Problems and countermeasures of underground mining technology in coal mine

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Keywords: underground coal mine; mining technology; there are problems; problem countermeasure

Abstract: Underground mining technology of coal mine is a crucial link in the process of coal mining, which has a direct impact on the production efficiency, safety and economic benefits of coal mine. With the depletion of coal resources and the increasing mining depth, underground mining technology is facing increasingly severe challenges. Despite the continuous progress of modern technology, underground mining in coal mines still has many problems, such as frequent equipment failures, imperfect ventilation systems, high risk of gas explosions, and harsh working conditions for miners. These problems not only affect the production efficiency, but also pose a serious threat to the life safety of miners. Therefore, it is particularly important to study and solve the problems existing in underground mining technology and put forward feasible countermeasures. This paper mainly analyzes the problems and countermeasures of underground mining technology in coal mines.

1. Introduction

Underground mining technology is an important part of coal industry, and its development is directly related to the safety and efficiency of coal mine production. However, with the gradual depletion of resources and the increase of mining depth, the challenges faced by underground mining in coal mines are becoming increasingly prominent. At present, there are many problems in the practical application of underground mining technology, such as insufficient reliability of mechanical equipment, low efficiency of ventilation and drainage system, imperfect gas control and fire prevention measures, and the working environment and safety of miners need to be improved. These problems not only limit the production capacity of coal mines, but also pose a serious threat to the safety of miners. In view of this, it has become an urgent need to improve the overall level of coal mining industry to study the problems existing in underground mining technology and put forward corresponding countermeasures.

2. Problems in underground mining technology of coal mine

2.1 Insufficient reliability of mechanical equipment

The reliability of mechanical equipment is the most important thing in underground mining operations, but there are still many shortcomings in this field. First of all, the coal mine environment is harsh, high temperature, high pressure and high humidity conditions to the normal operation of mechanical equipment has brought great tests, making the equipment more prone to failure or damage. At the same time, coal dust, gas and other factors will also accelerate the aging process of mechanical equipment, shorten the service life. Secondly, the coal mining operating environment is complex and changeable, and the mechanical equipment needs to be moved and adjusted frequently, which is highly susceptible to collision and vibration in the process, affecting the reliability of the equipment. Moreover, the occurrence conditions of coal seams vary greatly, and the existing mechanical equipment may be difficult to cope with the operation under some special geological conditions [1]. In addition, there are also some problems in the maintenance of mechanical equipment. Due to the cyclical impact of mining operations, many equipment cannot be repaired in time after high-intensity use, resulting in increased failure rates. At the same time, the professional quality and maintenance experience of the maintenance personnel are uneven, and the

  DOI: 10.25236/icceme.2024.042

equipment cannot be maintained and maintained in place. In addition, some coal mines are still using outdated mechanical equipment, and the reliability of the equipment itself is low. For the imported advanced equipment, due to the lack of supporting management mechanism and talent team, it is often difficult to give full play to its due performance. In general, the reliability of mechanical equipment is not enough to become an important factor restricting the efficiency and safety of underground mining operations in coal mines. It is necessary to improve the reliability level of coal mine machinery and equipment from improving the quality of machinery and equipment itself, optimizing the operating environment conditions, strengthening maintenance and other aspects.

2.2 Low efficiency of ventilation system

The low efficiency of underground ventilation system in coal mine has always been a bottleneck problem restricting mining operations. First of all, coal mine underground space is narrow, roadway crisscross, air circulation is difficult, it is difficult to form an efficient ventilation circulation system. At the same time, coal mining operations will constantly change the underground space structure, disturb the original ventilation pattern, and need to adjust the layout of ventilation system frequently. Secondly, coal mining process will produce a lot of waste gas, dust and toxic gases, if the efficiency of the ventilation system is not good, these harmful substances will accumulate in the mine, seriously harm the health of miners, and may lead to gas poisoning, coal dust explosion and other major safety accidents. Especially in some old coal mines, the ventilation facilities are seriously aging, and the ventilation capacity is very limited. In addition, the control ability of ventilation system for air volume, air pressure and ventilation resistance is also weak. The demand for ventilation in mining operations will change at any time, but many ventilation systems cannot be adjusted in time, resulting in "excess ventilation" or "loss of air" and so on, wasting a lot of energy. At the same time, the unreasonable arrangement of the ventilation system will also increase the wind resistance and reduce the overall efficiency. In addition, because the ventilation system is complex and the maintenance workload is large, if the management is not good, the failure rate of the ventilation equipment will increase. Once a critical ventilation facility fails, the entire system can be paralyzed, which can have a serious impact on operations. In general, the low efficiency of the ventilation system not only affects the safe production of coal mines, but also increases energy consumption and operating costs. It is necessary to strengthen the technical innovation and intelligent transformation of the ventilation system, improve the monitoring and early warning mechanism, and strengthen equipment maintenance, so as to improve the overall ventilation efficiency.

