Size effect of Water-flowing fracture Zone height based on FLAC³ᴰ

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Abstract. The loss of water resources caused by mining fissures is a key factor restricting the green development of coal resources in western mining areas. in order to analyze the influence of mining thickness and face width on the development height of water diversion fracture zone, based on the characteristics of overburden in Xinzhuang Coal Mine, the finite difference software FLAC³ᴰ is used to simulate and analyze the size effect of water diversion fracture zone height. The simulation results show that the height of the water diversion fracture zone is positively correlated with the increase of mining thickness and working face width. When the mining thickness is 9m and the width of the working face is 240m, the height of the water diversion fracture zone is 115m, and the average distance between the coal layer 8 of Xinzhuang Coal Mine and the bottom of the Cretaceous aquifer is 106.9m, which may cause water inrush in the mine. Therefore, according to the simulation results and referring to the mining size of part of the mine face in the attached Binchang mining area, it is suggested that the mining thickness of Xinzhuang Coal Mine is about 10m and the width of the working face is not more than 200m.

1 Introduction.

The water diversion fracture zone is the channel of underground water and gas migration [1-2]. For the western mining area with fragile ecological environment, analyzing the development law of water diversion fracture zone and studying and judging the development height is an important way to realize mine safety, high efficiency, green mining and protect surface and groundwater resources [3-4]. Previous studies have found that the development of water-conducting fracture zone is the result of the joint action of many factors such as mining size and overlying rock properties [5-6], in which mining thickness and working face width are important main / controllable factors [7-8]. And it can be adjusted and optimized continuously with coal mining. Xinzhuang mine is adjacent to Binchang mining area, in which Hujiahe, Dafusi and other mines are affected by strong aquifers [9-10]. Because the thickness of 8 layers of main coal mining in Xinzhuang coal mine varies greatly, the hydrogeological conditions are complex and the buried depth is large. How to select the appropriate mining thickness and face width under complex conditions will be the key to effectively control the stability of roof aquifer and ensure the safety of mine production.

2 The basic general situation of the mine

Xinzhuang Coal Mine is located in the southwest margin of Ordos Basin and belongs to Ningzheng Mining area of Qingyang, Gansu Province. The planned production capacity of Xinzhuang Coal Mine is 8.00Mt/a. The thickness of 8 layers of main coal mining is 0 ~ 27.42 m, with an average of 8.50 m, and the structure is simple. The buried depth of coal seam in this mine field is 660 ~ 1260 m. The hydrogeological conditions of this mine field are complex, the influence of surface water on mine mining is small, and the influence of groundwater on mine mining is complex. There are mainly five groups of aquifers above the roof of 8 layers of coal in the mine field, among which the aquifers of Cretaceous Luohe and Yijun formation are strong water-rich aquifers. Because the average distance between the coal layer 8 and the bottom of the Cretaceous aquifer is 106.9 m, the structure in the mine field is undeveloped, and there is no hydraulic connection with the underlying Jurassic strata without mining. When the coal seam is mined, the water diversion fracture zone may spread to the aquifer. Hydraulic contact occurs with various aquifers of Jurassic, making it the main water filling source of the mine.

3 Numerical simulation scheme design.

This simulation uses the finite difference software FLAC³ᴰ, according to the geological data of Xinzhuang mine, and considering the calculation needs, determine the numerical calculation model. The three-dimensional numerical calculation model of Xinzhuang coal mine face is shown in figure 1. Orthogonal experiments are used to simulate the failure of overlying strata when the mining thickness is 3m, 6m, 9m and the width of working face is 150m, 180m, 240m

respectively, and the relationship between the development height of water diversion fracture zone and coal seam mining thickness under the condition of different face width is analyzed.
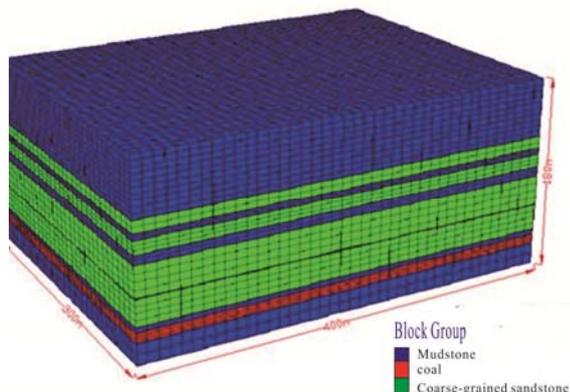
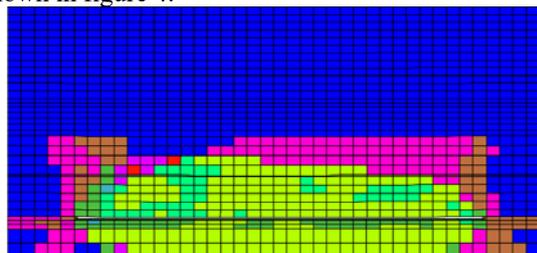**Fig. 1** numerical simulation model

