Structure optimization of coal blending equipment in coking

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Abstract. With the continuous increase in industrial production requirements and production costs, manufacturing companies and factories constantly optimize and improve the system structure. In view of the actual problems in the actual coal blending process, in this paper, the structure of existing coal blending system is optimized, and the experimental results are compared with experimental data. By comparing the experimental data, it can be seen that the larger the structure error is, the better the optimized structure is. The results are of great value for practical application. Through optimizing the structure of coal blending system, the accuracy and stability of coal blending process control system can be improved, the coal blending error can be reduced, and the quality of coal blending can be improved.

1. Introduction
At present, economic and reasonable coal blending is very important in coking production in China. Coking coal enterprises need a series of coal matching tests such as coke oven test or semi industrial test when the best coal blending scheme is the best. The cost of the experiment is very expensive. It needs to be tested repeatedly and repeated experiments, but there is still a certain difference in order to meet the requirements of the enterprise. Maximizing the rational use of resources and optimizing the allocation of coke output are the problems that coking enterprises need to pay close attention to it. It is necessary to optimize the design, optimize the configuration, realize the optimization process of the design of the coal blending process, and make use of the minimum resources to achieve the maximum optimization process of the coal output. This is the arduous task that the modern enterprise must complete, and continuously achieve the optimal allocation of the resources and realize the optimization and docking of the coal blending. It is the biggest goal of modern enterprises [1-2].

In the early 1960s, many foreign countries studied the theoretical scheme of coking coal in large steel plants very profoundly. And most of the research was mainly to reduce costs and reduce environmental pollution. At the end of 1970s, a series of research on coal blending scheme was made in China. Because of the uncertainty of artificial coal blending, it is difficult to find a control system to optimize the allocation of coal blending process. The traditional control mode is insufficient to meet the demand for the growing coal matching, and the requirements of its control are also very rare to meet the requirements. However, the overall structure control still needs to be improved. In the process of intelligent coal blending, human operation still needs to be carried out [3-4]. The research on the guiding strategy of coking coal blending needs further optimization and promotion.
2. Structural analysis of coal blending equipment

2.1. Overall structure of coal blending equipment
Coal blending is a complex and important process, and is in a closed environment. Therefore, the coal blending error is easily affected by the unsteady interference. When the coal is taken, the manual operation heap is used to pick up the coal machine, and a certain amount of coal is put on the transmission device according to the demand. The transport equipment is transported through the conveyor belt to the coal trough through the conveyer belt, and the quality of the coal before the electronic scale is weighed. Then, a variety of coal is mixed according to a certain coal blending ratio, and the blended coal is transported to the coke oven by the conveyer belt quantitatively [5]. In this process, due to various uncertain factors, it is necessary to sample the mixed coal on the conveyor belt regularly, and carry out the test and error analysis of the sample after the sampling, and determine whether the amount of coal is in the allowable range of error [6]. If the error is exceeded, the corresponding parameters of the coal blending system need to be tested and adjusted.

2.2 Coke weighing system
The requirement of automatic weighing system for coke blending is to realize automation and efficiency of control in the whole process of control [7-8]. The general coal blending system chooses the nuclear scale as the measuring tool. The nuclear scale is a weight measuring tool combined with nuclear technology, microcomputer technology and electronic information technology. It adopts non-contact indirect measurement. The core of the nuclear scale is the $\gamma$ radioactive source of emission. In actual operation, the radiation source is fixed on the material and radiated from the material, some of which will be penetrated through the material, and some of the material will be blocked by the material that will be irradiated. Under the combined action of negative high voltage, an electrical signal proportional to the radiation is generated, and the size of the signal corresponds directly to the number of materials.

