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New Progress on Coal Mine Dust in Recent Ten Years

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Abstract

Coal mine dust is one of five major disasters in coal mine, which led to enormous loss. In order to systematically investigate the new research progress on coal mine dust in recent ten years, supply the instruction effect for further research on coal mine dust, US EI Compendex was used to search relevant literatures during 2001-2010. Analysis and statistics were made to these literatures in detail. Statistics and result of analysis showed as follow: the research literatures were increased gradually year by year, especially in 2008, 2009, 2010; China is the most fruitful country, the occupation rate was also increased, more than 50%. The research directions mainly concentrated on dust character, law research, dust explosion, etc. Discussions were made on problem of coal mine dust research, the incidence of a disease and the total number of coal dust disease of China was relative high, has certain gap to the developed countries. At last, the conclusion put forward the long-term and arduous work of coal mine dust research.

Keywords: coal mine dust; dust character; numerical simulation; dust removal

1. Introduction

Coal mine dust is one of five major disasters in coal mine. Great amount of high concentration dust was generated in the mining and other processes, in recent years, the dust concentration increased in mining and driving face along with the mechanization and modernization increased, high production, high...
efficiency and low consume modern mining technology, the dust production of which was far more than traditional.

The main sources of mining and driving face dust origin from crushed, loaded, supported of mining machines, secondly, the transhipment point of transfer machine and conveyor[1]. The dust concentration in fully mechanized caving face commonly reached 3000mg/m³, the dust concentration in fully mechanized driving face reached 500mg/m³, and the amount of respirable dust to total amount dust reach as high as 20% more or less, according to statistics, the number of pneumoconiosis in mine has exceeded 200000, nearly half of all vocation pneumoconiosis of our country[2]. Dust also induced the damage of electromechanical equipment, the dust research is of great important for coal mine safety production[3].

In order to systematically investigate the research progress on coal mine dust in recent ten year, US EI Compendex was used to search relevant literatures during 2001-2010 by theme word: coal dust, and carried on systematically analysis and research on these literatures.

2. The literatures search result of coal mine dust in recent ten years

About 1703 literatures were obtained by searching, classified statistics was made to these literatures, statistics result was obtained as Fig.1-3, the characters were as following:

1) In the ten year from 2001 to 2010, the tendency about coal mine dust research totally kept increasing, 2008, 2009, 2010 had the most literatures compared with former, which were showed as Fig.1.

2) From the countries the literatures delivered, which showed as Fig.2, China had the most, USA, Russia, Germany, etc were second place. These countries have high level on coal science and technology in the world.

3) From Fig.3, which show that the total literatures proportion of China have increased from 10% to 60% during the ten years, the sum of delivered literatures and the proportion in each year kept increasing, as in new century, China got rapid development in economy and science and technology, human-oriented, emphasized promoted workers person health and safety, method and condition to research coal mine dust have great improvement and enhance, promoted coal mine dust research.

![Fig. 1 The time distribution of literatures delivered](image)
3. The research direction of coal mine dust

According to detailed analysis on these literatures, the coal mine dust research direction could be summarized up as following:

1) Dust character research

Liu Jian, et al used Rosen-Rammler distribution function to analyze dust particle size distribution data in intake airway, transfer point, support of the working face, supported basis for proper dust removal[4]. Yang Jing discussed dust diameter and the express method, used Winner3001 the laser particle size tester to calculate the fractal dimension of dust, which as the basis for wet parameter, established a dynamic model of liquid wetting coal dust a wet characterization.[5]. Page, Steven J. used industrial and statistics analysis methods researched the character of airborne dust generation from bituminous coals, especially respirable sized dust. Zhao En-biao developed a new sensor for measuring the consistence of coal dust via the charge method[6]. Wu Chao described a new measuring method of dust wetting agent performance, researched improvement of addition of sodium sulfate on wettability of coal dust by anionic surfactants[7].

2) The law research of dust

Zhao Zhen-bao researched on diffusion and mitigation law of dust cut generated by coal shearer, concluded the mass concentration law of downwind or upwind[8]. Wang Peng-fei built mathematical model of the concentration distribution of respirable dust at the conventional face. Zhou Gang, et al [9]
based on collocated grid SIMPLE algorithm, numerical simulation of dust concentration in fully-mechanized caving face, applied software FLUENT to numerically simulate simulation of dust concentration in fully-mechanized caving face, fully-mechanized excavation face with far-pressing-near-absorption ventilation and fully-mechanized coal face. Ma Yun-dong carried out numerical simulation on application of diffuse regulation with power dust in transshipping site[10].

