

Application of Green Mining Technology in Mining Engineering

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Abstract : Green mining technology is mainly oriented to resource protection and environmental protection, which promotes the coordinated development of social economy and ecosystem. Under the background of current green economy development, the exploitation of mineral resources also needs to be combined with green environmental protection technology innovation, which is an essential part of current mining technology development. As traditional mining techniques are limited, traditional construction operations can easily affect most of the surrounding geological environment, thus affecting the natural environment of the entire mining area. Therefore, the green mining technology is very necessary, can protect the environment on the basis of maintaining mining efficiency, but also conducive to the construction of our eco-friendly society.

1. Introduction

Target tracking technology has an important application value in both military and civil fields . In 1937, the first tracking radar station (SCR-28) appeared in the world . Since then, with the continuous development and progress of sensor technology, target tracking systems based on radar, laser, infrared and satellite appear more and more in various fields. Moving target tracking is a hot topic in many scientific research institutes at home and abroad, which involves advanced technologies such as control, signal processing and communication. Among them, this technology is also widely used in the intelligent workshop product tracking system.

2. Application Significance of Green Mining Technology

In the process of mining engineering, green mining is a key part, some operations need to use green mining technology, mainly in order to protect the ecological environment and achieve the full use of resources, avoid the problem of wasting resources ^[1] . Moreover, in the actual mining process, the waste generated will also be significantly reduced, and even some of the waste can be reused, not only can effectively reduce waste emissions, moreover, it can promote the economic benefit effectively and make the development of mineral industry pay more attention to the effective protection of ecological environment. China is rich in natural resources and has a long history of coal resource exploitation. In the process of mining coal resources, it is easy to affect the local natural environment, and it is also easy to appear the phenomenon of resource waste, and causing significant damage to the land itself. Therefore, the application of green mining technology is very important in the process of mining ore resources. However, in the process of actual mining, there are some uncertain factors that can affect mining efficiency and mining quality to different degrees. If green mining technology is used, these negative effects can be effectively controlled, it can also realize the effective protection of the environment and improve the safety of mining.

3. Environmental Impact of Mining Projects

3.1 Water Pollution

As for the coal resources themselves, most of them are located deep underground in the rock stratum. In the actual mining process, it is necessary to go deep underground to carry out operations, and it is easy to destroy the underground aquifer, as a result, underground water cycle have been significantly damaged, leading to a significant drop in water levels and damage to water resources.

Under the condition of continuous mining, the contaminated water can easily be discharged to the surface environment, which will seriously damage the surrounding vegetation system. At the same time, different levels of soil collapse may occur, causing obvious obstacles to the normal flow of surface water, causing rivers to dry up easily in arid environments, it has a direct impact on irrigation of nearby farmland.

3.2 Atmospheric Environmental Problems

The mining process of coal resources is very complicated, and it is easy to produce some harmful dusts, which affect the surrounding environment and air quality, and is also harmful to workers' health, it is easy to induce respiratory disease in workers. In addition, in the actual mining process, will produce some harmful gases such as CO₂, SO₂, resulting in varying degrees of ambient air quality decline. For example: CO₂ content is too high, very easy to cause the greenhouse effect, other kinds of acidic substances will further deepen the pollution of the environment. The formation of haze weather leads to reduced road visibility, increasing the probability of traffic accidents.

3.3 Land Resources Have Been Severely Damaged

In the process of coal mining, but also the land itself caused some harm. Mainly because in the process of mining coal resources, land resources are easily destroyed. For example, some areas are prone to obvious soil erosion problems due to mining work, and there will be large surface cracks and serious surface can cause loess collapse, large-scale landslides and other phenomena, all this has led to the clear destruction of land resources and even threatened the safety of people.

4. Application of Green Mining Technology in Mining Engineering

4.1 Water Conservation Mining Technology

In the process of mining coal resources, the use of water conservation technology can effectively improve the natural environment in the mined area, but also can significantly improve the safety of the mined area, in order to achieve the important goal of safety in production. The use of water-retaining mining technology, but also to effectively avoid environmental damage, will not affect the groundwater level. In the process of actual production and operation, it is necessary to fill and support the surface well and underground well according to the situation of the filling system, so as to avoid the subsidence due to the goaf, but affects the groundwater level and the groundwater quality. Among them, if the use of water conservation mining technology, can effectively avoid the actual mining process in the obvious subsidence or cracks, and can avoid the problem of large-scale loss of water resources.

