



Research Progress and Trend of Coal Dust Removal Technology in China

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Abstract Coal mine dust has great harm to mines and miners. To understand the latest developments in coal mine underground dust removal technology in China, to interpret the development trend of coal mine dust removal, and to use the method of reviewing a large number of coal mine dust prevention and control methods, chemical suppression dust from adding wetting agents. , foam dusting, personal protective equipment in three aspects, combined with the results of relevant researchers, analyzed the latest developments and superiority of coal dust underground dust research, and from the development of traditional dust removal technology and promote the use of new technologies The prospective analysis of the development trend of coal dust removal technology shows that China's coal dust removal technology has already found a suitable road for the sustainable development of coal mines in China.

Keywords Coal mine; Dust removal; Progress; Trend

1. Introduction

China is one of the countries with rich coal resources and raw coal production in the world. At the same time, it is also the country with the most serious coal mine disasters. The dust problem is one of the five major disasters in coal mines. It not only poses great threats to underground safety production, but also poses serious hazards. The physical health of underground workers [1]. According to statistics, there were 60,969 new cases of occupational diseases in 2015-2016 in China, of which 54167 were pneumoconiosis patients, accounting for 88.84% of the total, including 24,695 coal mine workers, accounting for 45.59% of new pneumoconiosis patients. Behind the figures is a tough miner brother. The annual direct economic losses caused by pneumoconiosis reach more than 10 billion yuan, and the indirect economic losses amount to more than 40 billion yuan [2]. Coal dust also deteriorates the excavation environment, accelerates mechanical wear and tear, leads to accidents at work, and can cause serious explosion accidents.

At present, China's coal mine dust removal technology research is improving, but there is still a big gap with the developed coal mining technology developed countries. At present, most of the research on coal dust removal technology concentrates on the conventional methods such as coal injection, wet rock drilling, water seal blasting, internal and external spray of coal mining machine, dust removal in crushing system, air flow purification and purification, spray, dust real-time monitoring and individual protection among hydraulic supports, and how to use new technologies and new technologies, which are efficient, safe and low cost. Preparation has also become an urgent problem for many scholars and front-line engineers. Chongqing Research Institute of Coal Science Research Institute, China University of Mining and Technology, Henan Polytechnic University and other institutions have made new strides in the research of new technology and new equipment



of mine dust control. It is of great significance to popularize and popularize the latest theoretical and practical results for the sustainable development of coal mines.

2. Research Progress of Coal Dust Removal Technology

2.1. Chemical wetting dust added with wetting agent

The wetting agent helps to improve the ability of the water to wet the dust and improve its dust suppression effect. Humidifiers have been widely used in many dust removal areas of coal mines, such as blisters, blasthole blasting, water seal blasting, wet rock drilling, sprayers inside and outside the coal mining machine, lifting frame sprays, water curtain cleaning sprays, and transfer point sprays. Wait. Under normal circumstances, the use of chemical wetting agents needs to be combined with spray towers, self-excited washing stages, and venturi scrubbers such as wet dusting or spraying equipment [3]. However, how to determine a more reasonable formula for the use of the wetting agent in the process of use, so that the use of the wetting agent to reduce the corrosion of the equipment in the use, prolong the time to suppress dust, reduce the cost is the real concern in the actual production of the coal mine.

Zheng Riqiang and other patents: A natural material modified dust suppressor [4], using natural substances secreted by trees as alkyl hydrogenated phenanthrene resin acid as raw materials, using molecular design methods to modify it, have a better effect The dust inhibitor, it is non-toxic, non-polluting, anti-drag performance, and non-irritating and corrosive. Liu Yuzhong's patent: High-efficiency fire-prevention dust material and synthetic method [5], which consists of calcium chloride dihydrate, magnesium chloride hexahydrate, dispersant, corrosion inhibitor, etc. It not only has the characteristics of fire prevention, but also reduces the equipment's Corrosion and environmental pollution. He Yong et al. patent: powder material dust suppression agent and preparation method [6], it consists of water-soluble polyacrylate, polyacrylamide, sodium polyacrylate, surfactant and water, when sprayed on the powder material It can form a kind of net-like structure with good water-retaining performance and strong bonding ability, which can suppress the generation of dust. Li Hanjiang and other patents: A method for the manufacture of dust suppressants for the transportation and handling of pulverized coal [7]. It consists of powdered instant polyvinyl alcohol, starch ethers, high molecular weight polyacrylamides, and anti-UV agents. Neutral environmental protection materials are adopted, which have no damage to the human body and are easy to use, effectively solving the problem of dust emission during coal transportation. The patent of Ningxuan: An environmental-friendly decomposing dust suppressor and its preparation method [8], which consists of natural latex, natural plant fiber, glycerol, surfactants, etc. It has many advantages such as film formation, wetting and coagulation. Excellent characteristics, and non-toxic, non-corrosive, no secondary pollution, low cost features.

