

# Research on Maintenance and Fault Diagnosis of Coal Gasification Machinery Equipment Based on Unsteady Seepage Transfer

Xufang Yuan

School of Mining and Coal, Inner Mongolia University of Science & Technology, Baotou, China

**Keywords:** Unsteady seepage transfer; Mechanical equipment; Maintenance and fault diagnosis

**Abstract:** In recent years, the economic losses and personal casualties caused by coal mine machinery accidents have had a very negative impact on the healthy and development of coal mine enterprises and society. Based on this, starting with the current situation of coal mine machinery and equipment development in China, this paper discusses how to effectively diagnose and repair the mechanical equipment failure, and establishes a two-dimensional mathematical model of the interaction between unsteady seepage transfer and chemical reaction in porous media, taking the planar two-dimensional underground gasification area as the simulation object. The normal operation of mechanical equipment directly affects the sustainability of the production process of coal mining enterprises and the level of economic benefits. Firstly, the paper briefly introduces the maintenance types of coal mine machinery and equipment, expounds several kinds of equipment fault diagnosis techniques that are commonly used in practice, and proposes countermeasures to further improve the maintainability of coal mine machinery equipment.

## 1. Introduction

With the rapid development of science and technology, the mechanization level of coal mining enterprises has been improved accordingly. For coal mine enterprises, maintaining the good operation of production machinery and equipment is an important guarantee to ensure the sustainability of production process and to realize the continuous improvement of economic benefits [1]. In coal mining enterprises, in addition to a large number of coal miners, coal mining machinery and equipment is essential to ensure coal production, and with the continuous improvement of science and technology, the degree of mechanization of coal mines in China will be increasing [2]. Although the research and development of China's machinery and equipment has made great progress in recent years, the level of automation is still relatively backward, unable to effectively meet the needs of today's growing society. With the rapid development of China's socialist society, the demand for coal has also shown a linear upward trend, and the widespread safety problems in coal mine machinery and equipment have seriously restricted the rapid development of China's coal mining enterprises [3]. By establishing a reasonable physical model. The appropriate mathematical methods can be used to describe the key phenomena of the underground coal gasification process and predict the development trend.

It can be seen that a more reasonable method is to connect the thermal pretreatment device to the feedstock and combustion system, which will be less investment, less difficult and more efficient than the traditional process of only deep purification of flue gas and heating surface [4-5]. Various activities related to the maintenance of machinery and equipment should be carried out, often with economic, material or spiritual rewards, and for individuals who have lost their responsibilities for their own reasons [6]. With continuous improvement, the mechanization of coal mines in China will be increasingly improved. Practice has proved that the failure of mechanical equipment due to various reasons in the production process frequently occurs, which seriously affects the effective production of coal [7]. Not only has it adversely affected the coal output and its economic benefits, but also restricted the rapid development of society to a certain extent. In addition, the absence of system and system is particularly evident in the research and development of coal mine machinery and equipment. As an important part of China's nationalized assets, the optimization and reform of the coal mine system must keep pace with social development [8]. To explore the two-dimensional

effect of temperature field distribution in seepage gasification channel, it is expected that it will be of certain reference significance for the design and operation of underground coal gasification process.

## 2. Methodology

So far, there are few reports on seepage heat transfer in fixed bed and its effect on coal pyrolysis reaction and volatile matter mass transfer process. As loose coal seams and roof caving fill the gasification passage space, the gas flow passes through the heated coal with high permeability, so that the combustion process continues to gasify, and a solid permeability porous evacuation gasification reaction passage can be formed [9]. Because the structure of coal mine machinery and equipment is more complex, and there are various types, and there are great differences in the operation environment, so the causes of mechanical equipment failure are also various [10]. There are problems with the mechanical equipment itself, including the quality of the manufacturing and the rationality of the design structure, as well as the problems of human use and maintenance, including improper installation and improper operation. However, due to the large number of maintenance, unnecessary equipment downtime and maintenance costs increase, which reduces the use efficiency of the equipment and increases the maintenance cost.

