Journal of Applied Science and Engineering Innovation, Vol.9, No.1, 2022, pp. 12-14
ISSN (Print): 2331-9062
ISSN (Online): 2331-9070

Research on Calculation of Coalbed Methane Resources in Pinggou Coal Mine

Yue Jun[1,2]

[1]*China Coal Technology and Engineering Group Chongqing Research Institute, Chongqing, 400037, China*

[2]*State Key Laboratory of the Gas Disaster Detecting Preventing and Emergency Controlling, Chongqing, 400037, China*

Abstract*:* As one of the important energy sources in my country, the accuracy of its resource calculation directly affects the economic benefits of CBM development. In order to more accurately guide the subsequent exploitation and utilization of coalbed methane resources, combined with the data of the gas geological law of Pinggou coal mine, the calculation method of the resource quantity was analyzed, and the relatively accurate data of the coalbed methane resource quantity of the Pinggou coal mine was calculated, and the Pinggou coal mine was obtained. The total amount of coalbed methane resources in the unexploited areas of 9#, 10#, and 16# coal seams is 137.09Mm3. The research results provide the basis for the development and utilization of coalbed methane resources in Pinggou Coal Mine.

Keywords Coalbed Methane, Resources, Development and Utilization, Volume Method.

INTRODUCTION

Coalbed methane is commonly known as mine gas, and its resources refer to the amount of coalbed methane with practical economic significance and potential economic significance that is estimated to exist in the coal seam and is currently exploitable or may be mined in the future based on certain geological engineering [Wen, *et al.*, 2019]. The resource calculation result is a prerequisite and necessary work for realizing the large-scale development of coalbed methane, and it is the basic basis for the country's strategy and planning for energy structure allocation and coalbed methane industry development [Bi, *et al.*, 2018 and Chen, *et al.*, 2020].

My country has rich experience in CBM reserves calculation. Zhang Xiaowu et al. increased the amount of CBM resources in surrounding rocks and non-minable coal seams, as well as the resources of free gas and dissolved gas, and discussed the calculation method of CBM resources [Zhang, *et al.*, 2008]. Guo Mingtao et al. took the K1 steeply inclined coal seam in Zhongliangshan South Mine as an example, analyzed the mathematical model for fitting the resource parameters, and finally applied the Monte Carlo method to take the content as Beta PERT distribution, the coal thickness as the log-normal distribution, and the area as the log-normal distribution. For the mathematical model of gamma distribution, the coalbed methane resources of the K1 coal seam in the Zhongliangshan South Mine are simulated [Guo *et al.*, 2016]. Li Rifu proposed an "indirect deduction" evaluation method for CBM resources, and used this method to estimate the gas resources in the stable mining area of the 5310 working face in Jincheng Chengzhuang Mine [Li,, 2018]. Gao Jiancheng et al. divided the Pingdingshan mining area into blocks, and used the estimated volume method of coalbed methane resources to calculate the coalbed methane resources of each group of main coal seams in the mining area [Gao, *et al.*, 2019]. Li Dan calculated the loss of coalbed methane resources in the working face by using the gas emission prediction method of the working face, and established the calculation method of the coalbed methane resources in the mining stable area [Li,, 2020]. Therefore, the calculation of CBM resources in Pinggou Coal Mine is a very important issue.

RESOURCE CALCULATION METHOD

The basic geological conditions in my country are complex, and the coal seam occurrence conditions in different regions are very different, which brings many problems to the determination of parameters such as gas-bearing area and gas content during the calculation of CBM resources. At present, the calculation methods of CBM resources in my country mainly include the following:

(1) Volume method

The volume method is the basic method for calculating the geological reserves of coalbed methane (also called the volumetric method), which is suitable for the calculation of the geological reserves of coal seams of various grades. Its accuracy depends on the knowledge of gas reservoir geological

conditions and reservoir conditions, as well as on the accuracy and quantity of related parameters.

(2) Numerical simulation method of gas reservoir

This method is to use special software on the computer to fit and match the acquired reservoir parameters with the early production data or trial production data. This method can obtain a gas reservoir model and geological reserves representing the average characteristics of the reservoir, and can also estimate the future production status and recoverable reserves of CBM wells. The accuracy of the results is based on abundant data and computational precision.

