

# Arrangement of Gas Drainage Boreholes and Investigation and Analysis on Effect of Pre-drainage Gas by High Gas-drainage Roadway

PanFeng<sup>1</sup>, RenPeiliang<sup>2</sup>, WangNianhong<sup>3</sup>

<sup>1,2</sup>Yima Coal Industry Group, Institute of Gas Technology Centre, Yima, Henan, China

<sup>3</sup>Yima Coal Industry Group, Yian Mining Co., Ltd of Luoyang, Luoyang, Henan, China

E-mail: ymjtwss@163.com, feiyngting@126.com

**Abstract:** In order to investigate the effect of drainage arrangement and time of the Roadway pre-pumping high seam Coal gas drilling, take YiAn mine FD003 alley pumping of Yima Industry Group as test site, By investigating the Five presbyopia drilling group arrangement and control scope of which the spacing is four meters, five meters and six meters, through the length time of the drainage to analyze the drainage effect. Experiment results show that through changing holes arrangement, expand control scope and increase control drainage time can improve drainage effect, could also eliminate the risk, through analysis on the drainage time, size of excavation and validity of the indexes for the footage investigation, Drilling distance is six meters, Drainage time seventy-five days, could get the best effect, compare with other three layouts the speed of tunneling can increase by 50%.

**Keywords:** high gas-drainage; gas; arrangement; investigation and analysis

China is the first country which develop and utilize coal in the world, so far in our country's energy production and consumption structure, coal still accounts for about 70%<sup>[1]</sup>. The gas drainage is mine the main technical measures on gas disaster prevention. The gas drainage is not only the way to reduce quantity of gas into mine quantity airflow but also the best way to improve the productivity of Rich methane mines, coal and methane outburst mines<sup>[2]</sup>. If take the gas as the associated resources of coal, and use the Gas from coal mines, can be changed harm into a benefit, it is favorable to the environment protection and reduce the amount of gas vented into atmosphere. In Rich methane mines, coal and methane outburst mines, Gas extraction is the main technical measures in the working face. But without protective of mining in single outburst mines, construction Bedding and crossing hole Pre-pumping coal seam gas is the main technical measures in the main area of extraction. According to the coal gas drainage specification, generally speaking, if gas drainage rate reached more than 25%, it play a significant role on gas outburst<sup>[3]</sup>.

The geological structure of Xin'an coal field is extremely complicated, the coal seam is unstable and with difficult occurrence, especially the thickness of coal seam often changes, belong to stress concentration area and gas occurrence unstable area, layer of the coal seam is soft, and with strong structural damage, belong to the difficult drainage coal seam, only use drainage of this coal could not eliminate the risk of the outburst working face, Therefore study the pre-drainage gas technology on the top and floor of the tunnel is the key technology in Xin'an Coal field. Optimize the parameters of the

drainage, improve coal gas drainage rate, ensure eliminating outburst effect, eliminate the risk of coal and gas bursting, has an significant influence on realizing the safety production and high efficiency of coal mine.

## 1. General Situation of The Working Face

Yian FD003 coal high gas emission roadway located in the crossheading of the FD003 working face orbit, the horizontal distance between two roadways is twenty meters, parallel with the FD003 mining track. FD003 high gas emission roadway arranged in the roof of coal seam, the distance to the roof of coal seam is five meters. According to the 3d seismic exploration data, there is no medium and large mature fault in FD003 high gas emission roadway, the main geological structure type is folding structure, create coal strata undulate. According to the related geological data and actual situation of tape overhaul roadway, hydrogeological conditions is not complex. The main filling water is fissure water from roof sandstone. The top two 1 coal seam is agensis, the direct roof is yakatagite, part upgrowth, the thickness is 0–30 meters. the roof is Quartz sandstone, the thickness is 2.0–14.6 meters, the false bottom is agensis, the direct base is powder (fine) sandstone, the thickness is 3.0 meters. The original base is L7 limestone, the thickness is 5.0 meters. According to the build Well's geological reports, the gas emission of this well field is large, gas content is 4.02–12.19  $m^3/t$ , average gas content 7.22  $m^3/t$ .

