Theory and Technology System of Green Coal Mining for Mine Areas with High Confined Pressure Groundwater

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Abstract: Hanxing mine areas are famous with high confined pressure groundwater in Ordovician limestone in China. With the increase of mining depth and intensity, especially into the subjacent coal mining, mining environment becomes increasingly complex, water pressure, ground stresses and ground temperature grow continually, threats from groundwater in Ordovician limestone with high confined-pressure and powerful water-rich become obvious, the problem of geothermy, mill dust, noise and so on which affect directly miner’s physical and mental health miners increases continually, environmental pressure caused by waste rock hill, ground subsidence, mine waste water becomes bigger. Aim at these problems, the concept of green mining is illustrated from four aspects, coal mine safety, occupational health, geothermy utilization and environment protection, a whole set of theory and technology system of green coal mining for mine areas with high confined pressure groundwater is presented, risk assessment and control of water-inrush from bottom, formation mechanism and control of mine heat disaster, integrated comprehensive control of noise-reduction and dust-abatement, waste rock filling, ground subsidence and pollution control, mine water resource and recharge nourishment source, which are: (1) the module of Karst sinkhole prediction and exploration are presented, which lay a foundation for the Ordovician limestone flood control; (2) geothermy abnormality in the area mainly controlled by geological structure, magma activity is heat resource for geothermy disaster, groundwater is geothermy carrier; (3) equipments with multifunction in one we re researched and developed, such as waste rock filling conveyer and tunnel filling grout-inject equipment, waste rocks still in well, without waste rock hill on ground, waste rocks substitute coal resource are actualized; (4) based on integrated technology of Inertia gravity coupled with dust-abatement noise-reduction, combination with gravity dust-abatement mechanism, Inertia dust-abatement mechanism, sound-absorption and noise-isolation mechanism, special diversion pagoda were used to control dust and noise at mine air pit exhaust ostium; (5) after treatment of mine drainage water, a part of them used to production and life, the other used to recharge Ordovician limestone aquifer, not only sewage drainage being solved but also basic balance of groundwater being hold.

Keyword: green mining, Hanxing mine areas, mining safety, occupational health, environment protection.

Harmonious society should include the social harmony and the harmony of the relationship between human and the nature. With a larger population, shortage of resources and the fragile environment, it is a hard task that we build a harmonious society and open up a path of sustainable development. The modern mineral exploration’s economic activities are in the process, according to the resource utilization—green mining technology--resource recycling, which is the enclosed type, energy cycle, feedback, efficient and ordered. The result is keeping the production of high quality, lower costs and less waste, the influence of the environment and the destructiveness are lowest. Green mining technology is one of the nucleuses of constructed harmony between human and the nature. Academician Qian Minggao thinks that green mining technology includes the following: ① water resources protection(the technology of protecting water in mining), ② land and building protection(the technology of grouting bed-separation in mining), ③ drawing out methane (the technology of simultaneous extraction of coal and gas in working face), ④ the technology of support design of coal level lane and decrease the output of waste rock, ⑤ the technology of coal underground gasification.

Green mining technology cover a wide range of content. According to the author’s understanding, the green mining technology should include several meanings. First, safety mining technology, second, protection of workers’ physical and mental health, third, damage control and environmental protection, fourth, striving to change waste material into valuable things, the last, the efficient production.
As the specific conditions of Mining or the differences of mining conditions, the key concept of green mining theory and technology is also different. For the high confined pressure groundwater in mine in Hanxing area, the first, green mining technology should control the flood incident, the second, eliminating the miners’ sickness which caused by dust, noise, heat damage, the last, avoiding major environmental geological problems, such as, surface collapse, groundwater depletion, drying up springs, the water cycle damage and pollution. For the high confined pressure groundwater in Hanxing mine area, this paper discuss the green mining theory and technology system which include the establishing and improving mine safety, occupational health, environmental protection, comprehensive utilization (Fig. 1).

