Application of Automation Technology in Coal Preparation Technology

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Abstract: In order to improve the quality of the coal preparation process and realize the automatic control of the coal preparation process, this article takes an intelligent transformation project of a coal preparation plant as an example to analyze the application of automation technology in the coal preparation process. The article introduces the actual situation of a coal preparation plant and the specific application of automation technology, analyzes the research ideas of the coal preparation plant's automation technology, the automatic transformation, installation and commissioning of the coal preparation process equipment, and analyzes its process test results. It is hoped that this analysis can be helpful to the good application and development of automation technology in coal preparation technology.

1. Introduction
With the continuous development of today's social economy, the development of coal enterprises is also very fast. Coupled with the development of various advanced science and technology and equipment, the coal preparation process has gradually developed in the direction of automation and intelligence. In the HM coal preparation process of a coal preparation plant, if the quality of the raw coal changes, the suspension process parameters will also fluctuate, which will cause a certain degree of adverse impact on the product quality. Therefore, in order to effectively solve such problems and improve production quality, the coal preparation plant reformated the overall coal preparation process and further upgraded the original automation technology to achieve further savings in energy consumption, and achieved the purpose of downsizing and increasing efficiency.

2. Overview of a coal preparation plant
The site of a coal preparation plant was selected on the west side of Pangpangta Coal Mine Industrial Plaza, on the east side of Pangpangta Power Plant, and on the south side of the railway station, in order to use the railway line as the loading line of coal preparation plant, and it is convenient for downstream users’ demand for raw coal transportation from Pangpangta power plant. Its industrial site is located in Chengzhuanggou, Yangzhai Village, Chengjiata Township, Lin County, Lvliang Area. The terrace is on the north bank of Chengzhuanggou, a tributary of the Qiushui River in Linxian County, it is on the west of Yangzhai Village, which is about 420m from east to west and 265m from north to south. The terrain of the site is flat, which is high in the east and low in the west, and the natural terrain elevation is between 1125.00-1133.00m. In this coal preparation plant, the organic components of the coal seams are mainly vitrinite, followed by the inert group, and the content of the chitin group is less; the inorganic components are mainly clay and contain a small amount of iron sulfide.

3. Overview of automation technology
IPC technology is also called process indirect communication technology, which can transmit signals
or data between two or more processes or threads. Among them, process refers to the smallest unit of resource allocation in a computer system, and thread refers to the smallest resource scheduling unit in the computer system. Each process will have a part of its own independent system resources, which are isolated from other processes and other resources. The process indirect communication technology allows different processes to achieve resource access and coordination, so as to meet the user's demand for information resources. The application of IPC technology to the automation of the coal preparation process can realize the automatic acquisition and transmission of various mechanical equipment operating parameters, so as to promote the automatic development of the coal preparation process[1].

4. Analysis of research ideas

(1) Research ideas on automatic control system of a coal preparation plant

With the aid of raw coal splitting and dust test, the best raw coal separation density is determined to ensure that the measured density of qualified raw coal medium gradually approaches the given value until it is equal to the given value. Because the coal preparation process plays a decisive role in the density of qualified media in normal production, the monitoring system can control the density of qualified media by means of automatic water supplementation. Because the non-desliming and non-grading selection of the heavy-medium coal preparation process will play a decisive role in the slime content in the qualified medium in normal production.

(2) Research ideas on density control system of dense medium cyclone

The system is divided into two parts, the first is the PID fuzzy controller, and the second is the density support decision system. The PID fuzzy control part mainly includes PLC controller, communication system and computer configuration monitoring system. In the process of this intelligent transformation, the fuzzy control algorithm was added to the original PID system to achieve a further improvement in the degree of automation of the density control of the dense medium cyclone[2]. For the density support decision-making system, in the process of intelligent transformation, the expert system is mainly used to adjust the density set value of the industrial computer according to the density data changes in the actual production process, and transfer it to the PLC controller of the next layer, In order to realize the automatic output and control of each execution parameter.

5. Automation transformation, installation and commissioning of coal preparation process equipment

(1) Automation transformation of equipment

In the process of this equipment automation transformation, the traditional DMAC-II automatic control system was improved and upgraded to solve the problems of large media consumption, online monitoring and parameter adjustment in the current heavy-medium washing process. The IPC plus board form in the original system is changed to IPC plus PLC form.

In the discharge pipe of the qualified medium pump, 9 sets of magnetic content meters are added to detect the slime content online; 3 sets of chute sampling machines are added, and a belt is installed on the north side of the 801 belt to transport the collected heavy medium Clean coal; 3 new X-ray ash analyzers are added to separately detect the ash content of heavy medium clean coal in each system; the shunt valve and series medium valve electro-hydraulic gate valve are connected to the centralized control to realize remote control of the series medium amount.

In addition, after the PLC technology is applied to the coal preparation process, the traditional manual dosing form has also realized the transformation of the automatic dosing form. The actual flow and concentration changes are used as the basis to automatically adjust the dosing amount, which is to improve the production efficiency of clean slime, it also effectively avoids slime water system problems and floating "backward channeling" problems[3].

(2) Increase of flotation intelligent control equipment

The first is to increase the slurry ash detector, according to the on-site production situation, through the detection of concentrate, adjust the reagent system according to the ash content of the concentrate, improve the extraction rate of the concentrate, and ensure that the ash content of the concentrate does
not exceed the target. This transformation adds 2 online concentrate ash content detectors, each
concentrate ore slurry ash content meter alternately detects the concentrate ash content of 2 flotation
machines, and the detection time is about 10 minutes. In specific applications, in order to make full
use of the flotation concentrate ash detection data, the adjustment of the flotation time interval in
actual production should be determined according to the actual production situation.

