ABSTRACT

Aiming at the problems of unreasonable mining plan, serious waste of coal resources, the material based on fly ash for filling the residual mining area was developed. Then the ground pulp system, underground transportation and filling system were designed. As a result the safe mining at old mining area was realized. The management technique provided a new way for resource integration mines with many abandoned roadways.

INTRODUCTION

The climax of establishing mines sprang up across the country during the early 1990s, and most of the mines were small coal pits\(^{[1-2]}\). Those small coal pits often used the backward mining methods such as knife-cylinder mining, driving on behalf of mining etc. So it leaded to the resource recovery rate lower than 30 percent. Shanxi Province conducted mergers and reorganizations for coal resources across whole province in 2009, and promoted fully mechanized mining technology. Whereas the residual mining area existed a lot of serious problems such as gas accumulation, water hazards and roof caving. So most coal mines had no choice but to abandon those resources. These random abandoned roadways cut up the integral coal resource, and made the integration mine can’t arrange an intact mechanized mining panel\(^{[3-5]}\). Therefore it’s very significant to take effect measures to filling the abandoned roadways in order to eliminate the problems above-mentioned and achieve safe production, meanwhile prolong the service length of mine.

TYPES OF ABANDONED ROADWAY

According to the presence situation of abandoned roadways at old mining area, the types of abandoned roadway are classified, respectively the intact, the top of coal caving, the top of coal and roof caving. Although the destruction extents of
abandoned roadways are different, they have a common character for a continuous space which can meet the condition of grout flowing. If filling the abandoned roadways, they require a low grouting pressure, and the filling area is concentrative. Due to the space of abandoned roadways is very large, the amount of filling is large. Hence, It’s suitable to take the management method of ground station. Whereas, some mines choose the way of forcing to pass or removing the equipments and excavating new workface to avoid the abandoned roadways. The former will face a serious security threats and it may be result in roof or gas accidents. The latter will leave over extra a lot of coal pillars bringing about a large of resources loss. Meanwhile, it also influences the normal mining schedule and expends large manpower and material resources. As for integration mines, the amount of coal resources for mining is very limited. If the abandoned roadways can’t be get effective management, it will make a bad influence on mine production in the long term.

**FILLING MATERIAL**

As the amount of filling material to backfill abandoned roadways is very large, the cheaper filling material should be researched in order to relieve the burden of the coal corporation. Due to there are large amount of inexpensive fly ash nearby, so fly ash is selected to be the main filling material, and the hydrated lime is chose as exciting agent. Then the experiments for searching reasonable compounding ratio of the filling material based on fly ash are conducted. The engineering of backfilling the abandoned roadways demand the filing material have a better flow ability, expansibility and consolidation strength. A better flow ability can meet the requirement of pump, and a proper expansibility and consolidation strength can meet the requirement of roof-contacted for filling body and well supporting the roof stratum.

After a large number of experiments in the laboratory, it’s found that the speed of hydration reaction of fly ash and hydrated lime is very slow after mixing under different implantation volume. The flow ability and consolidation strength can’t meet the requirement of engineering and normal mining schedule. So in order to achieve the goal of quick setting and strengthening, It’s necessary to research a auxiliary materials to stimulate the activation of fly ash. The auxiliary materials are made up of activator, accelerating agent, early-strength admixture, and expanding agent etc.

The optimal composition of filling material based on fly ash is obtained by experiment on the basis of studying the composition of fly ash and the excitation means of activation. The optimal composition of filling material is: fly ash with 80 percent, hydrated lime with 15 percent, auxiliary material with 5 percent, water cement ratio with 0.7:1. The basic indexes of filing material are that, the flowability of neat paste is 240mm on 30th minute after being made into grout, the expansivity are 2.4 percent on 24th hour, the uniaxial strength is 6.55MPa on the 90th day. With the time increasing, the filling material will form a three-dimension stereoscopic system structure, meanwhile along with the strength build-up. The condensation samples of filling material based of fly ash is shown in figure 1.
GROUND PULPING SYSTEM AND UNDERGROUND FILLING SYSTEM

The establishment of the ground filling system has many advantages. Firstly, it’s easy to establish filling site on the ground, because there is no restriction of the space. Then, it’s convenient for material storage, transportation and operation management. The complexity of the ground pulping system depends on the composition of the packing material. The material composition is simpler, the ground pulping system equipment is simpler. The whole ground pulping system is mainly composed of the loading system, feeding system, weighing system, mixing system, and the slurry storage system. Ground pulping station uses high-speed eddy current pulping system and uses combination of high speed centrifugal pump blades cutting and eddy mixing. It has the function of rapid mixing and rapid dumping. Two sets of mixing system work alternately, intermittent mixing and continuous dumping. The stability of pulping equipment operation and the continuity of the packing operation are guaranteed. The ground automatic pulping system is shown in figure 2.

The traditional ground pulping system has low automatic degree and mostly adopts manual controlling. The workers’ labor intensity is high and because the workers’ proficiency in operating is irregularity, the quality of grout is volatile, so the property stability of cementation cannot be guaranteed. The new type of ground pulping system is combined with electric and pneumatic. The monitor station shows the whole system running state by the data exchange with PLC. The centralized monitoring by convenient and reliable control room can be realized.
Through a predefined procedure, automation can be realized, which will greatly reduce the workers’ labor intensity. The system is configured to perform manual operation at the same time, in order to combine the two functions to deal with emergency situations. Through designing packing material proportioning and pulping parameters, a reasonable filling operation cycle diagram was formulated, so the efficiency of pulping is guaranteed.

The design of transportation and filling system decide whether the grout can flow into abandoned roadways or not. So it directly relates to the success and failure of filling work. It should reduce the utilization of variable-diameters, elbows, and valves etc, in order to avoid dead end of pipeline. The underground filling system is shown in figure 3. The filling technology for abandoned roadways can be divided into two procedures for the following:

1. Constructing the grout stopped walls and inserting the pipes filling
   - At first, it needs to construct the grout stopped walls at the ends of abandoned roadways which should be filling. Then it should be ejected cement concrete in order to avoid the filling material leakage. Secondly, utilizing the individual hydraulic prop as supplementary support measure. Then setting up two holes, one for filling and the other for observation. After arrangement of filling pipes, the grout will transport from ground to underground.

2. The checking and supplementing of filling effect
   - After the filling work being finished, it’s necessary to construct some borings for peeping to check the filling effect. If the effect of filling isn’t ideal or existing hollows area, it has to conduct secondary filling.

![Figure 3. The underground filling system.](image)

**SUMMARY**

Engineering practice shows that the ground station filling technology is effective to deal with abandoned roadways. In combination with the site system semi continuous mixing, continuous grouting and the rational circulation ratio, a pipe self conveying can be realized. The pulping system capacity can reach 60~80m3/h and it can realize automation control. After the governance of abandoned roadways, the mining workface drives smoothly and there are no roof or gas problems which influence on the normal production. Meanwhile the coal mining recovery rate is improved.
REFERENCES


