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## Application of safety entropy principle in coal mine safety management process

Yao Kang

School of Safety Science and Engineering, Henan Polytechnic University, Jiaozuo Henan 454000, China  
E-mail : [yao2339136279@163.com](mailto:yao2339136279@163.com)

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**Abstract** Coal mine safety investment is increasing, related equipment and facilities are becoming more advanced, and related coal mine safety management methods and principles have also developed maturely, but accidents cannot be eliminated, the safety benefits brought by traditional coal mine safety management principles and methods can no longer be significantly improved, and the marginal effect of safety investment has emerged. In order to effectively improve the efficiency and effect of coal mine safety management, a new safety principle is required, and the concept of entropy in physical thermodynamics is introduced here, and the principle is introduced into coal mine safety management activities by using interdisciplinarity, and the concept of coal mine safety entropy is proposed, and the correctness and practicality of the safety entropy principle are proved through the chaos principle and dissipative structure theory of safety system, which can be applied to coal mine safety management. According to the factors affecting the safety entropy of coal mines, the safety production work of coal mines is ensured by controlling the safety entropy of coal mine safety logistics and people flow, and the efficiency of coal mine safety management is improved.

**Keywords** safety entropy; safety principles; Chaos principle; dissipative structure theory; Coal mine safety management

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### 1. Introduction

For an isolated, running system, it will gradually change from an orderly and neat state to a disorderly and chaotic state, and the disorderly and chaotic state of the system will cause unsafe behavior of people and unsafe state of things, and even the bad working environment of the system. The first two are the direct causes of accidents, and the focus of safety management is to prevent the unsafe state of things and unsafe behavior of people, so in other words, the guiding direction of our safety management is how to manage the disorder in the system. However, people's unsafe behavior, the unsafe state of things, the poor system environment (all can be attributed to the defects of safety management), these disorderly phenomena and behaviors are not in line with enterprise safety management rules, social security technology and national safety laws and regulations, and show a considerable degree of chaos and disorder. The traditional eight safety management principles include system principle, integration principle, feedback principle, closure principle, elasticity principle, energy level principle, humanistic principle, and power principle, which have played an important guiding significance in safety management. However, as mentioned above, the marginal effect of safety management has emerged, and a new principle or method is needed to guide our safety management work, in order to face the complexity, chaos and disorder in the process of safety management, so the concept of safety entropy in the theory of safety chaotic system is introduced to guide coal mine safety management has a very important guiding significance.

Fan Yajiong [1] discusses the relationship between safety entropy and safe production, and believes that the gestation, growth and loss of accidents is the process of increasing system entropy, which is a comprehensive



chaos and error. Wang Haoyu [2] created the safety entropy model of hazardous terminal operation system, which provides a new safety evaluation model for hazardous terminal and eliminates the influence of uncertainties on system safety. Ma Chunmei [3] was the first to apply safety entropy in mines, and the system developed by the C sharp program was able to analyze the safety entropy of the inclined shaft tandem system in coal mines. Wang Yungang [4] et al. through analysis, combined with the concept of safety entropy, believe that to improve the security of the system, external intervention is required to make the factors in the system complete their own security functions. Wu Daming [5] applied the entropy theory of physical thermodynamics to explain the safety production theory, constructed a dynamic model, demonstrated the scientificity of the theory of coal mine safety production success, and provided a basic theoretical reference for the production of "zero accidents".

By introducing the safety entropy of coal mine and the safety chaos principle and dissipative structure theory related to the safety entropy principle, this paper puts forward some feasible suggestions for coal mine safety management by using the principle of safety entropy.

## **2. Coal mine safety entropy**

### **2.1 Definition of safety entropy in coal mines**

The scope of entropy is not limited to the thermal system of physics, but also plays an important role in other disciplines. According to the concept of entropy and the principle of entropy increase in thermodynamics, the concept is extended and extended to the field of coal mines, and the operation rules and changes in the field of coal mine safety can also be inferred. The essence of the universality of the law of entropy is that one reversible process can be deduced from another, and there is some relationship between two different processes.