4 The results of simulation experiment
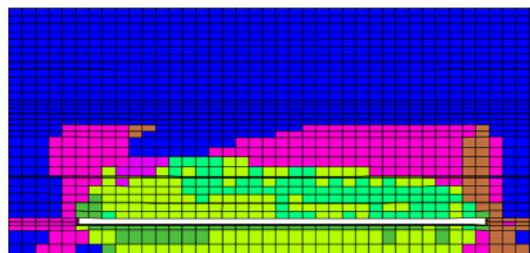
4.1 The width of the working face is 150m.

The main results are as follows: (1) under the condition of mining thickness of 3m, after pushing 300m, the height of the plastic failure zone of the roof develops to 58m above the roof, and the development height of the water diversion fracture zone does not develop to the aquifer of the Cretaceous Luohe formation of the roof, as shown in figure 2.

(2) under the condition of mining thickness of 6m, after pushing 300m, the height of the plastic failure zone of the roof has developed to 67m above the roof. The water-conducting fracture zone has not yet developed to the bottom of the aquifer of the Cretaceous Luohe formation, and the thickness of the aquifer at the bottom of the water-conducting fracture zone and the Cretaceous Luohe formation is 34m, as shown in figure 3.
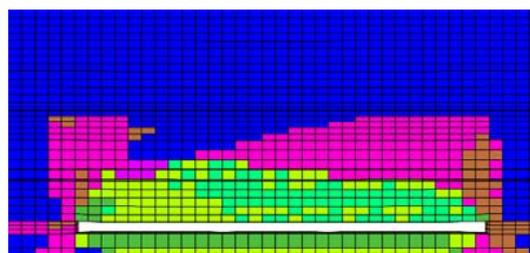
(3) under the condition of mining thickness of 9m, after pushing 300m, the height of the plastic failure zone of the roof has developed to 75m above the roof. The water-conducting fracture zone has not yet developed to the bottom of the aquifer of the Cretaceous Luohe formation, and the thickness of the aquifer at the bottom of the water-conducting fracture zone and the Cretaceous Luohe formation is 26m, as shown in figure 4.

Fig2. Distribution characteristics of plastic failure of roof overlying rock (mining thickness is 3m)

Fig3. Distribution characteristics of plastic failure of roof overlying rock (mining thickness is 6m)
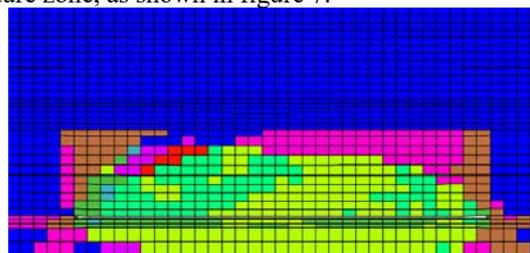

Fig4. Distribution characteristics of plastic failure of roof overlying rock (mining thickness is 9m)
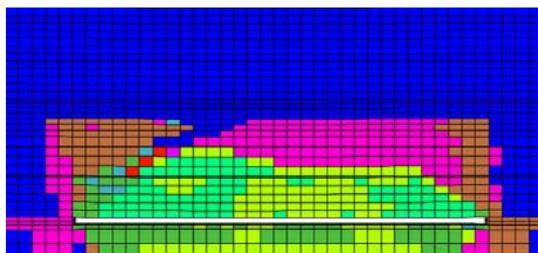
4.2 The width of the working face is 180m

The main results are as follows: (1) Under the condition of mining thickness of 3m, after pushing 300m, the height of the plastic failure zone of the roof develops to 62.5m above the roof, and the development height of the water diversion fracture zone basically does not change, and it also does not develop to the aquifer of the Cretaceous Luohe formation of the roof, as shown in figure 5.

