Research on key technologies and strategies of mine water protection and utilization

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Abstract: With the continuous expansion of the scale of coal mining, the problem of coal mine water has become increasingly prominent, which not only causes waste of water resources, but also causes serious pollution to the environment. This paper deeply discusses the importance of coal mine water protection and utilization, analyzes the key technologies of current coal mine water protection and utilization, and puts forward corresponding strategic suggestions. The research shows that the protection and utilization of coal mine water is of great significance to alleviate the shortage of water resources, reduce environmental pollution and promote the green development of the coal industry. Purification treatment technology, reuse technology and resource utilization technology of mine water are the key to realize the protection and utilization of mine water. In order to promote the development of coal mine water protection and utilization, comprehensive measures should be taken from the aspects of policy and regulation guidance, scientific and technological innovation drive, technology demonstration and promotion, market mechanism incentive and public participation education, so as to comprehensively promote the protection and utilization of coal mine water.

1. Introduction

As an important energy resource in China, coal plays an irreplaceable role in the development of national economy. However, the problem of mine water produced in the process of coal mining is becoming more and more serious, which not only causes a lot of waste of water resources, but also causes serious pollution to the surrounding environment. According to statistics, China 's annual coal mine drainage is as high as billions of cubic meters, most of which are discharged directly without treatment, causing serious environmental problems and waste of resources. Therefore, strengthening the protection and utilization of coal mine water is not only the need for sustainable development of the coal industry, but also an important part of the national water saving and emission reduction strategy. This paper aims to explore the importance of coal mine water protection and utilization, analyze the current key technologies, and put forward corresponding strategic suggestions to promote the rational utilization of coal mine water and the green development of the coal industry.

2. Importance of coal mine water protection and utilization

2.1 Easing water shortage

The protection and utilization of coal mine water is of great significance to alleviate the shortage of water resources. Our province is rich in coal resources, water shortage. A large amount of mine water is produced in the process of coal mining. If it can be used reasonably, it will become an important way to alleviate the water pressure. Through advanced treatment technology, mine water can be purified and reused in coal mine production, industrial water and agricultural irrigation. This can not only reduce the damage to groundwater, but also be used as unconventional water for other water use links. In addition, the recycling of mine water can also improve the utilization efficiency of water resources and reduce the use of fresh water. With the continuous progress of mine water protection and utilization technology, its role in alleviating regional water shortage will become

more and more significant, making an important contribution to the sustainable utilization of water resources.

2.2 Reducing environmental pollution

The protection and utilization of coal mine water plays a key role in reducing environmental pollution. Untreated mine water first does not meet the relevant requirements of environmental management in our province, and then direct discharge will cause pollution to the surrounding environment. The mine water in our province is more acidic, and the main pollutants in the water are suspended solids, total salt, iron and manganese and other pollutants. These pollutants will lead to the increase of total salt content in surface water, the increase of suspended solids in water, and the damage of river ecological environment system. Appropriate mine water treatment technologies should be adopted, such as coagulation sedimentation, chemical treatment and other methods, which can effectively remove the pollutants in the water, so that the treated water quality can meet the discharge or reuse standards. At the same time, the reuse of treated mine water for industrial enterprises, landscape, agricultural irrigation, etc., can not only increase the utilization rate of reclaimed water, but also reduce the environmental pressure on the receiving water body. In addition, some coal mining enterprises also reuse the treated mine water for ecological restoration and greening in mining areas, which not only reduces pollution, but also improves the ecological environment of mining areas. With the continuous innovation of mine water treatment technology and the improvement of management measures, its role in environmental protection will be more prominent, providing strong support for the green development of the coal industry.

3. The key technology of mine water protection and utilization

3.1 Mine water purification and treatment technology

The purification treatment technology of mine water is the basis for realizing the protection and utilization of mine water. In view of the complex composition of mine water and the variety of pollutants, modern mine water treatment technology comprehensively uses physical, chemical and biological methods to form a complete treatment system. In terms of physical treatment, commonly used technologies include coagulation sedimentation, filtration and air flotation, which are mainly used to remove suspended solids and part of COD in water. Chemical treatment technologies mainly include chemical neutralization, redox and ion exchange, which are used to adjust pH, remove heavy metal ions and other harmful substances. For example, neutralization treatment with lime or lye can effectively remove acidic substances, while ion exchange resin can selectively remove specific heavy metal ions. Biological treatment technology uses microbial metabolism to remove organic matter and some heavy metals, such as activated sludge process and biofilm process, which has the advantages of good treatment effect and low operating cost.

