

Research article

Based on the coal mine's essential safety management system of safety accident cause analysis

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Abstract

This Paper analyzes the current situation of our country coal mine safety, and explains the accident reasons of coal mining enterprises. Based on the coal mine's essential safety management system and the real condition of coal mine accident in our country, combined with the Accident-causing Theory, we proposes the coal mine accident causation theory model. **Copyright © AJEPR, all right reserved.**

Key words: coal mine safety, essential safety management system, accident causation model

1 The current situation of our country coal mine safety

China is a country rich in mineral resources, the mining industry in the national economy accidenting for a large proportion, but safety is relatively backward, resulting in all kinds of accidents occurred, causing serious casualties and property loss. According to statistics, in 2005, in the producing coal big country of the whole world, the megaton death rate of the United States has dropped to about 0.035, Germany was 0.04, South Africa was 0.3 and India was 0.27, Australia was 0, but the index value of China was 2.81 in 2005, far higher than the average level of the world. According to the National Safety Supervision Bureau of statistics, the annual death accidents of China coal mine occurred more than 10 people were 40 times more. After the current actively various measures adopt, China's coal mine production safety situation has been greatly improved, the occurrence of safety accidents in coal mines was 1687 times in 2009, the death of people were 2535, one million tons of mortality rate of the first drop to below 1, was about 0.892. But according to Chinese saws was disclosed, in 2010 China coal mine accident number was 1403, the death toll was high up to 2433 people. This shows that, China coal mine safety and production situation remains very serious, major coal-producing coal mine accidents frequently, mine casualties have broken the world record, becoming China's coal mine safety production process of rapid economic development, a special social problems.

China's coal mine safety accidents, there are many factors influence, the directly objective reasons caused coal mines such as breach of coal mining law, blind act recklessly, overloaded production; also has indirect reasons, such as weak foundation work, inadequate safety technology and equipment; and the objective of the natural factors, such as coal natural occurrence condition is complex and changeable, employment conditions; However, the accident statistics show that most accidents are caused by unsafe acts of coal mine workers, management error decision-making or enterprise management factors (such as enterprise organization, enterprise culture and rules of procedure) and other factors, namely, human factors^[1]. A large number of domestic and foreign data statistics show that, in the total accident, 70%~90% of the accidents are caused by unsafe human behavior. In the modern industrial enterprise accident statistics, the accidents caused by people directly or indirectly of the total number of accidents accounted for about 85%, in some large catastrophic accidents, the proportion is high up to 70%~80%. In the serious accidents of the process of coal mine production, as high as 97.67% accident due to human factor accident, the proportion is much higher than other factors caused by the accident proportion^[2].

2 The Summary of essential safety management system

The essential safety management is the important guarantee of safety production. The coal mine essential safety management system is a "constant pursuit of system safety limit" management concept, namely, in the relative reliability of the technology, equipment and environment, through effective management mechanism and methods, eliminating the main factors caused coal mine unsafety system, namely human unsafe behavior, make mine disaster and accident rate very low, which is the acceptable limit^[3].

2.1 Coal mine essential safety management system and its components

The coal mine essential safety management system is a kind of innovation of safety management mode, and it is the integration of people, machine, environment and management. It throughes the strengthening of hazard source identification and risk assessment, strict management processes, operational procedures and standards, promoting the fine management. It puts risk management technology and human behavior management into safety management system, making employee occupation health, environmental protection, comprehensive quality management and safety management combined closely. Its components include: Human factors, machine factors, environment factors, management factors. In the production process of essential safety management system, it requirements to: personnel without error, equipment failure, system without depression, no loopholes in the management, in order to achieve the essential safety of the person, equipment, environment and management^[4].

During its components, human factors mainly include the physiological, psychological, technical quality and safety values; machine factors mainly includes production equipment condition, with or without automatic anti jamming ability, the ability to adapt to the change of the external environment, the machine running stability; environmental factors mainly include the temperature, humidity, lighting, noise, dust, toxic and harmful to other concentration of underground working environment; management factors mainly include coordination of person, machine, environmental factors in the production, realizing no loopholes in the management and no defections in the system.