The $\gamma$ ray satisfies the law of the nuclear scale:

$$I = I_0 e^{-\mu d \delta}$$  \hspace{1cm} (1)

In the formula:  
$I$ is ray strength before passing through the material  
$\mu$ is the mass absorption coefficient of the material  
$d$ is the proportion of material  
$\delta$ is the material thickness

The data processing of nuclear scales satisfies the rules:

$$F = -A \ln U_0 / U$$  \hspace{1cm} (2)

In the formula:  
$U_0$ is average output voltage  
$U$ is instantaneous output voltage  
$A$ is load constant of nuclear scale  
$F$ is load of belt conveyer

Instantaneous material content satisfaction formula:

$$L = F \cdot V$$  \hspace{1cm} (3)

In the formula:  
$V$ is belt conveyer speed  
$L$ is the instantaneous flow of material on a belt conveyer

The accumulation of material satisfies the formula:
\[ W = \int_0^t L d_t \quad (4) \]

In the formula: \( t \) is time interval of material transport
\( W \) is accumulative transport of material

Generally speaking, there are two ways to weigh the nuclear scale, one is the small belt weighing, the other is the main belt weighing. The small belt weighing is mainly aimed at the control system equipped with a separate coal feeder, and the main belt type is mainly used for weighing the mixed coal. The weighing diagram is shown in Figure 1.

3. Structure optimization of coal blending equipment

3.1. Improvement of coal blending structure equipment

The actual situation shows that all kinds of external factors and the restriction of current technological conditions lead to greater errors in coal blending process. The coal in the coal tank still contains some impurities and moisture. The error of single quantitative coal extraction in domestic coal blending plant is about 5%, which is hard to avoid and reduce at present. After processing, the error of coal weighing before mixing is about 1%, because the relative disturbance factors of coal in this part are few, so it is easy to control and change [9-10]. At present, the intelligent control system of coal blending is also used to correct and deal with the current error. The system can control and detect the ratio of each coal in real time, and can only adjust the set value of the system and detect the measured value, and it could not reflect and detect actual errors and proportions. Therefore, in actual work, people need regular sampling and testing for the quality ratio of the current blended coal, which will cost more time and manpower [11-12]. The diagram of coal blending system work principle as shown in Figure 2. The primary error of domestic coking plant's coal blending is guaranteed to be less than 5%, and the two level error is guaranteed to be less than 1%. And with the change of technology and technology requirements, we need to ensure that these two errors are as small as possible. Taking account of labor cost and time cost, sampling and testing can reduce the error of 1%, but at the same time, it is accompanied by high cost. So we hope to reduce the error by changing the hardware structure.
3.2. Optimization experiment of coal blending structure

At present, there are several ways to improve the quality of coal blending.

- Improve the quality of coal yard, improve the quality of impurities and raw coal density.
- Improve coal blending, drying and preheating technology.
- The development of coal processing technology, selective crushing, equipped with additives (lean agents and anticoagulants etc.);
- Optimize the equipment structure of the coal blending system;
- Use accurate coal blending technology to optimize or improve the system algorithm.

Taking into account the practical application and technical cost, the coal treatment base is large, the environment is bad and the human factors could not be estimated. This article only studies the optimization structure of coal blending equipment. The structure optimization method studied in this paper is to add the high precision electronic scale in the conveyor belt structure after the coal mixing, measure the quality of the mixed coal according to the system demand at any time, and compare the quality error before and after the system comparison and analysis, in order to judge the cause of the error and modify it. The purpose of adding electronic scale is to replace the technical means of previous artificial sampling weighing error, which can not only improve the accuracy and accuracy, but also save time and manpower cost. The structure of the improved coal blending process is shown in Figure 3.
After the above structural improvement, the comparison of the actual design values of the 7 coals after the coal blending process was performed and the resulting error comparison table is shown in Figure 4.

Figure 4. Comparison of error values before and after structural improvement
According to the comparison of data in the table, we can see that the bigger the structural error is, the more obvious the effect is. Although the overall effect is not particularly obvious, the results are of great value for practical applications. So it can be seen that the improved structure can reduce the error in coal blending process.
4. Conclusion
This paper first introduces the overall structure of the existing coal blending control system in the domestic coking plant, and shows the deficiencies of the existing system equipment structure and the system controller, and improves and optimizes it. In terms of equipment structure, electronic scales connected to the system are added and data is fed back to the system. By comparing the experimental data, it can be seen that the larger the structure error is, the better the optimized structure is. The results are of great value for practical application. Optimized coal blending equipment effectively reduces the error of coal blending and improves the precision and stability of the control system of the coal blending process, effectively improves the quality of the coal blending.

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