3.2 Mine water reuse technology

Mine water reuse technology is the key to improve the utilization efficiency of water resources and realize circular economy. According to different application scenarios, mine water reuse technology can be divided into coal mine production reuse, industrial reuse, agricultural irrigation reuse and ecological environment restoration reuse. In the aspect of coal mine production and reuse, the treated mine water can be used for underground dust reduction, coal washing and equipment cooling. This requires targeted treatment of water quality according to different uses. For example, the water quality requirements for underground dust reduction are relatively low, and simple precipitation filtration can be used. Industrial reuse technology is mainly aimed at using mine water as industrial water, such as thermal power generation, chemical production and so on. Deep treatment technologies, such as reverse osmosis and electrodialysis, are usually needed to remove the total salt content in water to meet the relatively high reuse requirements of industrial water. Agricultural irrigation reuse technology needs to focus on the impact of salt and heavy metals in water on crops and soil, and adopt appropriate treatment technologies such as biological nitrogen

and phosphorus removal, membrane treatment, etc., to ensure the safety of irrigation water quality. The ecological environment restoration and reuse technology uses the treated mine water for ecological restoration of mining areas, artificial wetland construction, etc., which can not only further purify the water quality, but also improve the ecological environment.

3.3 Utilization technology of mine water resources

The technology of mine water resource utilization aims to transform mine water from environmental burden to valuable resources, which is an advanced form of mine water utilization. This kind of technology mainly includes the extraction of valuable elements, the preparation of industrial salt, the utilization of ground source heat pump and the development of mineral water. In the extraction of valuable elements, mine water often contains lithium, gallium, strontium and other valuable elements. Through selective adsorption, ion exchange, solvent extraction and other technologies, these elements can be extracted from mine water to achieve resource utilization. The preparation of industrial salt technology is mainly aimed at high salinity mine water. Industrial raw materials such as sodium sulfate and sodium chloride can be produced by evaporation crystallization, which not only reduces wastewater discharge, but also creates economic benefits. The utilization technology of ground source heat pump makes full use of the characteristics of stable temperature of mine water, and develops ground source heat pump system for building heating and cooling, which not only saves energy and protects the environment, but also improves the utilization value of mine water. The development of mineral water technology is aimed at the mine water with excellent water quality and rich minerals. After strict treatment and testing, the mineral water products are developed. This requires the establishment of a sound water source protection, treatment and quality control system to ensure product quality and safety.

4. Research on the strategy of coal mine water protection and utilization

4.1 Policy and regulatory guidance

The guidance of policies and regulations is an important guarantee to promote the protection and utilization of coal mine water. First of all, the relevant laws and regulations system should be improved. It is suggested to formulate special laws and regulations on mine water management, clarify the standards, responsibilities and obligations of mine water as a resource, protection and utilization. At the same time, the existing environmental protection regulations should be revised, and the protection and utilization of mine water should be incorporated into the environmental evaluation and supervision system of coal mining enterprises to form a comprehensive legal restraint mechanism [1]. Secondly, it is very important to formulate incentive policies. Preferential fiscal and taxation policies can be introduced, such as tax relief for investment in mine water treatment facilities, subsidies for comprehensive utilization of mine water projects, etc., to encourage enterprises to increase investment in mine water protection and utilization.

In addition, the establishment of assessment mechanism is also an important means of policy guidance. The mine water treatment rate and utilization rate are included in the performance appraisal system of coal mine enterprises, which are linked to the evaluation of enterprises and the verification of production capacity, so as to strengthen the main responsibility of enterprises. At the same time, government departments should strengthen supervision and law enforcement to ensure that relevant policies and regulations are effectively implemented. Through the comprehensive guidance of policies and regulations, a good situation of the whole society participating in the protection and utilization of mine water can be formed, which lays a solid foundation for the green and sustainable development of the coal industry.

4.2 Driven by scientific and technological innovation

Scientific and technological innovation is the core driving force to promote the protection and utilization of coal mine water. First of all, we should increase investment in research and development, increase national and local financial support for research and development of mine

water treatment and utilization technology, encourage universities, research institutes and enterprises to carry out key technology research, and improve technological innovation ability [2]. The focus should be placed on improving treatment efficiency, reducing treatment costs, and expanding utilization channels to solve the current technical bottlenecks in mine water treatment and utilization. Secondly, the establishment of industry-university-research cooperation platform is very important. Build a multi-party cooperation platform for coal mining enterprises, scientific research institutions, equipment manufacturers, etc., promote the transformation and application of technological achievements, and accelerate the industrialization process of new technologies.