2.2 Correlation analysis of four major factors

The factors of coal mine essential safety management system are not independent but interrelated, they are mainly manifested in the following aspects:

- (1) From the aspect of human factors, it directly influence the safety performance of machine equipment,

environment and management factors. People under the essential safety management system are able to produce good effect on work flow, achieve the standard operation requirement, make the personal behavior to meet the safety requirements, so as to promote the equipment safety performance improvement, promote environmental improvement and raise the level of management; make mine production continued to maintain a safe state.

(2)From the aspect of equipment factors, machinery and equipment safety is the important safeguard to create intrinsic safe coal mine. After essence safety type personnel function, machine equipment is always in good working condition, which can effectively guarantee the safety of personnel, make the environment from pollution and management play more effectively.

(3)From the aspect of environment factors, good environment can make people 's behavior and the machine equipment condition to achieve good fusion, make operation more coordinated, efficient, orderly.

(4)From the aspect of management factors, to ensure that the personnel, equipment, environmental harmony, it must pursue the scientific and efficient management, to make the personnel, equipment, environment get optimal configuration, so as to play the validity of variety of sources maximizly.

3 Based on the essential safety system of safety accident cause analysis

Through analyzing the factors of safety management system, we conclude that the human factors directly affects the machine, environment, management, combined with China's coal mine accidents reasons, we can see that people 's unsafe behavior may contribute to the unsafe factors of material, the material insecurity factors can objectively emergence unsafe behavior condition. That is coal mine accident analysis is widely studied the " Accident-causing Theory".

3.1 Accident-causing Theory

Accident-causing Theory is a accident mechanism and model derived from large number of typical accidents essential reason analysis. The mechanism and model reflects the accident occurrence regularity, it provide scientific, complete basis in theory, which is for the qualitative and quantitative analysis of accident cause, accident prevention and the safety management work improvement. With the development of science and technology, the accident law in changing, people in the know on the cause of the accident is ceaseless and thorough, there has emerged a dozen accident-causing theory. Among the-m, the most representative theory is of the Heinrich Accident Causation Sequence Theory. It set up the accident chain of events of important concept, promote the accident causing theory development, and it become accident research scientific pilot, which is an important historical position.

3.1.1Heinrich's Accident Causal Chain Theory

Heinrich's theory is on the basis of previous research, developed the accident causing theory, and then put forward causal chain theory. The theory's core idea is: the accident is not an isolated event, but a result of series of events occurred. Heinrich's accident causal chain theory thought personnel's harm is the outcome of the accident, the accident caused by the unsafe behavior of the people and the unsafe state of things; people's unsafe behavior and unsafe state condition of things are caused by human weaknesses; adverse environmental or genetic factors are the main reasons caused human weaknesses. This accident processes such as Domino, the first domino to fall, namely, the first reason appeared, after a chain reaction, the rest of dominoes were knocked over, which occurred one after another, until the damage produced.

The theory thinks that the human unsafe behavior is a major reason caused accident. Heinrich had investigated

75000 accidents, found that, 88% were due to the human unsafe behavior, 10% were due to the unsafe state of things, and the 2% were due to uncontrollable factors. At the same time, he thought that even if some accidents are due to the unsafe state of things, the safety state of the production is also due to the worker error. Then Heinrich emphasizes that enterprise safety management work center is to remove the chain accident in a domino -- prevent unsafe human behavior or eliminate unsafe condition of things, thereby interrupting the chain accident process, to avoid the occurrence of accidents. According to China Administration of safety production supervision statistics, coal mine accidents in China, 70%~80% is because of unsafe human behavior (illegal command, exercise of violate the rules and regulations, violations of labor discipline). So, we can think of Heinrich's theory of accident causation about the direct cause of the accidents analysis was consistent with a coal mine accident law.