In coal mine safety management, the production system is not isolated, but a system with sufficient communication with the outside world. In the management process, it is nothing more than the consideration and control of three factors: people, things and the environment. The process of exchanging materials, information, etc. with the outside world in order to carry out normal production activities in the working system is the process of entropy change. Here, we define coal mine safety entropy: in an isolated coal mine system, the degree of chaos in the production system caused by environmental changes or human behavior increases, and the production system spontaneously changes from an orderly and safe state to a disorderly and unsafe state.

The higher the safety entropy of the coal mine, the higher the insafety of the production system. Therefore, the safety entropy of the system must be reduced, first of all, the coal mine production system must be open and have full communication with the outside world, secondly, in the process of coal mine safety management, it is necessary to continuously exert external influence on the production system, reduce the safety entropy in the system, reduce the entropy value in the safety management process, so that the system operates in a safer environment.

### **2.2 Factors affecting the safety entropy of coal mines**

Human and machine factors: labor physiology, social psychology, operating procedures, laws and regulations, supervision by regulatory departments, safety education activities, labor system, labor legislation, social morality and other factors of staff.

Environmental factors: coal mine mechanical hazards, physical hazards, chemical hazards, dust, radioactivity, high temperature heat, abnormal air pressure, underground, static electricity, lack of oxygen, high-frequency microwave, noise, vibration, poisons and other factors.

## **3. Coal mine safety flow management measures: reduce employees' habitual violations**

According to the investigation of coal mine accidents, unsafe behaviors of miners lead to more than 96.5% of all coal mine accidents. Among them, habitual violations are one of the main causes of accidents.

Habitual violations refer to those habitual work behaviors that adhere to old bad work traditions and working habits, violate safety regulations and related procedures, and occur repeatedly for a long time and have exclusive habitual work behaviors [10]. Habitual violation is a long-term violation of regulations, which is essentially a blind behavior that violates the objective laws of safe production, or has no understanding, or does whatever you



want, but you are accustomed to it, and habits become natural. It is mainly manifested as habitual illegal operation, habitual illegal operation, habitual illegal command, and the violation has a certain stubbornness, frequent, potential, infectiousness and exclusivity, which is mainly related to the psychological characteristics, organizational management, safety culture, dangerous point control and standardized operation of employees. Habitual violations are an important cause of accidents.

### **3.1 Employee safety psychological management**

In coal mining enterprises, there is little psychological and behavioral training and research on employees, and the employee training programs of different positions and stations are different, which makes it difficult to unify training. Through strengthening education and training, not just simple speeches or presentations, but through a step-by-step and ear-to-ear approach, the psychology of staff can be changed, and psychological counseling can be carried out regularly for front-line workers in coal mines. Interest is the best teacher, the three principles of safe work are to establish and maintain interest, should increase the interest of coal mine employees in work, like safe work from the heart, and actually take action for the safety work of coal mine.

Kellman proposed three stages of attitude change, obedience stage, assimilation stage, and internalization stage, so that employees gradually accept the concept of safe production in coal mines and reduce the occurrence of unsafe psychology. During this period, the leaders of coal mining enterprises should also do a good job in the "role of leaders", grasp typical examples, unite employees, and cultivate safety backbones. Under careful inducement, cultivate employee values, make employees' working attitudes tend to be correct, and gradually change employees' psychology. In this way, the accidents caused by the unsafe psychological behavior of employees are fundamentally reduced, and the safety entropy of coal mines is effectively reduced.

### **3.2 Construction of coal mine safety culture**

In order to prevent and control the anti-habitual violations of employees in coal mining enterprises, it is necessary to start from the three aspects of safety psychological management, organizational management and safety culture construction, provide employees with a comfortable external environment, and create a good coal mine safety production atmosphere for front-line coal miners, and match the reward and punishment mechanism to reduce employees' unsafe psychology through training, in order to reduce anti-habitual violations from the root.

