Application of modern mining technology in mining engineering

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Abstract: Modern mining technology, with its characteristics of high efficiency, safety and environmental protection, has gradually become a research hotspot in the field of mining engineering. These technologies can not only effectively improve the mining rate of mineral resources, reduce production costs, but also reduce the impact on the environment, to achieve the harmonious coexistence of mining and ecological environment. Under the background of the current global resource shortage and increasing environmental pressure, the research and application of modern mining technology has important strategic significance for realizing the sustainable development of mining industry. However, the application of modern mining technology also faces some challenges and problems. For example, the rapidity of technological upgrading, the complexity of equipment maintenance, and the high requirements of safety production all need us to carry out in-depth research and discussion. Therefore, this paper expounds the modern mining technology and its characteristics, and analyzes the application strategies of different technologies in mining engineering, hoping to provide useful reference for the practice in the field of mining engineering.

Keywords: Mining process technology; mining engineering

Introduction

In the long river of the development of human society, mineral resources have always played a vital role. Whether it is steel, non-ferrous metals, or energy minerals, they are all important cornerstones to support national economic construction and social development. However, with the depletion of mineral resources and the increasing difficulty of mining, the traditional mining technology has been difficult to meet the needs of modern mining engineering. Exploring the application of modern mining technology in mining engineering is of great significance for improving mining efficiency, ensuring sustainable utilization of resources and promoting the healthy development of mining industry.

I. Overview of modern mining technology

In the past course of economic development, traditional mining technology has played a key role, but it has also exposed some shortcomings. Due to the limitation of the technical base and the lack of professional human resources, the traditional mining technology often cannot fully and effectively excavate mineral resources, and only can touch some areas of the deposit, which causes the loss of resources, increases the mining cost and reduces the economic return. In view of this, it is very important to introduce modern mining technology in order to realize the sustainable development of mineral resources. In addition, traditional technologies often have adverse effects on surrounding soil, water resources and air quality, contributing to the destruction of ecosystems and loss of biodiversity. Therefore, modern mining technology should emphasize the concept of environmental protection and minimize the damage to the environment through scientific mining area planning, implementation of soil and water conservation strategies and proper disposal of tailings. Taking into account the characteristics of all kinds of minerals and the differences in the mining environment, modern mining technology should pursue diversification, integrate physics, chemistry, biology and other multidisciplinary knowledge, and customize adaptable technical strategies for different types of mineral resources. At the same time, technological innovation should be strengthened, and mining technology should be continuously improved and upgraded to enhance the efficiency and economic benefits of resource mining.

II. The characteristics of mining technology

1. Adapt to mining conditions and change technological means

In view of the diversity of various mining conditions, the technical application of mining operations needs to be flexibly adapted. For example, waterflooding is widely used in the field of oil extraction to mitigate the impact on groundwater resources and geological structures. With the rational application of this technology, the quality of resource exploitation can be ensured, the damage to formation structure can be reduced, and the stability of formation can be enhanced.

2. Select the technology according to the distribution of resources and regional characteristics

The distribution of mineral resources in China presents the characteristics of rich in the west and poor in the east, and this pattern is difficult to change in a short time. Therefore, the mining technology should be selected according to local conditions and the geological structure characteristics should be fully taken into account in mineral exploitation. Only by closely combining the specific geological conditions and selecting the appropriate technology can we ensure the smooth mining operations, avoid adverse effects on regional industrial production and farmland construction, maximize the potential of resources, and promote the sustainable progress of regional economy.

3. Personnel adjustment to achieve a good application of technology

The mining industry has a high turnover of personnel, which requires careful planning of manpower allocation. According to the distribution of mineral resources and the unique needs of mining equipment, the professional skills of employees should be accurately

divided to ensure that they can play their strengths and effectively promote the application of process technology. In addition, regular professional skills training is also critical. Through continuous learning, mining personnel can keep abreast of the latest technical knowledge and improve their professionalism and operational skills. This not only helps to meet the ever-changing engineering challenges, but also improves operational efficiency, reduces safety risks and provides a solid guarantee for the efficient implementation of process technology.

III. The application strategy of modern mining technology in mining engineering

1. Caving mining technology

This technology is mainly divided into two strategies: first, unbraced continuous caving method. This technology relies on highly advanced mechanized operation and precision equipment, which significantly reduces labor requirements and production costs. Unlike traditional mining methods, it does not need bottom support, but cleverly exploits the stability of the rock formation itself. By breaking down the rock layer by layer, this method increases efficiency and reduces the need for manual intervention. Second, the braced sublevel caving method. This requires fine adjustment of certain key parameters, such as the spacing between the funnels and the height of the supporting columns. Proper funnel spacing helps control the caving rate and uniformity of ore distribution, ensuring a stable mining process. In general, the support column height is set between 7 meters and 13 meters, but the actual operation needs to be fine-tuned according to the specific geological conditions. At the same time, it is important to manage the stability of the rock structure below the support column to prevent potential threats to the overall mine structure.

2. Open pit mining technology

As the mainstream means in mining operations, open-pit mining technology only refers to the mining of mineral resources in open areas on the surface. However, because many large mines are located in harsh geological environment, open pit mining faces severe challenges and safety risks. In order to cope with these risks, effective measures must be taken to prevent disasters such as ground slippage and rock mass caving, and minimize the impact of mining activities on the surrounding environment. This includes the use of geological reinforcement techniques to stabilize slopes and rocks, the design of sound drainage systems to manage precipitation and groundwater, and the establishment of comprehensive environmental monitoring systems. At the same time, the application of cutting-edge equipment such as laser scanners, remote sensing technology and automation equipment can improve the level of production automation and operational accuracy, and reduce the impact of human error on mining operations. In the planning of mining strategy, it is necessary to take into account the distribution of resources, geological characteristics and economic benefits, flexibly adjust the mining sequence, change the mining strategy, or introduce innovative mining technology to adapt to the characteristics and changes of different deposits.