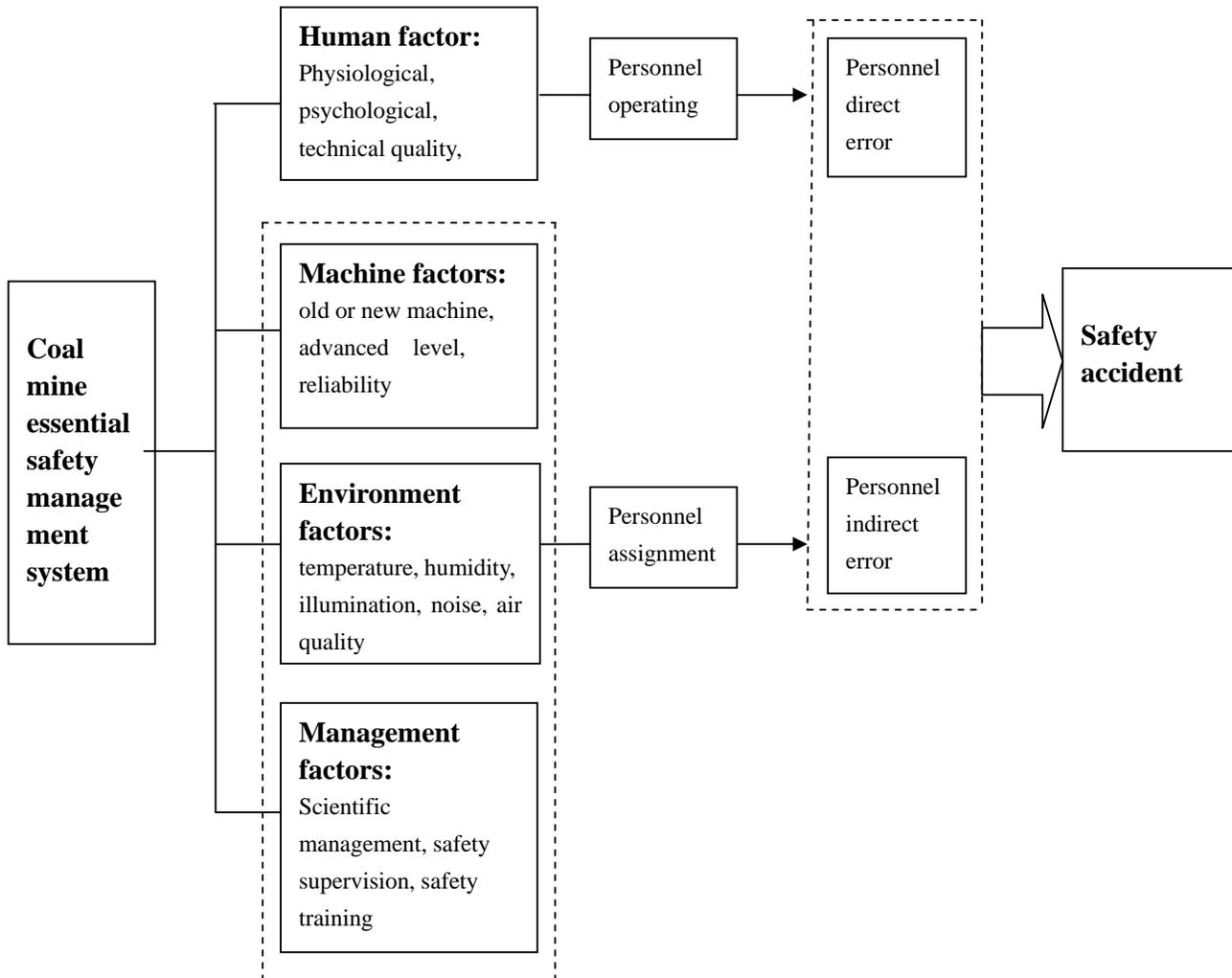
3.2 Accident causation theory model

According to Heinrich's theory, he put the human unsafe behavior reasons solely attributable to one's faults, including the character of congenital defects and the knowledge and skills acquired inadequacy, then held the hereditary factors and social environment factors. In the process of coal mining, a genetic caused character of congenital defects are difficult to control, the social environmental factors resulted in acquired knowledge and skill deficiencies are too general, it cannot be directly used for coal mine accident analysis and prevention. In addition, the direct cause of another important factor unsafe condition of things - Heinrich causal chain theory in the absence of previous layer to cause. At the same time, in the coal mine accident, some environmental factors including gas explosions, roof outburst, water permeable, spontaneous combustion of coal seam gas poisoning, often also is one of the direct reasons causing the accidents of coal mines. According to Heinrich's theory, all the direct reason for the upper reason is human, to explain all state of insecurity just by the human disadvantage is simple, it is not entirely consistent with the modern safety management system theory, it is difficult to implement the comprehensive control of coal mine accidents.

