

Design and Development of Training System for Teaching on Melter Gasifier Mechatronics

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Abstract—Based on the practical teaching requirements of metallurgical engineering, a cold position training device on the melter gasifier was designed in line with actual production. The control system adopts the integrated control cabinet and its design of the training device is implemented by the PLC of Siemens S7-300 and the configuration software of Real Bridge. The control mode includes two kinds of modes, which are remote control and manual control. Through the development and use of the melter gasifier training devices, the teaching content can be visualized. This device has been put into use in colleges, and obtained the good training effect.

Keywords—melter gasifier; mechatronics system; plc control system

I. INTRODUCTION

Metallurgical engineering is a major of strong engineering practicality, which is needed to improve the comprehensive analysis and the ability to use in practice. However, the ferrous metallurgical production process is a continuous industrial processes, and the process parameters are not allowed to change in the actual production process. So students do not achieve good effects by factory practice. In addition, students can not have the opportunity to practice by themselves in the practical process by taking safety and other factors into consideration. And it leads theory teaching to divorce from practice work. To make up the deficiencies of practical teaching and promote understanding of the professional foundation knowledge and metallurgical processes as well as equipments for students, developing related equipment for metallurgical technology training, creating realistic production environment of metallurgy process, enhancing the understanding of ferrous metallurgy production process for students and the engineering practice and innovation ability, are the basis to ensure the quality of course teaching[1]. Thus, we developed some practice teaching models of metallurgical engineering and the melter gasifier training device is one of the series of teaching model.

II. THE PRODUCTION PROCESS OF THE MELTER GASIFIER

DRI, calcined limestone and dolomite are added to the melter gasifier through the drop tube. The high temperature furnace charge through the distributor will be distributed in the semi-coke bed reasonably. In addition, non-coking coal, quantitative coke and silica should be added continuous by sealed cans. The oxygen blown from the tuyere can react with the coke and semi-coke to produce CO and release heat. Hot coal gas rise to transfer its sensible heat to semi-coke bed to

satisfy the metal-slag melting and other metallurgical reactions. Molten iron and slag accumulate in the hearth. The operation efficiency of the furnace relies heavily on the distribution of coal gas flow in the semi-coke bed and the use of sensible heat of the gas. The free space work temperature is controlled from 980°C to 1050°C to ensure the complete cleavage of the released volatile of the coal. The coal gas generated in the melter gasifier carries dust, which can be separated by the hot cyclone dust remover. The collected dust combusted with the auxiliary oxygen is returned to be injected into the melter gasifier for recycling by the dust burner located in the top of the semi-coke bed. The gas produced in the melter gasifier is blended with cooling gas to a suitable temperature (850°C), most of which is fed to the reduction shaft furnace and the excess gas is used to control the plant pressure.

III. THE MELTER GASIFIER TRAINING DEVICE

The melter gasifier training device was produced according to a 1:20 ratio of the actual melter gasifier, mainly including five parts of the main body of the furnace, distributing device, spiral ejector, charge recycling bins and base platform. The main body of the furnace is a semicircle structure, the upper part of which has air outlets and a number of pressure measurement points in the observation plane and the lower part of which has round hot blast pipes connecting the external the gas source and the gas tank through the gas flowmeter. And the main body of the furnace has 14 tuyeres. The base platform is located in the lower part of the main body of the furnace. The spire ejectors are installed in the location of feed tube corresponding to the each tuyere. Each spine ejector is connected to the motor and is controlled by it. The motor will connect the frequency converter and control the feed speed. The feed in the tuyere is to simulate the coke combustion consumption in the actual production. The other end of the spine ejector connects the charge recycling bins located in the base platform. The bottom of the furnace is a controllable and adjustable screw base to simulate the actual production of iron. Figure I is the training device of the melter gasifier process.

IV. CONTROL SYSTEM OF THE TRAINING SYSTEM

The control system uses mechatronics control cabinet, in which the computer system, frequency converter, PLC, circuit breakers and contactors are mounted. The control buttons are installed in the faceplate of the control cabinet. The computer's serial ports are connected to the PLC's MPI interface via the connecting cable.

The control mode includes two modes, remote manual control and local manual control. The remote manual control is operated by the operator via the HMI operator interface. The local manual control is operated by the buttons in the control box to control all the motors and valves on the scene.



FIGURE I TRAINING DEVICE OF THE MELTER GASIFIER PROCESS

The ECI control system is integrated modular unit of four layers. There are indicator lights of fault display corresponding to each motor in the front of the control carbinet. There are a total control and data displayer in the bottom of the indicator lights. There is a keyboard which can be pulled out below the displayer. When you perform an experiment, you should make sure all the circuit breakers in the carbinet are closed firstly, then connect to the external power and open the circuit breakers sequentially from left to right and from top to bottom lastly. If there is no exception appeared, the power indicator light will work. When the display screen is in normal standby state and there is no alarm and fault indication each part, the experiment can be carried out.