In order to study the influence of various factors on the coupling process of seepage, heat transfer and pyrolysis reaction in a fixed bed, the gas-solid temperature and coal pyrolysis volatilization in a fixed bed were investigated by changing the inlet seepage velocity and temperature. Figure 1 shows the distribution of solid temperature of coal particles along the bed height in a fixed bed.

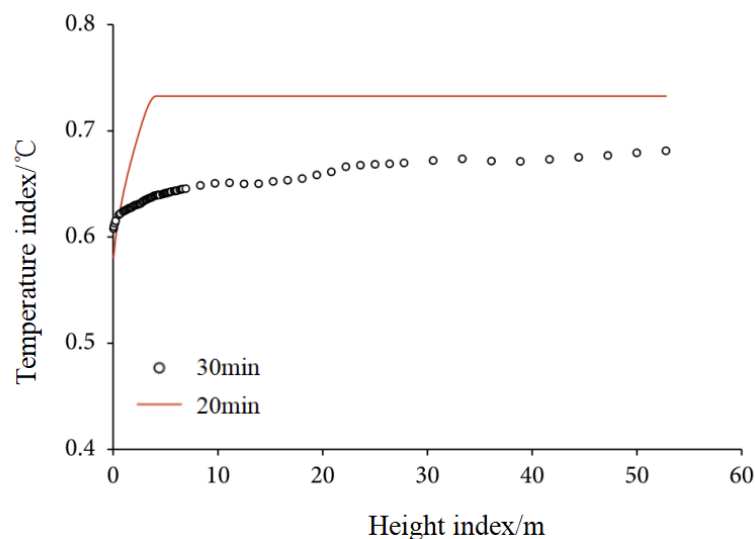


Fig.1. Distribution pattern of coal grain solid temperature along bed height

Some faults do not affect the use requirements, but have an impact on electrical equipment performance or electrical wiring, which we call performance faults. For example, if the no-load loss of the transformer increases, it indicates that there is a problem with the internal core of the transformer, because the failure of the core will reduce the performance of the transformer to a certain extent. The analysis and diagnosis of problems or malfunctions occurring outside or inside the coal mine machinery without any damage to the testing equipment is the most outstanding advantage of the non-destructive testing technology. If the equipment works abnormally, then judge the fault point of the equipment, and guide the maintenance personnel to carry out timely maintenance, so as to reduce unnecessary downtime and maintenance costs. In addition, the operation of mechanical equipment and the professional quality of maintenance personnel will also have a certain impact on its normal operation. Therefore, in the daily work period, we should attach great importance to the professional quality of equipment use and maintenance personnel. Through regular or irregular training of professional knowledge and skills, we can continuously improve

their comprehensive quality and provide technical guarantee for the safe and stable operation of machinery and equipment.

Figure 2 below shows the transient distribution of volatile matter release rate from coal pyrolysis. As can be seen from the graph, in the thermal infiltration zone, the temperature gradually rises with time and eventually reaches a stable distribution.

