmospheric pressure on a goaf is similar to that of respiration; Atmospheric pressure has little effect on the gas gushing out of the coal wall and falling coal. The pre-mining sequence, recovery rate, and goaf roof treatment method will all affect the gas gushing out of the mine. At the same time, the mining rate and mining rate also have a certain impact on the gas outflow, when the mining rate is low, the relative gas emission of adjacent rock layers and surrounding rock will increase, and with the increase of mining rate, the absolute gas emission will also increase, but its relative gas emission will decrease. At the same time, the rapid and concentrated mining of falling coal may reduce the amount of gas emitted [7-10].

6. Conclusion

Coal seam gas flow has an important impact on mine production safety and utilization of coalbed methane resources. Coal seam gas exists in different states of coal or surrounding rock, including free gas and adsorbed gas, and presents zonation characteristics in the vertical direction. The flow law of coal seam gas is affected by a variety of factors, such as spatial and temporal flow field changes, geological structure, coal body properties, etc. The study of gas emission is very important for the safe production of mines and the development and utilization of coalbed methane resources.

Therefore, it is of great significance to study the flow of coalbed gas in depth to formulate scientific gas prevention and control measures, improve the safety production level of mines, and realize the efficient utilization of coalbed methane resources. Through the study of the formation, occurrence state, flow law and gushing amount of coal seam gas, it can provide a scientific basis for mining and promote the sustainable development of mines.

References

[1]. Cheng Yuanping, Fu Jianhua, Yu Qixiang. Journal of Mining and Safety Engineering,2009,26(02):127-139.
[2]. Deng Huayi. Energy Science and Technology,2023,21(06):18-21.
[3]. Jia Junping, Xu Jiangtao, Zhang Ganxing. China Coal,2016,42(06):109-111+118.
[4]. Wang Xiangdong, Mu Yongliang, Liu Weiwei. Coal Technology,2023,42(02):143-146.
[5]. Zhao Yu. Research on gas extraction technology of fully mechanized coal mine face[J]. Automation Application,2023,64(23):215-217.
[6]. Chen Yongrang, Zhai Haitao, Xuan Dequan. Energy and Energy Conservation,2023, (10):61-63.
[7]. Jin Jingyu. Coal Economy of Inner Mongolia,2014, (08):14-16.
[8]. Cheng Bo, Yan Wenxue, Yang Liang, et al. China Coal,2019,45(11):63-67.
[9]. HE Qing. Mining Safety and Environmental Protection,2016,43(04):98-101.
[10]. Li Zeyu, Meng Xiangyun. Journal of Liaoning Technical University,2014,33(09):1212-1216.