(2) Under the condition of mining thickness of 6m, after pushing 300m, the height of the plastic failure zone of the roof has developed to 81m above the roof. The water-conducting fracture zone has not yet developed to the bottom of the aquifer of the Cretaceous Luohe formation, and the thickness of the aquifer at the bottom of the water-conducting fracture zone and the Cretaceous Luohe formation is 20m, as shown in figure 6.
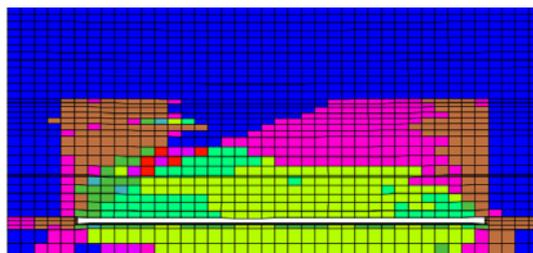
(3) Under the condition of mining thickness of 9m, after pushing 300m, the height of the plastic failure zone of the roof has developed to 95m above the roof. The water diversion fracture zone develops to the bottom of the aquifer of the Cretaceous Luohe formation, and the water of the aquifer in the lower part of the Cretaceous Luohe formation may enter the mining face through the water diversion fracture zone, as shown in figure 7.
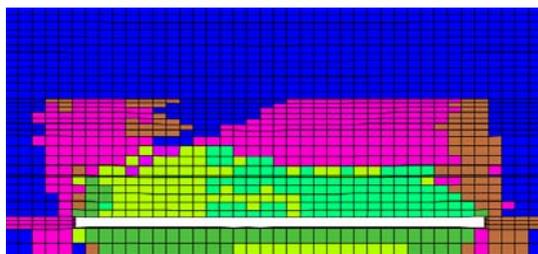

Fig5. Distribution characteristics of plastic failure of roof overlying rock (mining thickness is 3m)
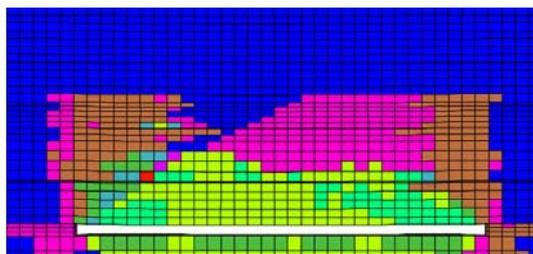
Fig6. Distribution characteristics of plastic failure of roof overlying rock (mining thickness is 6m)

Fig7. Distribution characteristics of plastic failure of roof overlying rock (mining thickness is 9m)

4.3 The width of the working face is 240m

The main results are as follows: (1) Under the condition of mining thickness of 3m, after pushing 300m, the plastic failure zone of the roof develops to 75m above the roof, but not to the aquifer of the Cretaceous Luohe formation, and the thickness of the water diversion fracture zone and the aquifer at the bottom of the Cretaceous Luohe formation is 31m. See figure 8.

(2) Under the condition of mining thickness of 6m, after pushing 300m, the height of the plastic failure zone of the roof has developed to 95m above the roof. The water diversion fracture zone develops to the bottom of the aquifer of the Cretaceous Luohe formation, and the water from the lower aquifer of the Cretaceous Luohe formation may enter the mining face through the water diversion fracture zone, as shown in figure 9.

(3) Under the condition of mining width 240m and mining height 9m, after pushing 300m, the height of the plastic failure zone of the roof has developed to 115m above the roof. The water diversion fracture zone develops to the aquifer in the lower part of the Cretaceous Luohe formation, and the water from the aquifer in the lower part of the Cretaceous Luohe formation can enter the mining face through the water diversion fracture zone, as shown in figure 10.
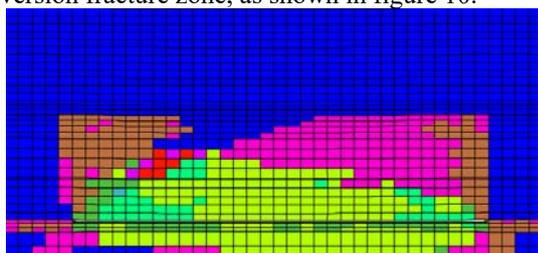

Fig8. Distribution characteristics of plastic failure of roof overlying rock (mining thickness is 3m)

Fig9. Distribution characteristics of plastic failure of roof overlying rock (mining thickness is 6m)

Fig10. Distribution characteristics of plastic failure of roof overlying rock (mining thickness is 9m)

4.4 The comprehensive result analysis

The statistical analysis of the numerical simulation data is shown in Table 1, and the relationship between the development height of the water diversion fracture zone and the coal seam mining thickness under the condition of different working face width can be obtained.