(3) Analogy method

The analogy method is a method for calculating CBM reserves using the correlation of developed CBM fields (or similar reservoirs). The more similar the geological conditions and reservoir conditions of the calculation area and the development area are, the more accurate the calculation results will be. Due to the complex geological conditions in my country, this method has great limitations and can only be used in very few areas. However, if the area is selected in the early stage of CBM development, the reserve level requirements are not high, and the geological data is relatively reliable. Using this method to select parameters is quicker and more intuitive. For other calculation methods, such as Monte Carlo method, material balance method, etc., because the calculation process is complicated or the parameter selection is difficult, it is not very practical, and few people use it.

RESOURCE CALCULATION AND PARAMETER DETERMINATION

Calculation basic conditions

(1) Resource calculation boundary

The area marked with the gas wind oxidation zone in the gas geological map can be circled directly without reserve calculation. The coalbed gas content and the lower limit of coalbed thickness are determined by the gas content contour and borehole data (for the lower limit standard, please refer to the Code for Coalbed Methane Resources/Reserves).

(2) Division of resource calculation units

The principle is to classify the reservoirs in the gas field with the same or similar CBM occurrence characteristics as a unit. Geological boundaries of gas reservoirs, such as faults, pinch-outs, and denudation, are the first choice for unit division. Then, the boundaries are calculated in combination with gas reservoirs. The boundary of net thickness of coal seam, the lower boundary of gas content and the boundary of gas weathering zone that cannot reach the lower limit of production are not calculated.

Determination of parameters of calculation formula

(1) Compilation of gas content contour lines

By studying the regional geological structure, the geological structure control characteristics of the mining area, and the mine gas geological law, different gas geological units are divided. According to the gas pressure and other basic gas parameters measured on site, find out the controlling factors of gas occurrence in different gas geological units, establish a mathematical model related to gas pressure and gas content, predict the gas pressure and content in the mine, and draw the gas pressure and gas content in the mine, etc. value line.

(2) Calculate the unit area

The area can be directly inquired through the developed coal mine gas geological analysis system software, instead of using the direct formula method and grid method commonly used to calculate the area of coal reserves, and the calculation results are very accurate. The change of the dip angle of the coal seam can be calculated from the density of the contour line of the floor, and then the actual area is corrected.

(3) Effective thickness of coal seam

That is, the thickness of the gangue removed from the thickness of the whole layer of coal, also known as the net thickness. You can view the adjacent drilling data, and arrange the thickness of the gangue through the logging curve or coring. Generally, it is marked near the drill hole on the map together with the thickness of the tectonic coal.

(4) Coal mass density

First search for nearby boreholes, and check the corresponding report to obtain the value of true coal density or apparent density; for the case where there are multiple boreholes in the calculation unit, the average value can be taken.

(5) Resource calculation

The resource calculation blocks are divided according to the contour map of mine gas content, and the CBM resources of each block are calculated according to the determined parameters of each block.

CALCULATION RESULTS AND EVALUATION OF RESOURCES

Mine overview

Pinggou Coal Mine is affiliated to Shenhua Group Wuhai Energy Co., Ltd. and is located in Wuhai City, Inner Mongolia Autonomous Region. The coal-measure strata in the Pinggou minefield are Carboniferous and Permian, with a total of 20 coal-bearing layers. Each layer is numbered from top to bottom from 1# to 20#, of which 9-2#, 10#, 14#, 16-1# and 16-2# are stable and relatively stable coal seams, which are the main coal mining of Pinggou Coal Mine Floor. Pinggou Coal Mine is mainly

mining 9#, 10#, and 16# coal seams, and the thickness of the coal seams is greater than the lower limit (0.5m) required for the calculation of CBM resources. Since a part of the mine has been mined at present, and the coalbed methane of the mined coal seam has been discharged, the coalbed methane resource does not count the mined part and the unminable part.

Resource calculation

Using the volume method, the calculation formula is as follows:

$$G_i = AhDC_{ad} \quad (1)$$

$$C_{ad} = C_{daf}(100 - M_{ad} - A_d)/100 \quad (2)$$

In the formula: G_i is the geological reserves of coalbed methane, Mm^3; A is the gas-bearing area of the coal seam, km^2; h is net thickness of coal seam, m; D is density of coal, t/m^3; C_{ad} is gas content of coal on dry basis, m^3/t; M_{ad} is the raw coal base moisture in the coal, %; Ad is ash in coal, %; C_{daf} is the dry ash-free gas content of coal, in cubic meters per ton (m^3/t).