Jin Longzhe et al.'s thesis: Experimental research on wet chemical dust suppression agents [9]. After comparing the properties of several materials, the optimization of base materials and auxiliary materials was performed. Based on the wettability of coal dust, it was determined. Calcium chloride and magnesium chloride were used as base materials, Triton X-100 was used as an auxiliary material, and it was found through experiments that this kind of dust suppression agent had a remarkable moisturizing effect. Shi Chunhong and other papers: The application of a new type of fire suppression dust agent [10], which consists mainly of inorganic salts and surface active agents with strong absorbency of magnesium chloride, calcium chloride and surfactants and adjuvants, which were found through field tests in Luling Coal Mine Not only can extend the moisturizing effect, prevent secondary dust, but also have the characteristics of fire prevention. Guo Junjie's thesis: Inquiring into the performance of modified starch/bentonite coal dust suppressor [11], it matches the ratio of raw materials such as polyvinyl alcohol, corn starch, sweet potato starch, N-methylene bis acrylamide and ammonium persulfate. The prepared wetting agent has good adhesion and high curing strength.

2.2. Foam dust removal

Foam dust removal is a kind of dust removal method that covers the dust source with a void-free foam body, so that the newly generated dust can be wetted, deposited and lose its flying ability [12]. The foaming agent is composed of foaming agent, wetting agent, stabilizer and solubilizing agent. Since the coal dust is mostly positive particles, the foaming agent is composed of negative surface activity, and it is necessary to ensure that



the production of the foaming agent uses low nitrogen and low phosphorus. Non-toxic and cheap. Of course, in addition to the properties of the foaming agent, the foaming device's mesh size, spray state, and other properties have gradually become the focus of research.

Wang Deming et al. patent: a kind of foam generating device for dust removal in coal mines [13]. The venturi tube is arranged in the cylinder body of the cylinder, and the hollow cone spoiler is placed in the Venturi tube with a certain number of small holes. In the diffusion tube, the foaming agent forms a jet at the throat of the venturi tube, and the device can effectively avoid the problem of clogging of the nozzle, so that the gas and liquid are fully mixed, and the foam is formed easily. Patent of Sun Yinyu et al.: Mine foam generator [14], the foam net is fixed on a rotating shaft connected with an external drive device, and at the same time the air flow generated by the air blow device is blown onto the foaming net after passing through a transmission pipeline provided with a mediation valve. It not only has good foaming effect and optimizes the mine environment, but also has the features of water saving and power saving. Zheng Jihong et al.'s patent: mine-excited net-type foamer [15], the foam net is set in the vibrating mechanism, so that the foam net is always in the downward immersed and upward lifting process, and the foam is used to spray the foam Conveyed to the outside of the foaming filling, this foamer has a compact structure, a high degree of automation, and a good foam spray effect. Yang Shengqiang and other patents: a foam dust removal system [16], by setting universal adjustable spray device to achieve any adjustment of the foam spray angle, give full play to the foam dust removal function.

Wang Zhenping's thesis: The research and application of a new type of foam dust removal device for fully excavated surfaces [17] uses underground high-pressure water as a power, and uses a proportional propeller with a constant proportion to achieve the mixing of foaming agent and water, and through pneumatic transmission and compression. The air is foamed and tested on the site of the Baodian Coal Mine. The dust removal efficiency reaches more than 90%, and no electric energy is essential safety equipment. Hong Kekuan et al. Paper: Research and application of a new type of coal mine borehole foam dust removal device [18]. The device is connected with downhole pressure water and air pressure system. It uses a sprayer to perform initial dust removal, and then uses a mixed foam equipped with a water flow meter. The device generates foam, and the siphon nozzle is used to direct the foam. By testing in Xuehu Coal Mine, the dust removal efficiency reaches more than 95%. This device has good stability and the device principle is simple and practical. Hu Dongliang et al. Paper: The application of foam dust removal technology in the fully mechanized mining face of the Shanjiaoshu Mine [19] is to connect a foam distributor to the foamer and connect it to different parts of the sprayer respectively. According to different shearer shears The difference in dust concentration at the site distributes different amounts of foam. Through the field test at the Shanjiaoshu Mine, the dust removal efficiency has reached over 75%. This equipment accurately removes dust and has a small amount of water, thus avoiding the waste of foam.