Table1 The height of water-conducting fracture zone (unit: m)

Working face width	Mining thickness		
	3	6	9
150	58	67	75
180	62.5	81	95
240	75	95	115
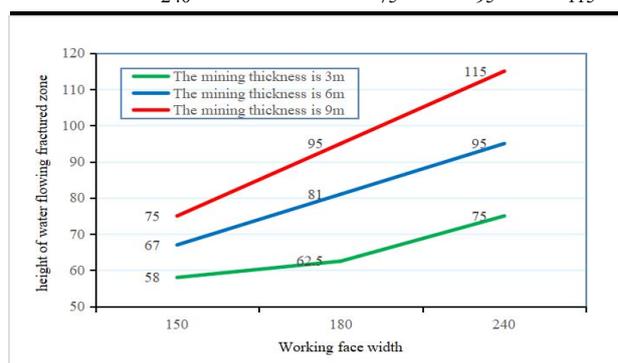
Fig11. The height of water-conducting fracture zone

5 Conclusion

(1) The simulation results show that the height of the water diversion fracture zone is positively correlated with the mining thickness and the width of the working face. Because the average distance between the coal layer 8 and the bottom of the Cretaceous aquifer is 106.9m, when the mining thickness is 9m and the width of the working face is 240m,

the height of the water diversion fracture zone is 115m, and the mining fracture must spread to the aquifer of Luohe formation, causing water inrush in the mine. Therefore, according to the simulation results and referring to the mining size of part of the mine face in the attached Binchang mining area, it is suggested that the mining thickness of Xinzhuang Coal Mine is about 10m and the width of the working face is not more than 200m.

(2) It is found that the height of the water-conducting fracture zone is directly related to the mining thickness, and the higher the mining height is, the higher the water-conducting fracture zone is. Therefore, the early mining face should not choose the area where the coal seam is too thick, and avoid the syncline axis of the syncline structure, first mine the thinner area, and actively take drainage measures.

Acknowledgement

References

1. Liu Tianquan. Influence of mining activities on mine rock mass and control engineering[J].Journal of China Coal Society, 1995, 20(1):1-5.

2. QIAN Minggao, XU Jialin. Behaviors of strata movement in coal mining[J]. Journal of China Coal Society, 2019, 44(4):973-984.

3. Fan Limin，Ma Xiongde，Ji Ruijun． Progress in engineering practice of water-preserved coal mining in western eco-environment frangible area[J].Journal of China Coal Society,2015,40(8):1711-1717．

4. Fan Limin,Xiang Maoxi,Peng Jie,et al.Groundwater response to intensive mining in ecologically fragile area[J].Journal of China Coal Society, 2016,41(11):2672-2678．

5. HU Xiaojuan, LI Wen-ping, CAO Dingtao,et al.Index of multiple factors and expected height of fully mechanized water flowing fractured zone[J]. Journal of China Coal Society, 2012, 37(4):613-620.

6. SHI Longqing, XIN Hengqi, ZHAI Peihe,et al. Calculating the height of water flowing fracture zone in deep mining[J].Journal of China University of Mining&Technology, 2012, 41(1):37-41.

7. Liu Yang. Research on relationship between different width of working face and height of waterflowing fractured zone[J].Journal of Coal Mine Safety,2010,41(4):13-17.

8. YANG Ke, XIE Guang xiang. Caving thickness effects on distribution and evolution characteristics of mining induced fracture[J]. Journal of China Coal Society, 2008, 33(10):1092-1096.

9. LOU Jinfu, XU Gang, LIN Qing, et al． Research on roof disaster mechanism and prevention under soft water-enriched roof in Yonglong Coalfield[J]. Coal Science and Technology, 2018, 46(7):10-18.10

10. Lin Qing, Qiao Wei. Water prevention and control technology of roof bed separation in Cuimu Mine[J].Coal Science and Technology, 2016,44(3):129-134．