V. SOFTWARE DESIGN OF THE TRAINING SYSTEM

The design adopts cost-effective homemade Real Bridge configuration software, which will be combined with PLC control system for secondary development. The configuration design can complete the remote manual of the entile production process, while the data can be collected and managed in real time. All operations can be completed by the pulled keyboard below the display screen and the built-in touchpad mouse. There are the operating virtual buttons of all components of the system and the corresponding striking indication in the display screen. When clicking on the device of the corresponding portion, it can be run according to our requirements. The production process and equipment operating parameters of the blast furnace of the whole process of the production line can display in the blast furnace process flow diagram, main screen of the blast furnace system, motor control system screen, flow detection system screen and pressure detection system screen. Parameters of the production process can be modified in the corresponding parts of the screen through the keyboard. All the collected and operational

data during the experiment will be recorded in real time by the mouse and keyboard. The data can be saved in any location of the hard disc. Figure II is the main interface of the melter gasifier training system. Figure III is the control interface of the data collection and run tendency system of the melter gasifier. Figure IV is the control interface of the inquiry system of the data collection of the melter gasifier. Figure V is the control interface of the grouping drawing system of the data collection of the melter gasifier.

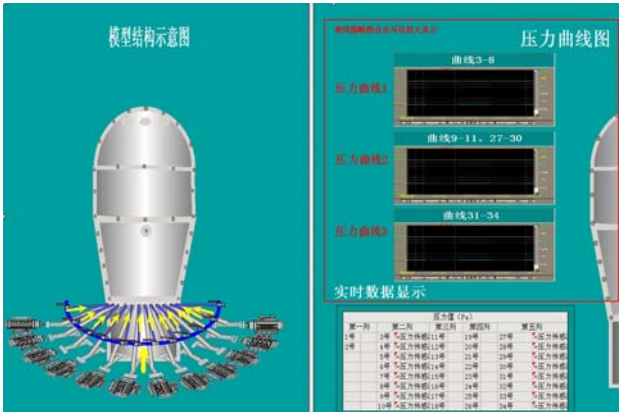


FIGURE II MAIN INTERFACE OF THE MELTER GASIFIER TRAINING SYSTEM

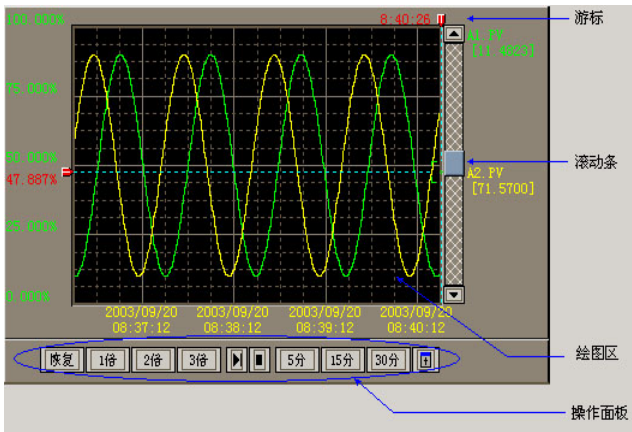


FIGURE III CONTROL INTERFACE OF THE DATA COLLECTION AND RUN TENDENCY SYSTEM OF THE MELTER GASIFIER



FIGURE IV THE CONTROL INTERFACE OF THE INQUIRY SYSTEM OF THE DATA COLLECTION OF THE MELTER GASIFIER



FIGURE V THE CONTROL INTERFACE OF THE GROUPING DRAWING SYSTEM OF THE DATA COLLECTION OF THE MELTER GASIFIER

VI. CONCLUSIONS

Through the development and use of the melter gasifier training devices, the teaching content can be visualized and the distance between the classroom and the practice can be narrowed. This device has been put into use for one year, and obtains the good teaching effect. The system has the following characteristics in practical teaching:

- (1) Applicability: The practical teaching system with its intuitive form can make students fully understand the production process and improve the timeliness of the teaching. The deficiencies of the field work which is allowed to see and not to try can be made up by establishing realistic simulation environment.
- (2) Comprehensiveness: Practical teaching system with computer modeling technique, powder-jet technology, mechanical transmission, motor drive technology and pneumatic conveying technology can achieve the integrated practice teaching of ferrous metallurgy process and operation, sensor, pneumatic technology, PLC control technology, electrical control system, mechanical system installation, motor drive technology, system maintenance, fault detection technology and configuration monitoring technology.
- (3) Flexibility: Practical teaching system can fit ferrous metallurgy, mechanics, automation, computer and other majors, which can meet the requirements of the practice training segment of understanding practice, production practice and graduation practice for students. Therefore, there is strong flexibility and more widely adaptability. On the other hand, not only the test can be appointed at any time, but also the impact on production by the operating conditions and the program changes can be experienced in the training process. It can enable students to deepen the understanding of the practice knowledge.
- (4) Security: Because of the complexity of the iron and steel metallurgy production process and the high degree of the continuity, there are security risks at any time and anywhere. Students will inevitably face security problems when they enter the site to study and practice. Practice teaching system provides a secure platform for teachers

and students to learn and practice. Teaching tasks can be completed in a more relaxed environment.

- (5) Practicability: Metallurgical engineering graduates, who are cultivated by the existing teaching mode, have poor perceptual knowledge for actual operation. So the factories often take a lot of time, effort and cost to retrain them. However, it makes teaching follow by the actual production by using practical teaching system to enable students to conduct necessary training operation to obtain practical skills.

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REFERENCES

- [1] X. G. Wang, J. F. Liu, J. G. Lu, "Design and realization of control system for heat transfer training device," *Automation & Instrumentation*, vol. 12, 2000, pp. 37-41