2.3 Drainage system problems

In underground mining operations in coal mines, the problem of drainage system has always been a big problem. First of all, coal mining process will produce a large number of mining wastewater, if the drainage system is inefficient, the wastewater will be a large amount of accumulation in the mine, not only affect the normal production operations, but also may lead to flooding, roof collapse and other major safety accidents. Secondly, the complexity of coal seam occurrence conditions also brings great challenges to the water supply and drainage system. Some coal seams have very high water content, which is easy to cause instability of coal wall when encountering water. Some coal seams are dry and need to prevent geological disasters such as ground collapse caused by excessive pumping. The requirements of drainage system for different coal seam conditions are very different. In addition, there are many problems in the construction and maintenance of the drainage system itself. The layout of underground pipe network is chaotic, the selection of pipe material and size is improper, the anti-erosion ability is poor, and it is easy to clog. The selection of pump is not reasonable, and the pumping capacity is limited; Drainage ditch seepage prevention measures are insufficient, and a large amount of water resources are wasted. At the same time, the automation and intelligence level of the drainage system is low, and the monitoring and warning means are single, and the hidden dangers can not be discovered in time. In addition, the daily operation and maintenance of the drainage system urgently needs to be

strengthened. Due to the harsh environment, the equipment failure rate is high; The professional skills of field operators need to be improved, and the ability of system optimization and debugging is insufficient; The control of key links such as corrosion prevention and seepage prevention is not strict, resulting in a large number of secondary pollution problems. In general, drainage system has become an important factor affecting coal mine safety production and resource utilization efficiency. It is necessary to control from the source, optimize the system layout, strengthen the automatic transformation of equipment, strengthen personnel training and management, and effectively solve this problem.

3. Solutions to problems existing in underground mining technology in coal mines

3.1 Improve the reliability of mechanical equipment

Improving the reliability of underground mining machinery and equipment is the key measure to ensure the production efficiency and safety of coal mines. The lack of reliability of equipment often leads to frequent downtime, which not only affects the production schedule, but also may bring security risks. Therefore, it is necessary to take comprehensive measures from many aspects to improve the reliability of equipment. First of all, the introduction of advanced equipment is the primary way to improve the reliability of mechanical equipment. Modern mining equipment is designed and manufactured with greater emphasis on durability and adaptability, and can better cope with the complex working environment underground. The introduction of internationally leading mining equipment can significantly reduce the failure rate of equipment and improve production efficiency. For example, high-efficiency hydraulic supports, shears and scraper conveyors have obvious advantages in terms of wear resistance, corrosion resistance and stability. Secondly, strengthen the maintenance of equipment. The maintenance of equipment is directly related to its service life and failure rate. The key measures to ensure the reliability of the equipment are to make a detailed maintenance plan and regularly overhaul and maintain the equipment. Specific measures include: according to the operation of the equipment and manufacturer's suggestions, develop a scientific maintenance cycle; Set up equipment files, record the operation, maintenance and failure of equipment, analyze the failure causes, and take targeted improvement measures; Focus on monitoring and preventive replacement of vulnerable parts to avoid equipment failures caused by damaged parts. In addition, improve the skill level of operators and technicians. The skill level of operators and technicians directly affects the device running status and troubleshooting capability. Therefore, you need to regularly train operators and technical personnel to improve their operation skills and troubleshooting capabilities. The training content should include the basic operation specifications of the equipment, the identification and treatment methods of common faults, and the maintenance knowledge of the equipment. Through training, improve personnel's operation level and emergency handling ability, and reduce equipment failures caused by improper operations. At the same time, advanced monitoring and management systems are introduced. The modern monitoring and management system can monitor the operating status of the equipment in real time and discover potential faults in time. By installing sensors and monitoring equipment, the temperature, pressure, vibration and other parameters of the equipment are monitored in real time. Once there is an anomaly, the system will immediately alarm and remind the operator to take corresponding measures. In this way, timely intervention can be carried out before the failure occurs to prevent the expansion of the fault [2].