At the same time, more strict and clear water recharge and control standards should be set to regulate water use, so as to ensure that in the process of mining coal resources, will not affect the groundwater level. And in the actual mining process, should guide all participants to establish a "Water conservation" awareness, so as to recycle water production, to avoid the problem of water waste. In addition, the closed-circuit method of wastewater treatment should be implemented, so that all the underground production wastewater and surface domestic wastewater can be treated to meet the reuse standard and be reused in the production water supply system. Thus, the pollution of waste water can be avoided in the actual mining process, and the water resources can be reused. A significant improvement in the level of water conservation will require the installation of dedicated centralized waste water storage facilities under mines and dedicated waste water treatment systems on the ground. When the underground waste water reaches a certain amount, it can be purified by the surface waste water treatment system, which can realize the reuse of water resources, reduce the damage to the environment and promote the sustainable development of coal mining

4.2 Filling Mining Technology

At present, there are three kinds of filling technology in China: paste filling mining technology, gangue (solid) filling mining technology and high water filling mining technology. Paste filling mining technology,

Paste (or similar paste) filling mining technology derived from: comprehensive mining paste filling technology, continuous mining filling paste filling technology, goaf grouting filling technology^[2]. With the development of filling mining technology, continuous mining and continuous filling can be divided into paste filling technology and "Drenching slurry direct mixing" filling technology, the main difference between the two processes is that the slurry preparation process is different, and the filling results are similar, the technology of filling paste coal mining is to make coal gangue or aeolian sand, fly ash, cement and mine water into paste paste without critical flow rate and dehydration treatment, adopting filling pump or gravity pressure, conveying through pipeline, filling goaf in time to control overburden rock, surface subsidence and digestion of waste rock solid mining methods. The paste filling mining technology includes three derivative technologies: (1) paste filling mining technology in fully mechanized mining, (2) paste continuous mining technology, (3) paste filling technology in gob of fully mechanized mining. The same point of three backfilling mining techniques is that paste is used as backfilling medium, the different point is the construction of underground backfilling area, backfilling technology and coal mining technology. With the expansion of filling volume and capacity, to improve filling efficiency, paste is generally built in the ground system. The typical paste filling system consists of five parts: filling raw material processing, batching and pulping, pipeline transportation, isolation and filling of filling area, and monitoring and monitoring system^[3]. Paste has low bleeding rate of filling material, high density of solidified body and high strength of filling body. Once filling, it can ensure the quality of top joint and has good control effect on rock movement and surface subsidence. The technology of fully mechanized mining with paste backfilling, adopting gangue paste as backfilling medium, filling space after coal mining technology forming face in fully mechanized mining face, through isolation of backfilling area, pumping or gravity flow backfilling, a filling mining technology, paste continuous mining and filling mining technology, also known as "Precision pulping" continuous mining and filling technology, which can realize coal resource recovery and solid waste treatment from three bottom to one top, the surface pulping technology is the same as the paste fully mechanized backfilling mining technology, but the difference lies in the construction technology of underground working face and backfilling area. The technology in the mining area up and down a wing layout to go to the long wall face, from the air inlet trough, return air trough, cut (return air lane) to form the whole face, the full negative pressure ventilation is realized by specially designed gateway and adjusting air door, and the mining is carried out by adopting the method of one remaining one (two) and fully separating mining. This technology is the main technology of continuous mining and filling. It has many advantages, such as simple filling system, high recovery rate, high construction efficiency of filling area, and so on. Paste goaf filling technology, similar to the yellow mud grouting technology, is the ground prepared paste through the form of pipeline pumping or gravity delivery to the working face goaf, a backfill mining technology is used to control the roof of goaf, prevent and extinguish fire and treat solid waste. This technology is mainly used in the condition that the regular filling face can not be arranged. The disadvantage is demanding conditions for the working face, and the filling process is still in the stage of optimization and perfection.

Gangue (solid) filling technology, The technology is to mine or ground gangue or other solid waste by crushing, to meet the requirements of the particle size filling, transport to the goaf or roadway for filling^[4]. According to the way of filling area construction, it can be divided into two kinds: full-mechanized mining with waste filling and mining technology and roadway with waste-throwing filling and mining technology. According to the way of conveying material, it is divided into mechanical transfer tamping, wind conveying technology and uncemented pumping technology. At present, the capacity of this technology is up to 2 million tons per year in China. Gangue filling system generally consists of the following four parts: material preparation, transportation, working face filling and monitoring and monitoring system. The common