## 2. Drilling Arrangement of Drainage

### 2.1 Five presbyopia layout

From the FD003 high point to the alley pumping inward 80 meters(that is the intersection between FD003 alley pumping roadway and FD003 orbit crossheading),begin construction drainage borehole, Drainage borehole arranged in the right side, the holes layout is five presbyopia, the drilling spacing is 1.5 meters, row spacing is 0.3 meters, Drainage hole uniformity control tunnels section of FD003 orbit crossheading, through the coal floor not less than 0.5 meters. The layout of five presbyopia borehole as figure1 shows below:

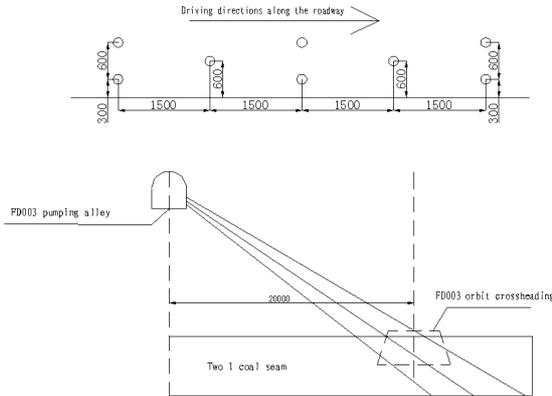


Figure1.The layout of five presbyopia borehole groups

## 2.2 The spacing of the arrangement is 4meters, 5meters and 6meters

The "five presbyopia" drilling group only control the roadways' cross section. According to the Article 4 from basic indexes of coal gas extraction AQ1026–2006: In coal mining excavate working face, the scope of gas extraction should be controlled outline of the roadway over 8 meters and more than 10 meters ahead the working face.

According to the above requirements: Since FD003 high point design inward every 160 meters, the spacing of 10 groups drainage borehole is 4 meters(the spacing of the excavate direction is also 4 meters), the spacing of 6 groups drainage borehole is 5 meters(the spacing of the excavate direction is also 5 meters), the spacing of 5 groups drainage borehole is 6 meters(the spacing of the excavate direction is also 6 meters).The spacing among 4meters spacing, 5 meters spacing and 6 meters spacing drainage borehole group is 6 meters. layout of drilling group which spacing is 4 meters shown in figure 2:

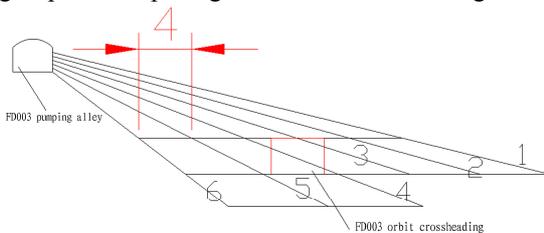


Figure 2 Layout of drilling group which spacing is 4 meters

## 3. Analysis on The Measure of Pre-drainage

### 3.1 Comparative analysis on tunneling speed

After the five presbyopia drilling group and drilling groups' spacing which is 4 meters, 5 meters ,6 meters respectively was completed in drill, Immediately sealing hole and drainage timely, the drainage time as shown in table 1.

Table 1 Drainage schedule of four different layouts

Different layouts	Five presbyopia	4 meters	5 meters	6 meters
Drainage time/d	60	30	45	75

Because of working turning is intension, the pre-pumping time is relatively short. According to the relationship between corresponding length of different design scheme and excavation time, Draw the tunneling speed Contrast table of four different pre-pumping bored arrangement, as shown in table 2.

Table 2 Relationship between tunneling time and tunneling spacing

Different layouts	tunneling spacing/m	tunneling time/d	tunneling speed/m/mon
Five presbyopia	80	33	72.6
4 meters	40	19	63.3
5 meters	30	17	52.8
6 meters	50	14	85.8

From table 2: The excavation speed of drilling group of which spacing is 6 meters maximum. The second is five presbyopia drilling group, the spacing is 4 meters and 5 meters is minimum. Because the spacing 6 meters drilling group is in the final of FD003 alley pumping roadway, finally excavate to this position, the drainage time is relatively long, the effect of eliminating outburst is obviously, tunneling easier. The drainage time of spacing 4 meters drilling group and spacing 5 meters drilling group is short. Coal seams are thick, elimination measures is a big workload, the tunneling speed is samller.