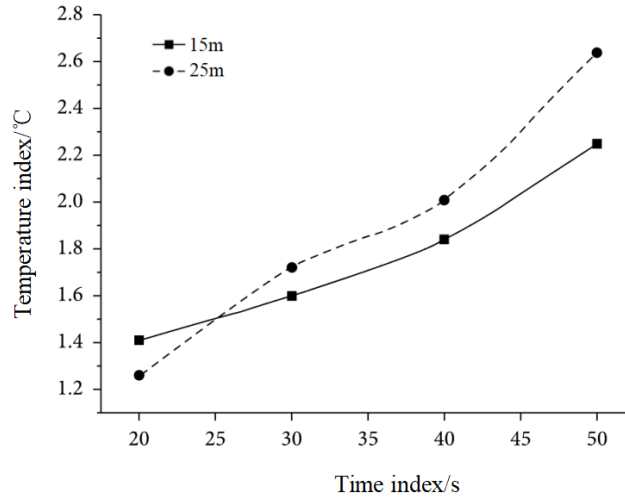


Fig.2. Transient distribution of volatile compounds in coal pyrolysis

Both accident prevention maintenance and active maintenance are carried out according to the working condition of the equipment, but the monitoring objects are different. Active maintenance focuses on monitoring the wear and tear caused by operation temperature, physical and chemical properties of oil and other factors affecting the function of equipment, so as to avoid the failure of equipment parts and a preventive method. Because of the difference of coal resistance and mineral filling in the passage, the airflow distributes in the passage at different velocities. The dense roof and floor and the coal seam with uneven permeability are the interface of the passage. The physico-mechanical model of porous medium seepage heat transfer and coal pyrolysis reaction and its volatile analysis was established by local non-equilibrium hypothesis and numerical calculation was carried out to study the gas-solid temperature and coal pyrolysis volatilization in the granular layer in fixed bed under different conditions. The concentration distribution law was analyzed to obtain the basic understanding of the coupling process of seepage heat transfer and coal pyrolysis reaction and the mass transfer law of volatilization analysis. But we can't make this kind of fault last too long, because it will affect the normal use of the equipment, and it will most likely evolve into a damaging fault over time.

### 3. Result Analysis and Discussion

The local temperature of the coal mine machinery and equipment will rise when the equipment wears or burns the electrical junction, and affects the mechanical properties of the material. Based on this, the temperature sensor is used to detect the temperature of different positions of coal mine machinery equipment. It is a method for analyzing the operating state and fault of a device according to the time domain or frequency domain characteristics of the vibration signal during operation of the device or its characteristic value. This kind of diagnostic technology is widely used because it can accurately and mechanically characterize the mechanical dynamic characteristics and its changing process in real time, and the monitoring and diagnosis method is simple and practical. The shape of debris particles and the physical changes of oil samples collected from hydraulic and lubrication systems of mechanical equipment can be identified and observed scientifically by means of spectral or ferrographic analysis, which can effectively judge the operating conditions of the equipment. Its greatest feature is that it can detect the internal or external faults of the equipment without damaging the equipment to be tested. It is a widely used technology in the field of coal mine machinery maintenance.

The development speed of high temperature zone in underground gasifier is the index to investigate the moving speed of flame working face. One-dimensional model is used to simulate the temperature distribution in seepage gasification passage with time, and the locations of high temperature zone at different times are compared. See Table 1.

Table 1 Numerical simulation parameter

Parameter	Numerical value
Percolation Channel Model Length/m	4.8
Model Width/m of Seepage Channel	2.4
Import pressure/MPa	0.3
Export pressure/MPa	0.2

In order to maintain and repair coal mine equipment, it is necessary to make efforts from the following aspects: regularly check the feeder switch casing, the explosion-proof shaft, the explosion-proof surface, whether there is any scratch damage, and repair it immediately if it is found to be damaged. The specific operation steps of this fault diagnosis technology are: first, sample extraction in the hydraulic and lubrication system of coal mine mechanical color, and then use the relevant oil analysis techniques such as spectral analysis and iron spectrum analysis to identify the state of oil wear debris, The physical and chemical changes occurred in the liquid medium are judged, and the final analysis and judgment results are used as the main basis to judge whether the coal mine machinery equipment is faulty. When using non-destructive testing technology to diagnose faults of coal mine machinery and equipment, it is necessary to determine which detection means to use. Therefore, first of all, the material, processing process and possible types of defects of the tested objects should be carefully analyzed. In the process of daily maintenance and maintenance of mechanical equipment, the purpose of lubrication should be strictly followed. The application of modern lubrication technology to the daily maintenance and maintenance of coal mine machinery and equipment can effectively prevent the wear failure of equipment, and then reduce the incidence of mechanical equipment failure.