mechanized solid filling process is characterized by the use of special tools (such as gangue throwing machine) to cast the gangue into the goaf for filling. Comprehensive mechanized gangue backfilling mining technology is to realize comprehensive mechanized gangue backfilling operation at the same time of comprehensive mechanized coal mining face mining, through the research and development of high-efficiency mechanized coal mining face with tamping mechanism of gangue filling hydraulic support, gangue filling machine and other equipment, gangue leakage into the shield space and to the goaf compaction filling mining method..The technology has been applied in Tangkou coal mine, Tingnan coal mine, Bayangol coal mine, etc. . The key technology is to develop gangue filling hydraulic support and gangue filling machine. The function of the hydraulic support filled with gangue is to realize the coal-mining operation in front of the support and the coal-filling operation in back of the support. Gangue filling hydraulic support is mainly composed of top beam, telescopic beam, column, base, tail beam, tail beam adjusting jack, tail beam hanging under the backfill scraper conveyor and ring chain, tamping mechanism, etc. The main difference between the support and the traditional hydraulic support lies in three aspects: removing the shield inclined beam of the traditional hydraulic support, replacing the horizontal short beam, and leaking the gangue directly into the space under the shield of the horizontal short beam; Second, in the horizontal short beam suspension scraper conveyor, forming a continuous transport gangue channel; third, gangue by weight from the hole into the cover cover space, and then use a special tamping mechanism to pressure the gangue to the goaf compaction. The chute of gangue filling conveyor is suspended under the tail beam by four round chains, the hanging round ring chain is connected with the lifting rings on both sides of the chain, and the chute plate is provided with a filling gangue leakage hole. Filling from the end of the gangue filling machine to the end of the direction of filling, that is, first open the self-pressing gangue filling machine head the first plug for “Free fall”, “Self-filling tamping” filling, when the gangue piles up to 200mm away from the conveyor, close the first plate, open the second plate, repeat the above work; Carry out the”Full tamping” phase. This technology has the advantages of relatively simple system, high mechanization, easy operation, low initial investment of filling system, no use of cement, relatively low cost per ton of coal filling, goaf solid filling rate of 50-75% .High water filling mining technology,The high-water quick-solidifying material is used for underground filling. The high-water material is composed of A and B solid powder. A by aluminate or sulphoaluminate with a variety of retarding and adjusting the role of the admixture composition. B mainly by gypsum, lime, clay with coagulant composition. A and B material respectively add a certain amount of water to make mortar. After mixing in a certain proportion. It can condense into a solid in a short time. When filling, the high-water material is sent to the goaf through the conveying pipeline. After the formation of solid to the effect of goaf filling

5. Rock Drilling and Blasting Technology

In the process of mining, rock drilling and blasting technology can greatly improve the efficiency of mining, rock drilling and blasting technology in the mining efficiency has a very key role[5] . At present, the rock drilling and blasting technology used mainly includes the development trend of manual rock drilling, pneumatic rock drilling, hydraulic rock drilling machine and rock drilling robot, the current drilling technology has been moving towards intelligent and automatic development direction. After a long period of development, various countries have now developed drilling devices that can meet different environments, for example, in the United States, Canada and other countries, in the process of mining mineral resources, flexible use of open-air rock drilling and blasting technology. According to the current development, the medium-deep hole sublevel drilling has been gradually mature, and the large-diameter stage of deep hole began to be more widely used. For example, the safety and working efficiency of the drilling rig invented by Sweden have been improved obviously, and the pollution is obviously lower, the operation is relatively simple, and the advantages are obvious. At present, our country has also invented some all-computer three-arm rock drilling trolley which can complete mobile operation, explosive loading and other multifunctional integration. In the actual mining process, we can try to use these new equipment, it can effectively improve the working efficiency, improve the quality of rock drilling,

reduce a series of safety risks in the driving process, and promote the intelligent mining technology gradually.