3) Dust explosion research
Dust explosion like gas explosion attribute the major disaster accident in coal mine, lead to serious loss and result. Based on former dust explosion models, established dust explosion model of wide range of size distribution and numerical simulation. Liu Qing-ming[11] in lab researched the gas velocity, overpressure, minimum concentration of dust explosion. Cashdollar. Kenneth L., et al found that the post-explosion incombustible content was always as high as, or higher than the initial incombustible content. Li Run-zhi developed physical and mathematical model to described the kicking-up and explosion process of deposited coal dust due to gas explosion, numerically simulated it by FLUENT software. Cai Zhou-quan in the experimental lane, to simulate drifting lane in coalmine, including the measured characters as: energy, propagation speed and weakening law of explosion blast wave, range of explosion hazard and so on.

4) Technology and method of prevention and control of dust
(1)Dust removed of ventilation
One of important aim of ventilation is to dilute the mine dust to a safe concentration and pipe out of mine, it is the most basic but most important in mine. Xie Yao-shen[12] developed dust removal technology with negative pressure, and corresponding device removed the dust effectively in industrial tests. Liu He-qing applied the air curtain to prevent dust diffusing to the work district of mining machine diver, the efficiency reached 72%. Qi Xian-feng applied ventilation of far-pressing-near-absorption in driving face, the efficiency of dust removal promote obviously[13].

(2)Reduce and suppress the dust source
The main method is coal seam infusion, wet drilling, water sealed blasting, water stemming, improve driving machine, etc. Yao Jin-lin described the mechanism of the coal seam infusion, drilling full-mechanized mining face and injection, monitored and the resulted indicated the dust decreased quickly[14]. Jin Long-zhe presented adding the dust-adhering bar into the drilling hole improving the infusion effect, besides developed high efficiency water stemming. Li Xiao-huo has been done a lot of work on the relationship between driving machine and the dust production, optimized design of driving machine parameters on the basis of minimum dust production, reduced 20% dust.

(3)Spraying for dust suppression designed
Tong Xia-min, et al[15]designed an automatic control system of spraying for dust suppression on coal face, reduced the dust with high efficiency. Zhou Gang, et al obtained the optimum droplet size to capture respirable dust according to theory and experiment study. Ma Su-ping studied the mechanism of reducing dust by spry further, set up relevant mathematics model and drew efficiency curves of reducing dust by MATLAB, grain the higher the efficiency of reducing dust, and different diameter dust grain has a relevant best water fume grain, selecting suitable water pressure so that a good result of reducing dust and economic may be obtained.

(4)Other technology
Chemical suppression of dust: many counties studied chemical suppression of dust on adding surface active agent to water. The sodium polyacrylate collosol adsorbt, NCZ-1sticky dust powder, CZYNS series surface active agent by mist spray for dust suppression, surface active agent used in coal seam infusion, macromolecule foam agent for dust removal, etc. They reduced the dust with better effect by applying chemical suppression of dust, dust removal efficiency 25%~40% more than clean water.

Dust collector: USA adopted dedusting fan, wet fiber dust collector, small cyclone dust collector, etc equipments. Britain adopted wet washing dust collectors and wet filter dust collectors in driving roadway and driving machine. Germany adopted dry bag type dust collector in crush transshipment point, driving
machine. China has developed wet fiber dust removal, self-stimulated dust collector, dry bag type dust collector, etc. Dust collector has widely applied in driving face.

Individual protection: the personal protective equipment, from the traditional cotton yarn guaze mask, developed chemical fiber filter material self-respiration prevent dust guaze mask, pressure air respiration and filter air supply dust-prevention guaze mask, etc.

4. The characteristics and problem in coal mine dust research

1) The character and problem in coal mine dust research
   (1) The research applied a lot of advanced technology and mathematical methods, which made the reliability and accuracy of coal dust research increased greatly;
   (2) The research was quiet comprehensive, referred to various directions;
   (3) The research achievements were already well spread and applied. Based on the research achievements, they were applied into practice in quiet a lot mines and the effects were obvious, effectively controlled the coal mine work environment.

2) The problem in coal mine dust research
   (1) Dust theory research was not perfect yet. The research on dust structure and the way, patter of harm, kinematics of dust and dynamic character, the action of dust particle to particle and to flow field were not entirely;
   (2) Dust hazard evaluation research relative few, the dust hazard evaluation most aim some a single index, it should established reasonable evaluation index system to evaluate dust hazard;
   (3) The rationality and applicability of dust technology and measure need further research. A lot of technologies and measures did not applied effectively in spot, lacked certain economy and practicality, many mines could not afford, abandoned them;
   (4) The incidence and total number of coal-dust disease of China were the most in the world, the level of mine occupational disease prevention and treatment was low in the world.

5. Conclusion

In conclusion, the scholars in abroad and domestic studied a lot to coal mine dust, which supplied the theory and practice basis. But there existed a lot problems and shortage, quantity of work needed to improved dust prevention and control level. Coal mine dust is a long-term and arduous work, concern with the worker’s health, coal mine economic benefit, society benefit.

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