The second is to increase the emulsification device and quantitative dosing device of the
medicament to replace the traditional manual control valve dosing; according to the feeding and
product parameters, feedback the optimal medicament system for the dosing system; the medicament
system is based on the input of the flotation machine real-time adjustment of parameters such as
material flow and concentration.

(3) **Installation of automation technology equipment**

First, add two industrial computer equipment in the centralized control room, and install DMAC-II
model heavy-medium process parameter automatic control software, STEP7 V5.3 programming
software and FX-V innovation form on the two industrial computer equipment for the automatic
flotation reagent addition control software[4]. At the same time, the PLC programmable device was
installed on the industrial computer equipment, its model is S7-300, and the PLC was programmed
according to actual needs.

The last is the addition of network equipment. With the help of industrial Ethernet, the
heavy-medium process parameter automatic monitoring system, centralized control automatic system,
and flotation reagent addition automatic control system are connected in the same network segment.

6. **Analysis of process test results**

After the optimization and improvement of this coal preparation process automation, in order to
identify the automatic control of heavy-medium process parameters and the actual operation of the
coal preparation automatic dosing system, the coal preparation plant carried out industrial tests on the
improved coal preparation process. The following is the specific coal preparation process test content
after this improvement.

(1) During the test, the process parameters of the intermediary system and the flotation system are
collected regularly, and the specific fluctuations of related data are observed.

(2) Carry out fast ash and fast float test on the middle coal separated from the three-product
heavy-media cyclone to check the content of the middle coal mismatch and calculate the productivity
and quantity efficiency of the clean coal.

(3) Make statistics on the actual consumption of media in the heavy media system and compare it
with the consumption before the upgrade.

(4) Perform a fast ash test on the tailings in the flotation system to check the coal running of the
tailings and calculate the productivity of flotation coal and the recovery rate of combustibles.

(5) Perform statistics on the consumption of flotation reagents, mainly including statistics on the
consumption of foaming agents and the consumption of collectors, and compare the statistics with the
consumption before the upgrade.

The following chart is the comparison of the technical indicators of the coal preparation plant
before and after the upgrading of coal preparation process automation:
Figure 1-Comparison of the separation density of raw coal before and after the upgrade of the heavy-medium control system of the coal preparation plant

Figure 2-Comparison of the level fluctuations of qualified medium barrels before and after the upgrading of the heavy-medium control system of the coal preparation plant

Figure 3-Comparison of the diversion opening fluctuation before and after the upgrade of the heavy medium control system of the coal preparation plant

Table 1-Comparison of clean coal production rates before and after the upgrade of the heavy-medium control system of the coal preparation plant

| Group          | Group1 | Group2 | Group3 | Group4 | Group5 | Group6 | Average yield |
|----------------|--------|--------|--------|--------|--------|--------|---------------|
| Before upgrade | 57.5%  | 58.1%  | 57.7%  | 58.9%  | 59.2%  | 56.7%  | 58.0%         |
| After upgrade  | 58.9%  | 59.7%  | 59.2%  | 59.5%  | 59.1%  | 58.7%  | 59.2%         |
Table 2-Comparison of media consumption before and after the upgrade of the heavy-medium control system of the coal preparation plant

| Group  | Group1  | Group2  | Group3  | Group4  | Group5  | Group6  | Average consumption |
|--------|---------|---------|---------|---------|---------|---------|--------------------|
| Before upgrade | 0.96kg/t | 0.99kg/t | 0.94kg/t | 0.96kg/t | 0.95kg/t | 0.98kg/t | 0.96kg/t |
| After upgrade  | 0.82kg/t | 0.80kg/t | 0.84kg/t | 0.84kg/t | 0.82kg/t | 0.81kg/t | 0.81kg/t |

Table 3 Comparison of the flotation tailings before and after the upgrade of the heavy-medium control system of the coal preparation plant

| Group  | Group1  | Group2  | Group3  | Group4  | Group5  | Group6  | Average ash  |
|--------|---------|---------|---------|---------|---------|---------|-------------|
| Before upgrade  | 68.5%   | 69.8%   | 68.4%   | 68.9%   | 69.7%   | 68.2%   | 68.9%       |
| After upgrade  | 73.8%   | 74.2%   | 74.4%   | 73.7%   | 74.9%   | 74.5%   | 74.2%       |

After half a year of trial operation, the effectiveness and advancement of the coal preparation process automation improvement of the coal preparation plant has been fully verified. It can be seen from the above chart that after this intelligent transformation, through the reasonable application of automation technology, which effectively reduced the content of mismatched coal in the middle coal, increased the productivity of clean coal by about 1.2%, and achieved a significant reduction in coal preparation media consumption. It can be seen that the intelligent upgrade and transformation of the coal preparation plant and the application of its automation technology have received very good results.

7. Conclusion
To sum up, in the coal preparation process of the coal preparation plant, the reasonable application of automation technology can allow the traditional coal preparation process to be optimized and upgraded, which will effectively increase the overall coal preparation process output and reduce the coal preparation media consumption, it can also make the coal preparation process more stable and reliable. This will play a good role in guaranteeing the production efficiency, production quality and production safety of the coal preparation plant, and will further enhance the economic benefits of the coal preparation plant.

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