The change of employees' habits needs to go through five stages: texting, process reengineering, institutionalization, materialization, and habituation, so the process of shaping employees' safety habits is still a gradual process. Coal mine organization management, safety psychological management and safety culture construction are all measures to reduce the safety entropy within the system of coal mining enterprise systems in the process of system safety management, which is also the fundamental way to reduce the safety entropy of the system, but even so, there is still safety entropy in the coal mine system, the safety entropy value is positive, there is a possibility of accidents, we still need other measures, such as adding negative safety entropy to the system to offset the safety entropy inside the coal mine system.

## **4. Coal mine safety logistics management**

### **4.1 Reliability and safety management of coal mining equipment**

The probability of completing the pre-designed functions of the equipment in the specified time and specified working environment is called the reliability of the equipment, but the machinery and equipment will fail in the process of use, divided into early equipment trial operation due to poor processing or assembly failure, random failure of the equipment during use, and loss failure in the later stage of equipment use due to wear and tear, through the series system or the use of high-reliability components and backup systems, although the reliability of the equipment will be improved, but the cost is too high. For random faults and loss faults, we should increase monitoring efforts, optimize monitoring methods, strengthen monitoring systems, timely discover equipment failures, and reduce safety entropy caused by equipment failures.

1. Coal mine machinery and equipment inspection and maintenance plan formulation: different machinery and equipment daily inspection and maintenance is different, according to the maintenance professional advice



provided by the manufacturer and the actual operation of the equipment, formulate different inspection and maintenance plans for different machinery and equipment.

2. Coal mine machinery and equipment maintenance process control: in the maintenance process, there should be professionals to supervise and register the maintenance process and maintenance situation, formulate a strict acceptance system, form maintenance documents, ensure the quality of maintenance, and facilitate spot checks in the later stage. And the inspection and maintenance plan should be compared to the inspection and maintenance plan, the maintenance should be completed within the specified time of the plan, and the unexpected situation such as maintenance delay should be analyzed and written into the new inspection and maintenance plan. Maintenance personnel training, maintenance personnel need to strictly implement the equipment maintenance plan, the maintenance personnel in the maintenance process of safety management, to ensure that the safety measures of machinery and equipment in place.

#### **4.2 Safety management of coal mine monitoring system**

Monitoring includes the original meaning of monitoring and control. The unsafe factors detected by the monitoring system are eliminated or reduced through the safety control system, so that the system operates safely and stably.

Coal mine safety control system is generally divided into four types, production operation safety control system: prevention and control personnel in the machine operation process into the dangerous area, the system made driving action to eliminate the danger control system. Combustible gas leakage monitoring system, according to the physical, chemical, electrochemical properties and other factors of the commonly used gas sensor, monitor the combustible gas present in the system, send out sound, light and other alarm signals, remind staff to evacuate and take necessary safety measures. Coal mine fire monitoring system: according to the three fire detectors of smoke, light and temperature, it monitors the delay, light radiation and high temperature generated when the fire occurs. Safety confirmation safety monitoring system: to prevent accidents caused by the failure of the safety monitoring system itself, only after confirming that there are no personnel in the danger area or no dangerous equipment can the safety monitoring system operate normally.

#### **5. Conclusion**

Through the definition of coal mine safety entropy and safety entropy principle, combined with the two aspects of safe flow of people and safe logistics in coal mine safety management, the comprehensive safety management of coal mining enterprises is achieved, the safety entropy production of the system is reduced, and the negative safety entropy is continuously added to the system through management, and the total safety entropy of the overall management system is prevented from excessive safety entropy and accidents. Compared with the general safety management principle, this paper has a more comprehensive and essential accident prevention and treatment mechanism, and also has better operability, so we still need to conduct a more in-depth exploration of the safety entropy principle to understand its evolution law.

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