The parameters of the calculation process are mainly derived from geological exploration data. The higher the degree of exploration, the more accurate the value of the parameters and the more reliable the results of the resource. However, for areas with a low degree of exploration or no current exploration, the selection of parameters is more artificial, and the reliability of the resource calculation results is questionable. The specific resource calculation results are shown in Table 1.

Table 1 Calculation results of CBM resources in Pinggou Coal Mine

Coal seam	9#	10#	16#
Area (km^2)	1.10	2.65	2.91
Gas content①(m^3/t)	6.1	8.2	8.6
Coal thickness②(m)	4.8	1.15	1.52
Apparent density③ (t/m^3)	1.48	1.42	1.37
Buried depth (m)	255~380	223~372	234~395
Geological reserves④(Mm^3)	47.64	35.62	53.83
Reserve abundance ($108m^3/km^2$)	0.43	0.13	0.19

Remarks: ①Take the average gas content of the encircled block; ②Take the average coal thickness of the encircled block; ③Take the average coal density of the encircled block; ④During the calculation of geological reserves, the gas content coefficient of surrounding rock is taken as 1.1.

It can be seen from Table 1 that (1) the 9# coalbed methane reserves are $47.64Mm^3$, and the average resource abundance is $0.43\times10^8m^3/km^2$; the 10# coalbed methane reserves are $35.62Mm^3$, and the average resource abundance is $0.13\times10^8m^3/km^2$; 16# coal seam CBM geological reserves is $53.83Mm^3$, and the average resource abundance is $0.19\times10^8m^3/km^2$. (2) The 9#, 10#, and 16# coalbed methane geological reserves belong to the small reserve scale and the ultra-low reserve abundance category. The CBM burial depth is shallower than 500m, which belongs to the shallow burial category. According to the geological reliability and economic development feasibility, the coalbed methane resources of 9#, 10#, and 16# coal seams are tentatively set as the predicted grade and the inherent economic category. (3) The total amount of coalbed methane resources in the unexploited areas of 9#, 10#, and 16# coal seams in the I panel is $137.09Mm^3$.

CONCLUSION

The relatively accurate data of CBM resources in Pinggou Coal Mine were calculated by the volume method, and the total CBM resources in the unexploited areas of 9#, 10#, and 16# coal seams in Pinggou Coal Mine were obtained as $137.09Mm^3$. And it provides a basis for the development and utilization of coalbed methane resources in Pinggou Coal Mine.

ACKNOWLEDGMENTS

This study was financially supported by China Coal Science and Industry Group Chongqing Research Institute Co., Ltd. Independent Key Project (No. 2021ZDZX05).

REFERENCES

Bi Caiqin. Quantity and distribution of coalbed methane resources in China [J]. Petroleum Knowledge, 2018(02):12.

Chen Dong. Discussion on calculation method and result evaluation of coalbed methane resources [J]. Inner Mongolia Coal Economy, 2020(12):23-24.

Gao Jiancheng, Qin Muguang. Calculation of coalbed methane resources in Pingdingshan mining area and selection of favorable blocks [J]. Coal Technology, 2019, 38(05): 28-30.

Guo Mingtao, Tang Yuegang, Su Xuefeng. Estimation of coalbed methane resources based on Monte Carlo method [J]. Coal Mine Safety, 2016, 47(10): 153-156.

Li Dan. Calculation of coalbed methane resources in stable mining area based on gas emission [J]. Coal Mine Safety, 2020, 51(04): 162-166.

Li Rifu. Evaluation method and application of "indirect deduction" for CBM resources in stable mining area of coal mines [J]. Coal Mine Safety, 2018, 49(04): 160-164.

Wen Shenchen, Zhou Ke, Lu Qian. Discussion on China's coalbed methane development strategy: Taking PetroChina Coalbed Methane Co., Ltd. as an example [J]. Natural Gas Industry, 2019, 39(05): 129-136.

Zhang Xiaowu, Qiao Junwei. Discussion on the calculation method of coalbed methane resources [J]. Inner Mongolia Petrochemical, 2008(11):43-45.