Therefore, in reference to the above of Accident-Causing Theory, combined with China's coal mine accidents regularity, based on essential safety management system of human, machine, environment management factors, we put forward coal mine safety accidents model to accord with our country coal mine actual productions, as shown in figure 1. Based on the essential safety management system of accident-causing model analysis, we not only analyzes the accident reasons of unsafe human behavior, but also introduces machine factors, environmental factors and management factors, so as to interpret a more comprehensive safety accident. Firstly, in the process of coal mining, the coal mine workers own disadvantages, such as low personal quality, production skills shortage, production safety consciousness, hold fluky mentality and psychology of adventure and so on, therefore the staff often carry out some unsafe behavior during the work, which directly leads to the occurrence of coal mine accidents. Coal mine personnel low quality a difficult problem in our country coal industry. According to the investigation of 《standard of classification of employee casualty accidents》 in 2000, in China more than 300,000 tons of large and medium-sized coal mines, the following junior high school education accounted for 62.67%, college degree or above accounted for only 5.44%, senior engineering and technical personnel account for 0.3%^[6]. So, the personnel's own factors will directly result in the accident.

Secondly, since the machine equipment is obsolete and aging, long-term neglected, poor safety performance, safety protection facilities inadequate, led to the equipment and facilities of the insecurity state, the unsafe condition of production equipment and security facilities provides the necessary material foundation for coal

mine accidents, so that the occurrence of coal mine accidents become possible. Namely, the insecurity of the things indirectly led to the personnel operational errors, then caused the safety accident. As of June 20, 2002 occurred in Heilongjiang province, Jixi Mining Bureau of Chengzihe Colliery resulted in the deaths of 115 big gas explosion, its reason depends on ventilation fan lack necessary daily inspection and maintenance, resulting fan stops running during personnel in coal mine working, causing the local gas accumulation, thus causing a gas explosion, and causing significant casualties.



Once again, China's coal production operation of complex natural environment is harsh, in the coal mining process, workers are vulnerable to water seepage, coal dust poisoning, roof tooth and other natural disasters threatening, and operation place is too concentrated, poor ventilation, inadequate lighting, easily lead to accidents, causing casualties. By using the data of 2002 as an example, the national coal occurrence of roof accident were 2364 cases, died 2766 people; occurrence of flood accident were 162 cases, died 516 people^[7]. So, environmental insecurity also indirectly affect the operation, causing the occurrence of coal mine accidents. Finally, China coal enterprises's overall planning of the production layout is not reasonable, blindly set operation, arbitrarily increase the operating point, and the workers' safety education training work does not reach the

designated position, the relevant government departments or coal mine safety production supervision and management institutions to colliery enterprise supervision and management are poor, resulting in some coal mine enterprises that does not have safe production on the premise of long-term production. Management mistakes including both as managers of the human error, also involves the management blind leading workers operation error, ultimately leading to accidents.

Thus, human factors changes will cause machine, environment, management factors change, personnel high comprehensive quality can be maximize the performance of the machine, reduce the environmental pollution and destruction, and improve the management level. While the machine, environment, management of the three factors is of mutual influence and mutual change, sophisticated machinery make the environment from pollution and management more effective play, good environment can improve the reliability of the machine, scientific management can be coordinated environment and machinery matching.

4 Conclusions

This paper firstly analyzes the present situation of coal mine safety in China: the megaton death rate is still high, from the accident statistics, we get the total number of coal mine accidents occurred of 70% ~ 90% caused by unsafe human behavior. Based on the coal mine essential safety management system of the four factors analysis, combined with accident causation theories, we undertook comprehensive interpretation of coal mine safety accident reason. On the foundation of Heinrich causal chain theory about personal unsafe behavior is a major accident direct reason, we introduce the essential safety management system of the other three factors: machine, environment, management. Personal factor defects will make people generate errors in the operation, caused mistakes directly, leading to the occurrence of safety accidents; and the defects of machine, environment, management three factors will be induced indirect error occurs when operating, also lead to the occurrence of safety accidents. At the same time, the human factors affect the other three factors change, therefore, the human factors defect is the main cause of the safety accident.

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