### 3.2 Analysis on drainage concentration

Through analysis on gas drainage material of experimental site, accumulate the same number of holes but different dates of drainage density, and then solve the average value, get the average value of Different Numbers drilling drainage concentration, The relationship shows in Figure 3:

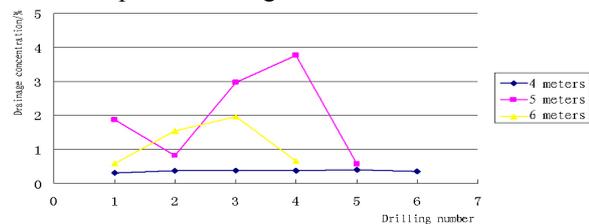
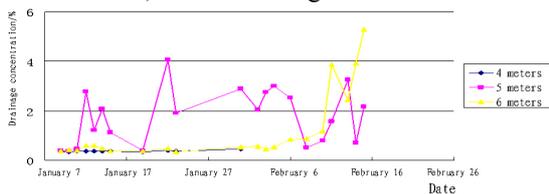


Figure 3 Average value of drainage concentration of different Numbers drilling

By graph 3 know that intermediate value is compare large of each curve, especially the interval distance is 5 meters and six meters drilling group drainage density is the most obvious graph. Because the middle Numbers of the holes (number two and number three,etc)located in inward the contour line or near the roadway contour line, Because after excavating tunnels the pressure of coal fully discharging, drainage effect is good, drainage density is larger. Whereas, numbers of drilling of two sides(number one and number six, etc)located in inward the contour line or far away from the roadway profile, After excavating tunnels the unloading of coal is not obviously, drainage density is relatively small.

According to the statistical data, take the same drilling group and the same date's gas concentration together and then solve the average value, get the different date's Contrast diagram of drainage borehole average concentration, as shown in figure 4



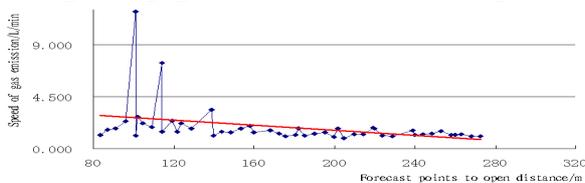
**Figure 4 Different date's Relationship chart of the drainage borehole's average concentration**

From figure 4 could know: With the passage of time, each curve own growing trend, but the start date growth of each curve generally the date excavate to this point, because in early days excavating tunnels not arrive here,there is no pressure relief in coal seam, The effect of gas drainage is not obvious, the drainage density is small. In the later period, after excavating tunnels, Coal seam discharging pressure fully, drainage density become large.

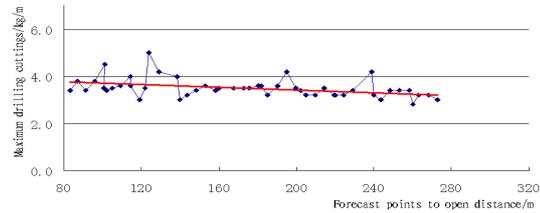
### 3.3 Comparative analysis on test results

#### 3.3.1 Comparative analysis on the maximum value of test results

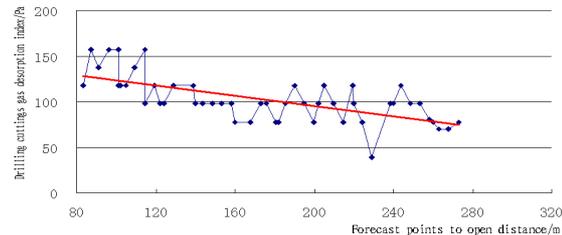
Through sorting the gas drainage material of the experimental site, research and analysis the Extract maximum value from the same place and the same index value of the test results, The maximum speed trend Change of the gas emission as shown in figure 5, The trends maximum quantity of maximum drilling cuttings as shown in figure 6, the index value's change trend of drilling cuttings gas desorption as shown in Figure 7.



**Figure 5 The Change trend diagram of the maximum speed of early gas emission**



**Figure 6 The Change trend diagram of the maximum speed of the maximum drilling cuttings**



**Figure 7 The Change trend diagram of the maximum speed of the drilling cuttings gas desorption index**

by figure 5-7 could get: Open 80meters to 160 meters in some distance, the value of the curve is maximum, the value of the curve become small between 160meters and 200 meters, the value of the curve become large between 200 meters and 230 meters, the value of the curve become small between 230 meters and 280 meters. Analysis it know that: five presbyopia drilling group of which distance to the open point is 80meters and 80meters that is located within the outline of the roadway, screening value is quite large, but appear overweight phenomenon two times. The distance to the open point 160meters and 160meters were designed spacing 4 meters, 5 meters and 6 meters drilling group respectively, the screening value of these three groups is relatively small compare with the five presbyopia drilling group, Because these three groups drainage borehole control scope is outside the roadway contour line beyond 8 meters, the control scope expanded, screening value is reduce. From the last three groups screen value can see: the screen value of which design spacing is 6 meters minimum, the screen value of which design spacing is 5 meters maximum. Because the drainage time of which design spacing is 6 meters is the longest, for 75 days,it's screen value is small. Dense drilling of which design spacing is 4 meters,the drainage time is so little, for 40 days, the screen value is relatively large compare with the design spacing is 6 meters.

