Mine Water Resource Utilization

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Abstract. In view of the influence and destruction of coal mining on water resources, from the concept of sustainable development and green mining, this paper explores the ways and means of mine water utilization in underground mining of coal mine. By using the storage of underground space formed by mining, people can purify mine water and combine mine heat source with mine water. By discussing the development trend of mine water, the key core technologies, methods and development of mine water resources utilization in the future are prospected.

1. Introduction
China ranks third in the world's coal reserves, and it has been the first largest coal producer in the world since the 21st century. China is a land composed of multiple tectonic plates that are spliced together by multiple geological structures. Geological conditions are very complicated. The complex geological conditions have made China one of the countries with the most serious water damage in coal mines in the world. With the continuous increase of mining depth, the reserves of coal resources in shallow and upper groups are gradually exhausted, and the problem of water damage of coal resource exploitation in the deep and lower coal groups is becoming increasingly serious. At the same time, the hydrogeological conditions of mine water filling are becoming more and more complex, and the control factors of water inrush are increasing, and the mechanism and type of water inrush are becoming more complex and changeable. According to the survey and statistics of the National Coal Mine Safety Supervision Bureau in 2012, in recent years, the actual drainage of coal mines is 7.17 billion m³ per year, and the water inflow of 61 coal mines is more than 1000 m³/h in China [1]. Because of coal mining, the destruction of groundwater is about 8 billion m³ each year, but the utilization rate of mine water is only about 25% [2]-[3]. The loss of mine water resources is equivalent to 60% of the annual industrial and living water shortage in China (10 billion t) [4]. How to keep the balance between coal mine exploitation and water resources protection and make good use of mine well water is one of the major problems in the development of coal science, and also one of the core contents of ecological civilization construction in coal mine area.

2. Underground Reservoir of Coal Mine
Underground reservoirs in coal mines (storage and utilization under well water well), that is, to store ground water in the space of the rock mass in the goaf formed by coal mining. The safety coal pillar is joined together by artificial dam, and the reservoir dam is formed [5]. Meanwhile, mine water storage facilities and water intake facilities are built at the right position. Make full use of natural purification
of goaf rock mass for the mine water, construct the underground coal mine reservoir project. This technology breaks through the original "interception method" water conservation concept, and adopts the idea of "guiding and storing". The method of dredging the mine water to the underground goaf for storage and utilization. This method avoids the efflux of evaporation loss, the high cost of surface water treatment plant construction and operation (Figure 1). It opens up a technical approach to coordinate the exploitation of coal with the protection and utilization of water resources.

![Figure 1. Underground reservoir of coal mine.](image1.png)

For multilayer coal, people can set up a number of underground reservoir, the reservoir can be water diversion. The reservoir should establish the monitoring and control system of water level and water quantity, realizing the water transfer between the reservoirs, ensuring the safety of the reservoir. (Figure 2).

![Figure 2. Water transfer of multi-layer underground reservoir](image2.png)

The coal mine underground reservoir technology has been used in Shendong mining area completing a total of 32 underground reservoirs of coal mine. In Shendong mining area, storage capacity of 31 million m³, is currently the world's only coal mine underground reservoir. The underground reservoir of coal mine supply more than 95% of the water for the mining area, which ensures the sustainable development of the mining area. The technology of coal mine underground reservoir not only provides production, life and ecological water of Shendong mine, the only 2 billion ton mining area in the world, but also lets the vegetation coverage of the mining area increased by about 30%.

3. Utilization of Mine Water Heat Energy
The coal mining in the Middle Eastern part of China is mostly in the deep area of the underground. The depth of mines is generally above 500m [6]. With the increase of mining depth, there is "high temperature" mine water in the deep area, and the temperature of mine water in many coal mines is above 30 degrees, and even there is heat damage. Harnessing the heat damage of the mine is also becoming an important part of the workers' occupational health protection.
By using the technology of water source heat pump unit, the utilization of the "hot water" in the mine is combined with the heating of the mining area. On the one hand, the "waste water" of mine is fully utilized, and on the other hand, the problem of daily bathing heat and winter heating in coal mines is solved. It is a scientific and technological project, and it is also a project of environmental engineering, benefit engineering and sustainable development.

Figure 3. Water source heat pump equipment and system
For example, by using the technology of water source heat pump, the original boiler system is reformed by "hot water" in Xin Yi coal mine, solved the heating problem of mining area. After the use of hot water in the mine, the heat exchanged can not only meet the workers' bath, but also basically meet the winter heating and the wellhead heat preservation in the mining area. (Figure 3). In the Zhao Lou coal mine, through the implementation of the cooling water of the downhole refrigerator and the waste heat utilization of mine water, the collection and utilization of the waste heat of the underground mine are realized. Zhao Lou coal mine therefore reduced 3 coal-fired boilers of 10t/h, and save standard coal more than 3300t/a.

4. Mine Pumped Storage Power Generation
The principle of drop type underground pumped storage power generation is consistent with the principle of conventional pumped storage. The difference is that the water storage facilities are placed underground, such as abandoned coal mines or metal mines in roadways and mined out areas (Figure. 4) [7]. Compared with conventional pumped storage facilities, the water storage space has already existed, only need to do corresponding transformation, and does not consume the land resources of the surface and damage the environment of the earth's surface.
Figure 4. Sketch of underground storage facilities in metal and coal mines

In the northern plain area, it is difficult to find the natural high drop terrain conditions for building surface pumped storage power station. So underground pumped storage power plants are a good choice. Especially, the construction of pumped storage power generation facilities by using the mine or abandoned mine space can not only reduce the cost of construction, but also produce good economic, social and environmental benefits, and shorten the period of building the database. Many large and medium-sized coal mines and abandoned coal mines are distributed in Northeast China, North China, Inner Mongolia and Xinjiang province. If some suitable coal mines or abandoned coal mines can be converted into pumped storage power stations, they can not only provide necessary conditions for the development of wind energy and solar energy, but also make use of the existing underground space. At the same time, through increased stability, the modified underground space can avoid the large surface subsidence and collapse of the ground, and the follow-up problem of water and air pollution.

5. Conclusion

It is the basis and guarantee of mine water resources utilization that we should further strengthen the "coal water" dual resource type mine construction, development of theory and technology research, as well as "water control coal mining" core technology research and development. The inevitable way to realize the harmonious and sustainable development of the modern coal industry includes:

1 According to the characteristics of high water pressure and high water temperature in the conditions of deep coal mine, the mine resources are comprehensively utilized.
2 The mine water, underground temperature, which is regarded as damages several years ago, can be pre pumped, or be utilized by the ground source heat pump.
3 The development of coal resources and the utilization of water and heat resources are studied as a comprehensive system to build a coal mine-water-heat multi resource mine.

6. References

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