In addition, the cultivation of professional talents is the fundamental guarantee of scientific and technological innovation. We should strengthen the construction of mine water treatment and utilization related majors, set up relevant courses and majors in colleges and universities, and cultivate high-quality technical talents. At the same time, encourage enterprises to cooperate with universities, carry out targeted training and continuing education, and improve the professional level of employees[3]. It is also necessary to establish and improve the incentive mechanism for scientific and technological innovation, and encourage scientific researchers and enterprises to actively participate in the innovation and application of mine water treatment and utilization technology. Driven by scientific and technological innovation, we will continuously improve the technical level of mine water treatment and utilization, and provide strong technical support for the protection and utilization of coal mine water.

4.3 Technology demonstration and popularization

Technology demonstration and promotion is the key link to realize the wide application of coal mine water protection and utilization technology. First of all, demonstration projects should be built, and typical enterprises should be selected in different types of coal mining areas to build demonstration projects for mine water treatment and utilization. These demonstration projects should cover different water quality characteristics, different treatment processes and different utilization methods, comprehensively demonstrate advanced technology and management models, and provide replicable and replicable experience for the industry. Secondly, it is very important to carry out technical exchange activities. It is possible to hold regular mine water treatment and utilization technology exchange meetings, on-site observation and other activities to promote the exchange and sharing of advanced technology and experience.

In addition, the preparation of technical guidelines for the comprehensive utilization of mine water has an important guiding role in the promotion of technology. For different types of mine water and utilization needs, the preparation of practical technical guidelines and operating procedures to provide technical support and guidance for enterprises [4]. These guidelines should include water quality assessment, treatment process selection, equipment selection, operation management and other aspects, so as to facilitate the reference and application of enterprises. Through various forms of technology demonstration and promotion activities, it can accelerate the popularization and application of advanced technology, improve the overall level of mine water treatment and utilization in the industry, and promote the green transformation and sustainable development of the coal industry.

4.4 Market mechanism incentives

Market mechanism incentive is an important driving force to promote the sustainable development of mine water protection and utilization. First of all, we should cultivate the mine water treatment market and encourage the development of specialized mine water treatment service companies. Through market-based operation, professional and standardized treatment services are provided to improve treatment efficiency and effect. The government can attract more social capital into the mine water treatment industry through policy support, tax incentives and other measures to form a benign competitive market environment [5]. Secondly, it is very important to develop mine water resource industry. Support the development of mine water resources utilization industry, such as mineral water production, valuable element extraction, etc., expand the economic value of mine water and form new growth points.

In addition, the establishment of water rights trading mechanism is an innovative way of market incentives. In water shortage areas, explore the establishment of mine water rights trading mechanism, allowing mine water reserves up to the standard to enter the water rights trading market, improve the allocation efficiency of water resources. This can not only create economic benefits for mine water treatment, but also promote the rational use of water resources. Through diversified market mechanism incentives, the enthusiasm of all parties to participate in mine water protection and utilization can be fully aroused, forming a good situation of government guidance, enterprise dominance and market operation, and promoting the sustainable development of mine water protection and utilization.

4.5 Public participation in education

Public participation in education is an important guarantee to promote the in-depth development of coal mine water protection and utilization. First of all, publicity and education should be strengthened to widely publicize the importance and related knowledge of mine water protection and utilization through various media channels, such as television, radio, Internet and social media. [6] Secondly, encouraging public supervision is an important means to ensure the effective implementation of mine water protection and utilization. Establish a public participation mechanism, such as the establishment of a reporting hotline, the opening of an online complaint platform, etc., encourage local residents, environmental protection organizations, etc.to supervise the treatment and utilization of mine water, and timely feedback problems and suggestions.

In addition, carrying out environmental protection activities can enhance the public 's sense of participation and responsibility. Organize environmental protection activities in mining areas, such as afforestation, ecological restoration, etc., so that the public can personally participate in the improvement of the mining environment and enhance environmental awareness [7]. It is also possible to set up a mine water protection education base, through field visits and interactive experiences, so that the public can more intuitively understand the process of mine water treatment and utilization. Through multi-level and multi-form public participation and education activities, a good atmosphere for the whole society to pay attention to and participate in the protection and utilization of mine water can be formed, which lays a solid social foundation for the long-term development of mine water protection and utilization in coal mines.

5. Conclusion

The protection and utilization of coal mine water is a systematic project, which requires technological innovation, policy support and multi-party participation. By adopting advanced processing technology, establishing a sound management mechanism and cultivating a good market environment, the protection and efficient utilization of mine water can be effectively realized. This can not only alleviate the pressure of water resources and reduce environmental pollution, but also provide important support for the green transformation and sustainable development of the coal industry. In the future, with the continuous progress of technology and the improvement of management level, coal mine water is expected to change from environmental burden to valuable resources, and make greater contributions to economic and social development.

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