The gasification process of underground coal gasifier is characterized by fixed fuel layer and moving flame working face. Therefore, studying the movement law of flame working face is helpful to understand and control the gasification process. In the fixed bed design and actual industrial operation, the temperature level of material in the bed can be increased by increasing the inlet temperature and inlet speed of hot gas, which can shorten the pyrolysis reaction time of coal seam and improve the operation efficiency and output of the device. At the same time, it is necessary to combine the actual situation of coal production, whether it is to repair mechanical and electrical equipment, equipment management standards must be fully institutionalized. Once you find that important equipment that involves personal attention to safety has fallen behind, you should not hesitate to eliminate it. In this way, the absolute safety of the production work is ensured. To achieve effective control of the failure rate of coal mine production equipment, in this way, in the production process of coal mining enterprises, the effective utilization rate of mechanical equipment is bound to be significantly improved, thereby creating greater value for coal mining enterprises.

#### 4. Conclusions

The use of fixed bed hot gas percolation heating method to properly preheat the coal before combustion can achieve effective pyrolysis of coal, and it is expected to achieve pollutant control of coal before combustion. The mechanism of seepage heat transfer and coal pyrolysis reaction in the granular layer is the theoretical basis for industrial device design and process optimization. In the seepage channel, the coal combustion gasification process is the coupling process of the percolation and chemical reaction of the porous medium. The one-dimensional transient temperature distribution along the gasification channel reflects the range and moving speed of the flame working surface, along with the gasification process. The gasification work is carried out in the direction of

the gas outlet. It is of great significance to ensure the safety of production. Green maintenance has become the development trend of mechanical equipment maintenance. Green maintenance can not only alleviate the environmental pollution caused by equipment maintenance, but also recycle the waste parts. Coal mine enterprises should discuss and study the problem of green maintenance while doing well in equipment maintenance.

## References

- [1] Liu W, Liu Y, Niu C, et al. A Model of Unsteady Seepage Flow in Low-permeable Coalbed with Moving Boundary in Consideration of Wellbore Storage and Skin Effect[J]. *Procedia Engineering*, 2015, 126:517-521.
- [2] Li Y Q, Jing H, Wang Q H, et al. Stability Analysis of Soil Slope and the Design of Anti-Slide Piles during Unsteady Seepage[J]. *Applied Mechanics and Materials*, 2012, 204-208:689-693.
- [3] Du E X, Sun J H. Finite Element Analysis of Unsteady Seepage Flow through the Earth Dam of Huangbizhuang Reservoir[J]. *Journal of Agricultural University of Hebei*, 2003, 594-597:1892-1896.
- [4] Min-Xia W, Rong-Bin Z. Judgment of Reservoir Water level Sudden Drop and Stability Analysis of Homogeneous Earth Dam during Unsteady Seepage[J]. *Journal of Yangtze River Scientific Research Institute*, 2009, 26(10):92-94.
- [5] Bityurin A K. Software for engineering calculations of the temperature and seepage regime of hydro developments under permafrost conditions on a personal computer[J]. *Hydrotechnical Construction*, 1993, 27(11):643-647.
- [6] Jin-Bao L, Han-Mei W, Yue-Ping Z. The improved variable seepage matrix method of the compound element for unsteady seepage flow with free surface[J]. *Chinese Journal of Computational Mechanics*, 2009, 26(6):811-709.
- [7] Chai J R, Xu W S. Coupling analysis of unsteady seepage and stress fields in discrete fractures network of rock mass in dam foundation[J]. *Science China Technological Sciences*, 2011, 54(1 Supplement):133-139.
- [8] Xiangbao D, Luofeng X. Unsteady Seepage Test under Condition of Rapid Drawdown[J]. *Journal of Yangtze River Scientific Research Institute*, 2009, 26(10):7-12.
- [9] Mao C X, Duan X B, Cai J B, et al. Empirical formulas for important parameters of unsteady seepage of levees[J]. *Journal of Hydraulic Engineering*, 2004, 35(1):52-56.
- [10] Fan X, Wang J, Zhang Q, et al. An evaluation of porosity and permeability based on an unsteady seepage model in a reservoir while underbalanced drilling[J]. *Journal of Petroleum Science and Engineering*, 2015, 127:367-376.