3.2 Optimize the ventilation system

The downhole ventilation system is not only responsible for providing clean air, but also for removing harmful gases and controlling ambient temperature and humidity. At present, many coal mine ventilation systems have problems such as uneven ventilation and gas accumulation, which seriously threaten the life safety of miners and smooth production. Therefore, the optimization of ventilation system needs to be comprehensively considered from the aspects of scientific design, equipment upgrading, real-time monitoring and management system. Firstly, scientific design of

ventilation network is the basis of optimization of ventilation system. The design of underground ventilation system should fully consider the geological conditions, roadway layout and production requirements of the mine. Proper ventilation network design should ensure that fresh air can evenly cover all working areas and effectively expel harmful gases. In the design process, the ventilation path and air volume distribution can be optimized with the help of computer simulation technology to ensure uniform ventilation in each area. In addition, the necessary ventilation zones should be set up, the air volume of different areas should be flexibly adjusted, and the ventilation strategy should be timely adjusted according to the production needs to avoid the problem of excessive or insufficient ventilation in some areas. Secondly, improving the performance of ventilation equipment is an important measure to ensure the efficient operation of ventilation systems. Modern ventilation equipment, such as energy-efficient main fans, local fans and ventilation ducts, has higher air volume and air pressure output capacity, which can significantly improve the ventilation effect. When selecting equipment, equipment with stable performance and high energy efficiency should be selected to ensure that it can remain in good condition during long-term operation. In addition, the ventilation equipment should be repaired and maintained regularly to detect and deal with equipment faults in a timely manner to avoid ventilation interruption caused by equipment faults. In addition, real-time monitoring of ventilation conditions is an effective means to optimize the ventilation system. Through the installation of an advanced ventilation monitoring system, the air flow and gas concentration in each area of the mine can be monitored in real time. The monitoring system should include wind speed and air volume sensor, gas concentration monitor and environmental parameter sensor, etc., to fully grasp the operating status of the ventilation system. Once poor ventilation or excessive gas concentration is found, the system can immediately alarm and remind operators to take emergency measures [3].

3.3 Improve the drainage system

Water accumulation in coal mines not only affects production efficiency, but also may lead to mine collapse and other safety accidents. The existing drainage system often has problems such as insufficient drainage capacity and aging equipment. Therefore, to improve the drainage system, it is necessary to carry out detailed analysis and improvement from various aspects such as upgrading drainage capacity, updating drainage equipment, regular maintenance and emergency management. First of all, improving the drainage capacity is the key to improve the drainage system. The problem of underground water accumulation in coal mines is often due to the insufficient design capacity of the drainage system, which can not remove groundwater and waste water generated in the production process in time. Therefore, the drainage system must be re-evaluated and designed according to the actual situation of the mine. Increasing the number and power of drainage pumps and expanding the diameter and density of drainage pipes can significantly improve drainage capacity. Especially in the rainy season or areas with complex hydrological conditions, the drainage system should be upgraded in advance to ensure that it can effectively drain water under extreme conditions. Secondly, updating and upgrading drainage equipment is an important measure to ensure the efficient operation of drainage systems. Due to long-term use of drainage equipment in many mines, there are problems of aging and efficiency reduction. The use of modern drainage equipment, such as efficient submersible pumps, automatic drainage control systems, can greatly improve drainage efficiency and reliability. Modern drainage equipment has a higher drainage capacity and energy efficiency ratio, and a high degree of automation, can automatically start and stop according to the water level, reducing human intervention and operational errors. In addition, the drainage equipment made of corrosion-resistant materials can extend the service life of the equipment and reduce the frequency of equipment damage and replacement.