#### 3.3.2 Comparative analysis on the average screen value

Through sorting the gas drainage data of the experiment site, From screen value of the same design group, accumulate the screen value for the same index and then averaged, analysis the average initial speed of gas emission get contrast diagram, the contrast diagram between maximum average quantity of drilling cuttings and average value of gas desorption index. As shown in figure 8 ,figure 9 and figure 10 respectively.

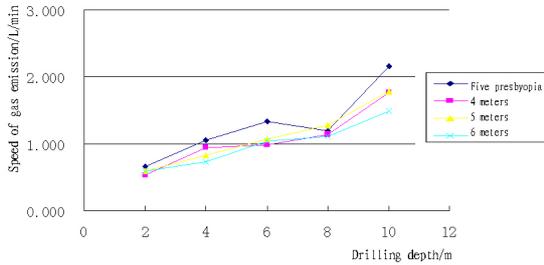


Figure 8 Average value contrast diagram of initial speed of gas emission

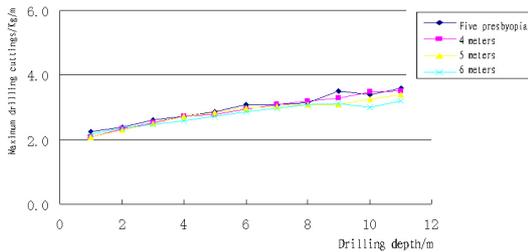


Figure 9 Average value contrast diagram of the maximum drilling cuttings

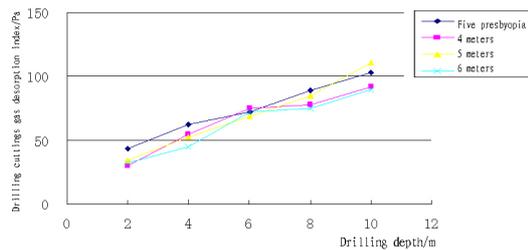


Figure 10 Average value contrast diagram of gas desorption index  
 By figure 8–10, each curve own growing trend, Maximum curve's value of five presbyopia drilling group is largest, curve's value of which the spacing is 6 meters is smallest. Screen value is change from small to large according to the change of drilling depth, because the coal seam outside the drill is near the tunneling section, Coal gas discharging pressure fully, screen value is relatively small; the deep coal seam of the drill is far away from tunneling section, coal gas discharging pressure is insufficiency. The screen value of five presbyopia drilling group is larger than other drilling groups, the screen value of which spacing is 6 meters is minimum, Its reason has already told, five presbyopia drilling group is located within the outline of the tunnel, screening value is a little big, control range of the other

three groups is beyond 8 meters outside the outline of the tunnel, the control range expanded, screen value become small. the drainage time of which design spacing is 6 meters is the longest, for 75 days, its screen value is relatively small.

#### 4. Conclusions

- (1) Through analysis on five presbyopia drilling group and other four drilling groups, obtain that effects of five presbyopia drilling group arrangement is the worst, it is not just relate to the holes arrangement, the most important reason is its control range is small, only control the contour line of the roadway.
- (2) Through the expansion of the side and the control range of the roadway, could not only make the screen value reduced but also detect the geology, hydrology and the thickness of the coal seam distribution, etc, it is good for adopting the corresponding measures timely and accurately, on the other hand can effectively intercept the gas emission to the roadway coal tunneling's working face. Reduce gas overrun phenomenon, avoid accidents.
- (3) Through analysis on the drainage time, tunneling size and screening index, through changing the arrangement of drilling group, improve drainage time can reduce the screen and increase tunneling speed. Tunneling speed of which spacing is 6 meters increased by 50% compare with the other three arrangement.

To sum up, design spacing is 6 meters, the relatively ideal drainage time is about 75 days. If add drilling density, ensure effective length of drilling, enlarge the hole diameter, improve drainage negative pressure, extend drainage time and improve the seal technology, drainage effect will be better.

#### References

[1] ZhuGuanghui, HanJianguang, HanZhen. Discussion on Outburst prevention and gas drainage technology[J]. Coal Mine. 2009, 18(1):49-50  
 [2] YuBaohai, LingZhiqian, LiuGuozhong. Optimization method of gas drainage borehole arrangement[J]. Coal mine safety, 2009, 36(3):25-27  
 [3] State Administration of Quality and Technical Supervision. The gas drainage standard (AQ 1027-2006) [M]. Beijing: China Coal Industry Publishing House, 2007.