2.3. Personal Protective Equipment

Personal protective equipment for dust pollution, from traditional cotton gauze masks, to chemical-fiber filter self-priming dust masks with air valves, and newly developed air flow helmets, pressure respirators, filter-type air supply dust respirator, etc. These personal protective devices play a role in protecting workers in some areas where large dust removal equipment is inconvenient to use [20]. There are corresponding standards for filter-type and power-type dust respirator countries. However, in coal mine practice, because of the poor air permeability of masks, inconvenience of wearing, and the impact on labor, most miners have waived their use. The patent of Wang Hongying et al.: Dust mask with dynamic breathing [21]. A miniature high-speed centrifugal fan is installed at the air intake of the dust mask, which can effectively ensure the pressure of the mask during use and reduce the user's breathing. Resistance, increase the comfort of use, improved the filter material under the premise of improving the structure, making the mask structure simpler, lighter weight, and more convenient to use. Cao Zhiqiang and other patents: A filter-type dust respirator that facilitates downhole coal mine operations [22], an anion release machine is set in the dust mask for the electrolysis of harmful substances in the air downhole, and a humidifier is also provided. The improvement of downhole air and the spiral air filter installed have greatly improved the performance of the conventional filter. This has great promotion value for mining tools that work long hours in the downhole environment. Lu Zhongliang's patent:



The new integrated mine dustproof and noise protection device [23] combines the new mining mask with the miner's cap used by the miners to create an integrated device that allows both dust masks to be fixed. The role of the miner's hat effectively solved the problem that the miners did not wear dust masks during production, and also had the effect of reducing noise pollution.

Deng et al.'s thesis: Design and implementation of air-supply dust respirator for coal mines [24]. A centrifugal fan controlled by a control circuit is installed in the dust respirator, which can adjust the fan air volume according to the downhole dust concentration and the oxygen demand. The sense of boredom of the miners, and the filter materials provided can be disassembled and replaced, saving the cost of use. The paper of Wei Jianan et al.: The preliminary design of a mining power-driven wind-dust type dust respirator [25] adopts a water-washing method to filter the downhole foul air and quantitatively set the air volume through a wind speed regulator, which not only simplifies the structure of the power air supply. Can also provide miners with cleaner air. Wang Weiwei et al.'s thesis: Research on the design of dust-proof masks for mining powered follow-up dust [26]. The connection between the ventilation filter and the air supply pipe and the dust mask is integrated, avoiding the need to externally filter the filter when it is worn. The inconvenience caused by users is conducive to the improvement of production efficiency.

3. Coal Mine Dedusting Technology Development Trend

Increase the intensity of research and development of traditional dust removal technologies and use the latest technology to eliminate backward production methods. At present, the ventilation and dust removal, coal seam water injection, and wet rock drilling used in coal mines should also strengthen theoretical research and field experiments, such as the study of dust transport laws, and use numerical simulation methods to determine the distribution of dust and dust in each work of underground wells; The mechanism of water injection, research and development of high-pressure water injection pumps and their supporting facilities, research of safer and more efficient chemical dust suppression agents, and the manufacture of additional addition and sizing devices; manufacturing of more suitable mining dust collectors to make them more environmentally friendly, Energy-saving; nozzles that are not easy to clog, improved sealing techniques and equipment, etc. Only by continuously improving and improving the currently widely used technical equipment, can we gradually improve the underground environment and truly implement the dust removal work.

Promote the use of new technologies and completely change the underground working environment. To learn from foreign advanced technologies, such as increasing investment in dust on-line monitoring and monitoring technologies, especially continuous monitoring of the more hazardous respiratory dust of miners; constructing occupational monitoring data centers and individual monitoring platforms to explore cloud computing service models. Research and development of new materials has led to improvements in the performance of mine dust measuring instruments and dust measuring sensors; improved mine dust removal automation, strengthened mine protective clothing and dust masks, and sought more humanized designs. The rapid transformation of other areas into the mine dust removal technology and equipment, the people-oriented production concept is implemented in people's hearts, China's underground coal mine dust removal work can make significant progress.

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