1 The forecast and detection technology of Karst sinkholes

Green Mine should be built upon safety production. The main hidden trouble of production safety for Hanxing subjacent coal mining come from the water bursting of Ordovician limestone with high confined pressure and powerful water-rich. While the Karst sinkholes are main channel which led to a major water inrush accident, accurate predicted and precise located Karst sinkhole detection are the key of water bursting prevention from Ordovician limestone. Therefore, prediction and effective control of Karst sinkhole are the main content of the green mine.

Prediction and detection mode of Karst sinkhole are proposed in practice. Firstly, studied the basis geological of study area and hydrogeological conditions, established the Karst sinkhole database which already had, studied the development distribution of Karst sinkhole, macroscopically forecasted the Karst sinkhole development; based on Karst sinkhole mechanism, screening main factor of Karst sinkholes, And transform into the Karst sinkhole predictor system, application of multivariate, multi-level forecasting model of fuzzy comprehensive evaluation and forecasting software of developed Karst sinkhole to quantitative predict, delineat of Karst sinkhole areas; applying multi-dimensional information combined with three-dimensional seismic data detailed interpretation to further narrow range forecast, geophysical anomalies identified, drainage experiment to determine Karst sinkhole water conductivity, drilling test comprehensive exploration to determine the exact location of Karst sinkhole.
2 The formation mechanism and control of mine heat disaster

Local heat energy which were brought by deep fracture from deep-seated crust, and heat energy which were brought by the radioactive decay of an element in magmination in coal base or which is brought by magma by cooling, are the formation of the necessary conditions for geothermal disaster; Groundwater is the propagation’s media and carrier, the deep groundwater circulation paths are active faults or broken rocks in mine field boundary, deep underground heat is brought by deep groundwater circulation, this is the formation of sufficient conditions for geothermal disaster. Thus, groundwater become hot water by itself circulation, then, the air in tunnel is heated by hot water flooding, or the superstratum is heated by the condition that hot water is upwelling, then, the rock transfer heat energy to air, the air temperature and humidity in tunnel are increased, finally, this lead to geothermy disaster.

Wutong mine is suffered by geothermic disaster, the groundwater’s temperature in Ordovician limestone reach 44 °C. The key of geothermy disaster is hot groundwater. Thus, the priority of prevention and control of geothermy disaster is treatment of hot groundwater. The working surface’s temperature is in normal range, through by the chief implementation of hot groundwater drainage and grouting for water-blocking, the subsidiary implementation of aeration-cooling and cooling measures.

3 The technology of waste rock filling in mine

To achieve the replacement of coal by waste rock, controlling the surface subsidence, eliminating waste rock hill and controlling the pollution, the paper studies the method of the replacement of coal by waste rock in mine. We have the breakthrough in the key technology of layout of workings and filling immediately. We successfully develop the equipment support system which has a variety of functions of waste filling conveyor and tunnel grouting.

The method of tunnel filling is the key of technology. After designing plan, equipment development, working site test, revising and improving and practice. We fix the plan of waste rock filling conveyor directly and high-pressure pump filling grouting program. In technology, Improve the traditional form of rock transportation used belt, scraper, tramcar and so on, used of pipeline transportation, have advantages of small size, small footprint, easy to move, flexible piping, disassembly convenient and so on; traditional methods cannot be completely filled the tunnel top, also difficult to transport good permeability materials, and more difficult to compact natural accumulation of waste rock. Thus, research and improve coal mining waste filling conveyer and tunnel filling grouting equipment, can easily set up the pipe in the tunnel top or buried in the waste rock, and use greater pressure to slurry into the waste rock, To squeeze into the gap of natural accumulation of waste rock, Increase the density of waste rock, improve support effect on the tunnel.

Beginning in 2004, waste rock filling technology successfully applied to Xingdong Mine, Xingtai Mine etc, achieving significant economic, social and environmental benefits.