6. Application of Gob-side Entry Retaining Technology

6.1 Cutting the Roof and Relieving the Pressure and Retaining the Roadway Along the Goaf

The gob-side entry with cut-roof and pressure-relief is supported by cut-roof and pressure-relief + constant resistance and large deformation anchor cable, and pre-split blasting can well protect the integrity of the roadway roof^[6]. Using constant resistance large deformation anchor cable to strengthen, control the roof subsidence, so that the left roadway wall rock can maximize its own bearing role, reduce the deformation of the roadway to ensure the effect of retained roadway. In the process of working face advancing, the retained roadway will be affected by dynamic pressure to some extent, and the corresponding temporary support measures should be taken for the retained roadway. The gob-side entry retaining by cutting roof and relieving pressure is mainly divided into pre-split seam of roof, constant resistance and large deformation anchor cable support and temporary support. Pre-splitting seam in the roof: adopting the pre-splitting technique of two-way shaped charge blasting, the specific specification of explosive is loaded in the energy gathering device with the effect of energy gathering in two set directions. After the explosive detonates, the surrounding rock of the blast hole is uniformly compressed in the non-set direction, but in the set direction is concentrated tension, depending on the rock compression and tension characteristics, so that the rock in the set direction of tension and shape, so that the blasting body in the set direction of tension and shape. This blasting technology is simple in construction, and the detonation products will form energy flow in two set directions, produce concentrated tensile stress, and make the pre-split hole run through along the direction of energy accumulation to form a pre-split surface. Because the rocks between the boreholes are directionally fractured, the unit explosive consumption will be greatly reduced, and because of the protection of the energy gathering device to the surrounding rock, the damage of the rock around the borehole will also be greatly reduced, it can achieve pre-split and protect the roadway roof at the same time. Constant resistance and large deformation anchor cable support: before pre-splitting and cutting the roof of roadway, constant resistance and large deformation anchor cable is used to reinforce and reinforce. In order to make the constant resistance anchor rope play a better hanging role in the course of retaining roadway, and protect the anchor end effectively. The density of constant resistance anchor cable reinforcement support is generally 1 ~ 2 anchors per meter, and it is more advantageous for roof support that the constant resistance anchor cable is mainly arranged at the cutting seam side. Combined with the original support form and parameters of the roadway, the constant resistance and large deformation anchor cables are arranged perpendicular to the direction of the roof with two rows, the first row of constant resistance anchor cables is 500 mm away from the main side of the retained roadway with a row distance of 1000 mm, the second row is arranged in the middle line with a row distance of 2000 mm, and the second row is arranged in the middle line with a row distance of 2000 mm. The first row of constant resistance cables are connected with adjacent cables by W steel strips parallel to the roadway strike. Temporary support in roadway: two rows of advance support are carried out from the working face to the coal wall within 20m (advance support area), along the groove to the two sides laid 2.6 m π beam, to use, remove a frame, support a frame, advance support column, beam must be a straight line. The distance between the upper support pillar and the upper support is 1.0 m, which is used as the sidewalk. In the influence area of 0-160m (temporary support area) behind the support frame, the single hydraulic prop and π beam are mainly used to carry out the post-support, and four single prop are arranged in each row, with a distance of 1000-1200mm, it is mainly arranged at the cutting seam side of the roadway. The first row of single pillar is 200 mm away from the seam line, the second row is 700 mm away from the seam line, the third row is 100 mm away from the middle line, and the fourth row is 1000 mm away from the solid coal wall. In order to prevent the gangue from leaping into the roadway in the goaf, the gangue retaining support is needed. The combined retaining gangue support is carried out by using steel

mesh and extensible 25 # U-shaped steel. The spacing of U-shaped steel is 500 mm, and the upper and lower sections of U-shaped steel are lapped with the retractable joint, the length of the U-shaped steel can be adjusted according to the height of the tunnel. Two pairs of Kalland are used to connect the U-shaped steel. The upper and lower edges of Kalland are 50mm apart from the overlap ends of the U-shaped steel, and the overlap length is more than 1m. 25 # U-shaped steel shed buried in the bottom not less than 200mm, adjacent retractable 25 # U-shaped steel connecting rod can be used to increase the overall stability. The steel mesh adopts welded steel mesh with diameter of 6 mm, the top plate steel mesh is tied together, the size of the steel mesh is 3000 * 1000 mm, the overlap between the steel mesh and the steel mesh is 100 mm, and is tied up with iron wire, the reinforcing bar net is lapped with the original supporting metal net. If there is more gangue leakage, reinforcing steel mesh to increase the diamond-shaped metal mesh to strengthen the gangue retaining support.

6.2 Concrete Wall Along the Empty Lane

Concrete wall gob-side entry retaining is to brush width of 2m along the track and groove direction in the face from the roadway slope to the working face before mining, and to support the roof by the way of bolting mesh and cable and beam support, after pushing the working face, a beam, three columns and the roof of steel shed support are set behind the support frame, followed by vertical formwork pouring concrete wall behind the support frame. Brush width support: $\Phi 20\text{MM} * 2000\text{mm}$ bolt is adopted, the distance between the bottom side is 500mm, the rest is 700mm, and a diameter $\Phi 21.8 \text{ mm} * 8000\text{mm}$ anchor cable is set every 2.7 m along the strike in the middle of brush width. Post support: follow the back of support with single hydraulic prop support beam three-column inclined shed, shed 550mm, column distance 1000mm, at the same time in the next side supporting a beam three-column and steel shed support roof, column distance equivalent shed distance. Concrete Wall: the size of wall is 1800mm on top and 2000mm on bottom. After the goaf is compressed periodically, the size of wall is adjusted to 1500mm on top and 1600mm on bottom. Anchor rods are arranged in the concrete wall according to 800 * 800mm spacing, in order to increase the strength of the wall, screw nuts, iron pallets and W pallets are arranged from outside to inside of the formwork. The concrete wall circulation footage is 2m. The ratio of concrete is cement: sand: gravel = 1:1.5:1.5. In order to improve the initial strength of the wall, 2% of the weight of the cement is added into the cement.