3.4 Strengthening gas control

Gas is a common harmful gas in underground coal mine. If it is not effectively controlled and controlled, it is easy to cause serious safety accidents such as mine fire and explosion. At present, there are some problems in coal mine gas control, such as insufficient monitoring means and lagging control technology. Therefore, to strengthen gas control, it is necessary to comprehensively

strengthen monitoring, control technology and management system. First of all, improving the gas monitoring system is the key to strengthen gas control. The establishment of a comprehensive and efficient gas monitoring system can timely and accurately monitor the change of underground gas concentration, and provide reliable data support for gas control. The monitoring system should include fixed and mobile gas monitors, covering all areas and working faces of the mine, to achieve real-time monitoring and alarm of gas concentration. In addition, advanced gas monitoring technologies, such as infrared absorption and laser spectroscopy, should be used to improve monitoring accuracy and sensitivity and reduce leakage and false alarms. Secondly, the use of diversified gas management technology is the key to improve the effect of gas management. The gas control technology of underground coal mine includes many means such as pumping, sealing, dilution, etc. Appropriate control measures should be taken according to the specific situation. For example, for the working face with high gas concentration, gas extraction technology can be used to pump underground gas to the surface for treatment; For the area where the gas source cannot be controlled, sealing technology can be adopted to seal the dangerous area to prevent gas leakage to other areas of the mine; For areas with low gas concentration, dilution technology can be used to dilute the gas below the safe concentration through the ventilation system. The comprehensive application of various treatment technologies can reduce the danger of mine gas to the greatest extent and ensure the safety of miners.

3.5 Strengthen fire prevention measures

The gas, dust and other flammable substances that may exist in the coal mine may cause fire or even explosion once they encounter the fire source, which brings great threat to the safety of miners' lives and the safe and stable production of the mine. Therefore, strengthening fire prevention measures is the most important thing to solve the technical problems of underground mining in coal mines. In this regard, we need to comprehensively consider from the gas drainage, ventilation, monitoring, management and other aspects to strengthen fire prevention measures. First of all, strengthening gas drainage and control is one of the important measures of fire prevention. Through the scientific and reasonable gas drainage system, the gas can be effectively discharged from the outside of the mine in time to reduce the possibility of gas accumulation in the mine. This requires reasonable design of gas drainage channel, equipped with efficient gas drainage equipment, and ensure its normal operation. At the same time, for the working face with high gas concentration, means such as directional drilling and blasting can be adopted to further reduce the accumulation of gas in the working face. In addition, the possibility of gas explosion can be controlled by injecting inert gases or oxidants, so as to strengthen gas management and improve fire safety. Secondly, optimizing the ventilation system and improving the ventilation effect is also one of the important means of fire prevention. The role of the ventilation system is not only to remove harmful gases, but also to dissipate heat from the mine, reducing the possibility of fire sources. Therefore, the ventilation system should be reasonably designed to optimize the layout of the ventilation network to ensure that fresh air can fully cover all working areas and remove harmful gases such as gas and dust in time. In addition, it is necessary to ensure the stable operation of the ventilation system, the normal operation of the equipment, the timely cleaning of the ventilation pipes and ventilation equipment, and the stability and continuity of the ventilation effect. Finally, strengthening technological innovation and experience summary is an important way to improve the level of fire prevention [4]. Mine technicians should be encouraged to actively explore new fire prevention technologies and methods, carry out innovative research on fire prevention technology, and summarize and promote successful fire prevention experience. At the same time, strengthen exchanges and cooperation with other industries, learn from the fire prevention experience and technical means of other industries, and further improve the level of fire prevention in mines.

4. Conclusion

The improvement and optimization of underground mining technology is the key to ensure coal mine safety and improve production efficiency. By introducing advanced technical means,

optimizing equipment and process flow, strengthening safety management and monitoring, the existing problems of underground mining technology in coal mines can be effectively solved. In the future, with the further development of science and technology, underground coal mining technology will usher in more innovations and breakthroughs, providing strong technical support for the sustainable development of the coal industry.

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