3. Open stope mining technology

In recent years, with the continuous development of coal mining technology, open stope mining technology has gradually received attention and been widely used because of its efficient and high-quality mining effects. The technology divides the mining area into two parts: pillar and chamber, following the order of first mining pillar and then mining chamber, so as to realize effective mining of resources. If the structural stability of the mining area is poor, it is usually chosen to open only the mining room to ensure the safety of the mining operation. In the mining process of the mining room, the reasonable use of surrounding rock and pillar for support is crucial, which helps to ensure the smooth progress of mining work, and prevent coal seam collapse and support structure damage. After the completion of mining, the proper treatment of the goaf is also indispensable. Methods such as filling and setting supports can be adopted to prevent the goaf collapse and surface settlement, and maintain the safety and stability of the mining area.

4. filling mining technology

In coal mine safety mining, filling mining technology plays a core role, its purpose is to effectively use the goaf and maintain the stability of underground mining environment. Filling the gob with filling materials can enhance its support and ensure the safety of mining operations. The choice of filling method will be based on the specific structure and mining direction of the coal mine, such as dry filling method, through the conveying equipment to sand and stone materials directly into the goaf, although practical, but the cost is high, the process is complex, low efficiency. The water-sand filling law mixes slag and tailings into the goaf, reducing the risk of surface settlement and providing better underground support, but the drainage cost is high, the process is complex, and the filling amount is limited. The cementing filling method is to mix lime, cement, tailings, gravel, etc. into paste, and send it into the goaf through the pipeline pump. It is easy to operate, high filling efficiency, and large filling amount, so it is widely adopted. However, the main challenge facing the cementing filling method is the insufficient supply of tailings.

5. Leaching mining technology

Leaching mining technology is an innovative mining method that relies on the physical and chemical properties of minerals to treat deposits with specific chemical solutions to efficiently extract valuable elements and optimize resource utilization while improving extraction efficiency and yield. The technology is widely used for its economy, advancement and environmental protection, which can excavate mineral resources more effectively and reduce the impact of mining on the environment. Compared with traditional methods, it has significant advantages. To implement this technology, it is necessary to precisely plan the well site, set the specifications and layout of the well, then drill the hole and install the facility. The configured leaching solution is then injected into the borehole to dissolve the target element from the ore. After that, the leaching solution is recovered and goes through an adsorption and washing process to ensure the purity and recovery of the extracted elements. The concentrated product is extracted through steps such as precipitation and filtration, while the waste water is

properly treated to comply with relevant regulations.

6. Rock mass reinforcement technology

In mineral mining, safety issues are of Paramount importance, and accidents often result from factors such as operational errors, complex geological conditions and unstable rock structures. In order to reduce accidents, advanced rock reinforcement technology should be adopted. The core objective of such technologies is to enhance rock stability and reduce large-scale rock slippage to ensure personnel safety. The choice of reinforcement method should be based on the specific situation, and can adopt targeted or standard reinforcement measures. Standard reinforcement usually includes anti-seepage curtain drilling and split method. Impermeable curtain drilling is done by drilling into the rock and injecting materials such as cement slurry to form a impermeable layer that enhances rock stability and is suitable for general geological conditions to help prevent rock breakage and collapse. The division rule is to drill a series of equidistant holes on the rock surface, insert reinforcement and other supporting materials, build a stable structure, enhance the overall strength and stability of the rock, and effectively avoid fracture and collapse. Targeted reinforcement is designed for the specific situation of the rock, which may require more drilling holes through the weak surface of the rock to further improve the stability of the rock and reduce the possibility of accidents.

7. Mining technology of steep coal seam

Steep coal seam mining technology is a key technical method for mining large dip coal seams. In practical application, the mining process is full of challenges due to the characteristics of large dip Angle and poor stability of coal seam. In order to cope with these challenges, we must establish a set of scientific and reasonable planning system, so as to ensure the quality and effect of coal mining operations to achieve the best. In the application of steep coal seam mining technology, we must first of all have a deep understanding and understanding of the environment of the mining area. This includes geological conditions, coal seam occurrence state, gas content and many other factors. Only by fully mastering this information can we determine the appropriate scale and scope of coal mining according to the actual situation and avoid the risks caused by blind mining. At the same time, we also need to optimize the production structure and improve the efficiency of coal mining according to the production environment and equipment. This includes the selection of suitable mining machinery, the formulation of reasonable mining technology, strengthening site management and other aspects. Through these measures, we can create a safer and more reliable production model, which provides a strong guarantee for the smooth progress of coal mining operations. In addition, mine ventilation is also an important part of steep seam mining technology. Good ventilation conditions can not only ensure the health of operators, but also effectively reduce the risk of accidents such as gas accumulation. Therefore, we must ensure the normal operation of the mine ventilation system to provide a safe and comfortable environment for coal mining operations.

IV. Concluding Remarks

To sum up, mining engineering, as a complex system engineering, involves geological exploration, mining design, mining technology, safety production and many other aspects. The application of modern mining technology needs to comprehensively consider the geological conditions of the mining area, the occurrence state of resources, the scale of mining and other factors, select the appropriate mining technology, formulate a scientific and reasonable mining plan, further promote the modernization of mining engineering development, improve the quality and efficiency of mining engineering operations.

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