4 Raw coal line noise comprehensive control technology

Mining ground noise source 80% running from of the raw coal line screening equipment, raw coal line noise after treatment by the room sound insulation and sound absorption method, noise reduction significant, the average noise volume about of 18.4dB (A), improve the operator's work environment significantly, eliminate the hazards of noise on people, at the same time solve the problem of disturbing problem caused by noise, relieve the relation of mine and surrounding residents.
(1) Using room sound insulation structure to insulate a sound source and making sound insulation measures for independent high-noise sources in workshop, such as coal machine, spiral classifier screen, crusher, coal chute (waste rock) etc; The implementation of sound insulation panel structure to stop the noise transmission. Additionally, interior wall lining in the porous sound-absorbing material affixed to eliminate the spread of the noise produced by the device;

(2) The application of the Moving sound Room (barrier) shows Good effect in Xingdong Mine, which has many characteristics, such as the structure Light and handy, mobile and flexible, easy folding and removal features, easy maintenance unit, good cooling, off-site, etc. The Noise of high noise equipment dropped from 101.4dB (A) to 82 dB (A) averagely. The decrease rate arrive 19.3 dB (A)

5 The technology of inertia gravity dust-abatement and noise-reduction

Nowadays, it has no effective dust-abatement and noise-reduction methods in the aspects of controlling dust in coal mine’s at home and abroad. Although some of mine air shaft tower have increased sound-absorption board or sound-absorption wall, it can only reduce noise, not get rid of the dust. This paper is based the theory of mine ventilation, fluid dynamics, computational fluid dynamics, aerosol mechanics and noise control theory. Without affecting the ventilation system and no increasing the burden of power, we will combine the mechanism of gravity and inertia dust-abatement, and dust-abatement and sound-absorption. We set the diversion tower which is made of sound absorption materials in mine ventilating duct in order to reduce noise. We set hoarding out of the tower. It has enough room between hoarding and tower. The room is depression area of inertial airflow and dust which are brought by tower. The hoarding make the airflow and dust downward and lateral movement inertially in order to isolate noise. In this method, the exhausting air in mine can not pollute the environment. We can achieve the purpose of dust-abatement and noise-reduction.

(1) The paper study creatively the technology of inertia gravity coupled with dust-abatement and, combination with gravity dust-abatement mechanism, inertia dust-abatement mechanism, sound-absorption and noise-isolation mechanism, while controlling control dust and noise at mine air pit exhaust ostium. The method is simple and high efficiency in dust-abatement and noise-reduction. It does not influence the capability of blower and the ventilation system. It can be used all coal mine.

(2) Key Features: ① the mechanism of inertia and gravity; ② The efficiency of dust-abatement and noise-reduction in tower: the efficiency of dust-abatement is greater than 80 %, when the dust is greater than 50μm; ③ The quantity of noise-reduction in tower: 15-20dB (A); ④ the increase in resistance in tower is less than 100Pa.

6 Reclamation of mine water and nourishment of source

A large number of groundwater is drained in mine water Mine Drainage year after year; the balance of groundwater is broken. Thus, the decreasing of groundwater levels lead to exhaustion of water resources; the environmental problems are brought by mine drainage, waste water by waste rock leaching and production.

The waste water in mine and life is treated and reached the quality of water. The water is used respectively in mine production, ground greening, irrigation, flushing the toilet and so on. We can achieve water recycling.

Mine water in Wutongzhuang contains suspended matter, such as coal dust. The salinity in mine water has far exceeded (salinity 4300-5800mg / L), in order to solve the water pollution and declining water levels Ordovician limestone and so on, we implement the project of mine water treatment and. The mine water has been treated in down hole, used the drainage way to the ground, and then transported the ground reclamation station in pressure, in last, transferred recirculation pump into recirculation borehole. We can achieve the real mine water recycling.

Reference:
