Discussion on some problems of risk identification of coal seam outburst

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Abstract: The identification of coal and gas outburst is a complex work. In order to strengthen and standardize the identification of coal outburst risk, the state has issued a series of regulations and requirements. Combined with various problems encountered in outburst identification work, this paper studies and discusses the selection of identification indexes, the situation that adjacent mines are identified as outburst, the situation that they do not have identification conditions, the relationship between measurement points and identification scope, and the location of geological structure areas, etc., and puts forward suggestions for relevant regulations, which will be helpful for future outburst coal seam identification work and revision of national regulations.

1. Introduction

For coal enterprises, coal and gas outburst has been one of the main factors restricting the safe and efficient production of coal mines. Once coal and gas outburst occurs, it will bring huge economic loss and bad social impact. The national requirements for outburst mines are more and more strict. In order to strengthen the prevention and control of coal and gas outburst in coal mining enterprises, since 2016, the relevant departments have successively issued the coal mine safety regulations [1] and the coal mine gas grade identification method [2], which put forward further requirements for the identification of coal and gas outburst.

In the process of coal and gas outburst identification for a long time, the author found that these new regulations have some problems to be discussed in guiding outburst coal seam identification. This paper studies and discusses these problems in order to provide reference for the revision of relevant regulations in the future, and also for the identification of outburst coal seam.

2. Selection of identification index

At present, the risk identification of coal seam outburst is mainly based on the actual occurrence of gas dynamic phenomenon. When the characteristics of gas dynamic phenomenon cannot be determined as coal and gas outburst or no gas dynamic phenomenon occurs, the actual measured outburst risk indicators should be used for identification [2]. There are four identification indicators, which are coal seam gas pressure, initial gas release speed of coal, and coal damage Type and soundness factor.

As everyone knows, the mechanism of coal and gas outburst is still in the research stage, and there is no final conclusion. What most researchers and scholars approve is the comprehensive hypothesis, that is, coal and gas outburst is the result of the comprehensive effect of three factors, including coal seam gas pressure, in-situ stress and coal physical and mechanical properties. However, in the four single indexes of outburst coal seam identification, the indexes of coal seam gas pressure and initial
velocity of gas release reflect the factors of coal seam gas participating in outburst, while the failure type and firmness coefficient of coal can reflect the factors of in-situ stress to a certain extent, but more still reflect the physical and mechanical characteristics of coal. Statistics show that most of the coal and gas outburst accidents occur near the geological structure area [3], in these areas, the ground stress has obvious changes. Therefore, the indexes reflecting the in-situ stress factors should be included in the single indexes of outburst coal seam identification, which can be determined by acoustic emissivity method, acoustic wave method, seismic wave method, resistivity method and other [4,5] and verified and feasible methods.

3. Coal and gas outburst mines nearby

According to Article 15 of the appraisal method of coal mine gas grade, the coal seam with the same coal seam reaching the initial outburst depth of adjacent coal mines shall not be defined as non outburst coal seam [2]. Some industry supervision departments interpret this clause as follows: the coal seams and geology in the same mining area are basically in the same coal forming period, and the difference of gas occurrence will not be too large. The outburst of the same coal seam in the adjacent Mine indicates that the coal seam has the natural attribute of outburst coal seam under the outburst elevation and burial depth. If the mining depth has reached the elevation and burial depth, the coal seam in this mine should Coal seam should also have outburst risk, so it is not consistent with the actual gas occurrence state of the coal seam.

However, the author believes that because the coal forming process is a long-term process, even in the same coal seam in the same mining area and the same coal forming period, there may be differences in coal quality and gas occurrence, sometimes even large differences.

For example, Zhenchengdi Coal Mine, Tunlan coal mine and Malan Coal Mine of Xishan Coal Power Co., Ltd. are adjacent to each other, but affected by Fengpingling fault and Malan syncline, the gas occurrence conditions of coal seam 8 of the three coal mines are quite different. The coal type of Tunlan coal mine is coking coal, Malan coal mine is coking coal and fat coal, and Zhenchengdi Coal Mine is fat coal (Fig1). According to the principle of division of geological units [6], the three coal mines belong to different geological units. It can also be confirmed from the field measurement results of gas pressure that the gas pressure of No. 8 coal seam in Tunlan Coal Mine reaches 1.36mpa, which is identified as outburst coal seam. The gas pressure of No. 8 coal seam in Malan coal mine is 1.47mpa, and that of No. 8 coal seam in Zhenchengdi Coal Mine is 0.45MPa. If the mining of the same coal seam reaches the initial outburst depth of the adjacent mine, it can not be defined as non outburst coal seam, Malan Coal Mine and Zhenchengdi Coal Mine No. 8 coal seam should be identified as outburst coal seam, which is obviously inconsistent with the actual situation of the mine.

Figure 1 Different coal type of adjacent coal mines

Another example is that there is a 180 m wide and 1700 m long wash zone in No. 3 coal seam of Licun coal mine of Lu'an Group in Shanxi Province (Fig2). On both sides of the scour zone, there are great differences in coal type and gas occurrence. In the east of the wash zone, the coal is mainly meagre coal, the gas pressure is less than 0.6MPa, and the gas content is 6-9 cubic meter per ton. in the
west of the wash zone, the coal is anthracite, the coal seam gas pressure (measured by indirect method) is more than 1.5MPa, and the gas content is more than 20 cubic meter per ton. According to the principle of division of geological units [6], these two areas cannot be divided into the same geological unit. If they are all managed according to outburst coal seam, it is obviously unreasonable.

![Figure 2 Different coal type on both sides of the wash zone in Licun coal mine](image)

Therefore, the author believes that a restriction should be added to Article 15 of the measures for the appraisal of coal mine gas grade, that is, mining the same coal seam to reach the initial outburst depth of adjacent mines in the same geological unit should not be defined as non-outburst coal seam.

4. Conditions without identification

In the coal mines in South China, many of them are coal seam group mining, especially in the area of Yunnan, Guizhou and Sichuan area. It is not uncommon for a coal mine to have several or even more than ten layers of coal. In these mines, if there is a layer of coal mining activities, it will depressurize the surrounding coal seam gas within a certain range, which leads to the inability to accurately determine the original gas pressure of the affected coal seam. Or the identified coal seam adopts surface well or other ways to carry out the coal seam gas pre-drainage before development. In this case, if we want to identify the outburst risk of one or several layers of coal, according to the requirements of relevant national regulations, it is easy to have no identification conditions.

Therefore, the author suggests that for the coal seams that need to be identified but do not have the identification conditions according to the requirements, the units with the identification qualification of the outburst risk can be entrusted to evaluate the outburst risk of the coal seams. The evaluation results are used to guide the development and mining of the coal seams, roadway layout and outburst prevention and control.

5. Relationship between measuring points and identification scope

According to Article 39 of the identification method of coal mine gas grade, when the coal seam is identified as non-outburst coal seam, the survey point distribution, geological unit, gas occurrence law, geological structure distribution, mining area boundary, development elevation, mining deployment and other factors shall be fully considered to reasonably define the identification scope [2].

At present, there are many organizations engaged in the risk identification of coal seam outburst, and there is no unified standard for the principle of identification scope. Many appraisal organizations will take into account the factors of geological units when delimiting the appraisal scope, and expand the scope delineated by the line of survey points to a certain extent, a few tens of meters or even more than a kilometer. In some provinces, the coal industry authorities require that the appraisal conclusion be non-outburst. When the coal seam outburst risk identification scope is defined, the scope delineated after connecting the survey points is the identification scope. This situation has little impact on the production mine, but for the infrastructure mine, the development area of the tunnel is small, and the
layout of the measuring points is limited, so the scope of identification is too small, which has little significance for the guidance of the mine.

The author thinks that if the identification conclusion is non outburst coal seam, considering the actual situation of the identified coal seam, on the premise of ensuring the full accuracy and representativeness of the survey points, it is possible to expand the appraisal scope appropriately, but there is a greater risk if there are too many expansion.

6. Distribution of points near geological structure

The most important single index of coal seam outburst risk identification is coal seam gas pressure. According to the requirements of "direct measurement method of coal seam gas pressure in coal mine" [7], the gas pressure measurement location should be preferentially selected in the tunnel or rock roadway, and the location with dense lithology should be selected, and the measurement points should be arranged in the geological structure without faults, fractures and so on. However, different geological structures have different effects on the storage and release of gas. Open structures (synclines or normal faults, etc.) are relatively small, but closed structures (anticlines or reverse faults, etc.) are conducive to the storage of gas. Near such structures, gas pressure and gas content have a significant increase trend [8]. In addition, the relative concentration of in-situ stress in the structural area is more conducive to inducing coal and gas outburst accidents. There is a contradiction between them, that is, whether the survey points should be arranged in the area with complex geological structure or not.

The author thinks that since the gas dynamic phenomenon and the occurrence of coal and gas outburst accidents are mostly related to the geological structure, therefore, when identifying the risk of coal seam outburst, the survey points should be arranged near the geological structure, especially the closed structure, so as to increase the reliability of the identification results.

7.Conclusion

7.1 In order to increase the accuracy, reliability and pertinence of the identification, it is suggested that the in-situ stress measurement index should be supplemented as one of the single indexes for the risk identification of coal seam outburst.

7.2 It is suggested to add a restriction condition to Article 15 of the measures for the identification of coal mine gas grade, that is, the coal seam with the same coal seam mining reaching the initial outburst depth of adjacent mines in the same geological unit shall not be defined as non-outburst coal seam.

7.3 It is suggested that for the coal seams that need to be identified as outburst risk but do not have the identification conditions, the units with the qualification of outburst risk identification can be entrusted to evaluate the outburst risk of the coal seams. The evaluation results are used to guide the development and mining of the coal seams, roadway layout and outburst prevention and control.

7.4 If the appraisal conclusion is non outburst coal seam, considering the actual situation of the identified coal seam, and on the premise of ensuring the full accuracy and representativeness of the survey points, the appraisal scope can be appropriately expanded.

7.5 In order to increase the reliability of the appraisal results, the survey points should be arranged near the geological structure, especially near the closed structure.

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