6.3 Retaining Roadway Along Goaf with Flexible Formwork Support

The flexible formwork concrete is used as the support body beside the GOAF, the width is 1.2 m, and is arranged in the roadway along the edge of the GOAF, in order to prevent the coal and gangue from destroying the support body near the roadway, to ensure the integrity of the roof of the area to be poured at the end, and to provide sufficient working space for the support body near the roadway, it is very necessary to strengthen the support of the end-head roof, the end-head of the working face and the lead-lag roof. In the mining face, the top-coal caving is not allowed within 5m of the upper and lower ends, and the non-top-coal caving section is strengthened. During the advancing process of the working face, a double-layer metal net is laid between the three end supports and the roof, and the metal net is laid along the edge of the coal wall of the working side. A $\phi 21.8 \times 8000\text{mm}$ anchor cable is installed at the distance of 0.4 m from the edge of the coal wall behind the support, and the anchor cable is perpendicular to the roof of the roadway with a row distance of 0.6 m. At a distance of 0.8 m from the edge of the coal wall of the working wall, two wood-point columns and one single hydraulic prop are alternately set and operated in the sequence of setting two wood-point columns and one single hydraulic prop with a distance of 0.3 m, single hydraulic prop is 0.9 m apart, and when single hydraulic prop or wooden pillar is installed, the top of dense pillar is protected by half-round timber beam of 0.5 m long, with timber beam spacing of 0.6 m and one end of timber beam facing goaf, one end is close to the anchor tray. With the advance of the working face during the coal cutting in production shift, the temporary strengthening support is carried out in the space to be poured by using single hydraulic prop and 2.0 m π beam. One beam and three columns are separated by 0.8 m, π beam is perpendicular to the advancing direction of the

working face, every time the working face advances 0.6 m, a row of single hydraulic prop is arranged at the back of the support, and the distance is 0.6 m. When the inspection and repair team hanged the mould, they withdrew the π -type beam and the middle single hydraulic prop, and supported the single hydraulic prop on both sides along the space to be poured, then hung the flexible mould, the single hydraulic prop was 0.6 m apart, one of the goaf side of the single hydraulic prop at the bottom of the steps.

7. Waste Treatment Technology

In the actual mining and operation, the gangue produced in the mining process needs to be treated, which can promote the exploitation rate of mineral resources effectively, and can also avoid the problem of the surface environment being destroyed, in order to obtain higher economic benefits. At present, there are two ways to recycle gangue: first, as a building material, so as to control the construction cost; second, can extract the metal elements in gangue, improve its own efficiency.

8. Conclusion

At present, the state pays more and more attention to the ecological environment protection, and puts forward the updated request to the mining operation, and the appearance of different green mining technologies provides important technical support and development direction for the development of various green mining. From the current use of a variety of different green mining technology, has been implemented in the production and operation of mining projects, and achieved good results. In the process of practical use, it is necessary to consider the basic conditions and specific objectives of mining engineering, select the most reasonable green mining technology, and give full play to its own value.

References

- [1] Yu Tao. Application of green mining technology in mining engineering [J]. Shanxi metallurgy, 2022(002) : 045.
- [2] Liu Shihu. Application of green mining technology in mining engineering [J]. World Non-ferrous metal, 2022(005) : 000.
- [3] Liu Shunguang. Study on the application of green coal mining technology [J]. Innovation and application of science and technology, 2021,011(012) : 173-175.
- [4] Yu Haidong. Study on the application of green mining technology in mining engineering [J]. China Science and Technology Journal Database, Industry A, 2021(11) : 3.
- [5] Wang Chengdong. This paper discusses the application of green mining technology in mining engineering [J]. China Metals Bulletin, 2022(10) : 16-18.
- [6] Yau Yiu-lung. This paper discusses the application of green mining technology in mining engineering [J]. Engineering Technology of Chinese sci-tech Journal Database (full text), 2022(11): 4.