Design and Development of Training System for Teaching on Sintering Mechatronics

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***Abstract*—Based on the practical teaching requirements of metallurgical engineering, a cold position training device on sinter 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 sintering training devices, the teaching content can be visualized. This device has been put into use in colleges, and obtained the good training effect.**

Keywords-sintering; mechantronics 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 sintering training device is one of the series of teaching model.

II. THE SINTERING PRODUCTION PROCESS

Sintering is a process of putting iron ore particles into blocks, which the various powdered iron-containing materials mixed with the right amount of fuel and flux and the appropriate amount of water will make a series of physical and chemical changes in the sintering equipment after pelletizing. Currently, the sinter is widely produced by the belt sinter machine. The process mainly includes the preparation of the sintered material, blending and mixing, sintering and product handling. And the sintering operation is the central part of the sinter process, which includes burden distribution, ignition, sintering and other main processes. ①Burden distribution: it is mainly used by round roller distributing machine. Before the mixture distribution, a layer of bed charge is added. Then the distribution is conducted. The particle size and chemical composition are uniform along the vertical and horizontal directions of the trolley during the distribution process and the mixture is some loose and has a smooth surface; ②Ignition: this operation makes the burden layer surface on the trolley ignite and burn; ③Sintering: accurate control of air flow, vacuum, material layer thickness, machine speed and sinter burn through point.

III. THE MECHANICAL EQUIPMENT OF SINTERING TRAINING DEVICE

The mechanical equipment of sintering training device was produced according to a 1:20 ratio of the actual sintering machine, mainly including four parts of sintering trolley system, burden distribution system, ignition simulation device and negative pressure ventilation system.

Sintering trolley system: the work area of the sintering machine is of width of 0.3 meters and length of 3 meters. There are 34 trolleys in total. The rotate speed of the trolley drive system is regulated by the frequency converter. There must be seals device structure between the trolley and the frame.

Burden distribution system: it includes bed charge distribution device and sinter material distribution device. Distribution mode and speed are adjusted by the frequency converter.

Negative pressure ventilation system: the system is divided into two parts, ventilation negative adjustment of the ignition and sintering process and ventilation negative adjustment of the firing and cooling zones. Each part of the negative pressure can be adjusted according to the requirement of the sintering process.

Ignition simulation device: the use of the electrical device to simulate the ignition process. Figure I is the training device of the sintering 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 SINTERING PROCESS

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. Figure II is the main interface of the sintering training system. Figure III is the control interface of the sintering machine teaching system. Figure IV is the simulation interface of the iron ore sintering process.

The ventilation sintering process of the belt sintering machine is carried out from top to bottom, which can generally be divided into five layers along the material layer height including sinter layer, combustion layer, preheat layer, dry layer and overwetting layer in sequence. Then the last four layers disappear one after another and only the sinter layer leaves eventually. To enable students to recognize this process, the sintering process model has been developed. The change of sintering process material layer at different times can be judged according to the various sintering ignition temperature, material thickness, trolley speed, negative pressure of sintering section and cooling section.

VI. CONCLUSIONS

Through the development and use of the sintering 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.

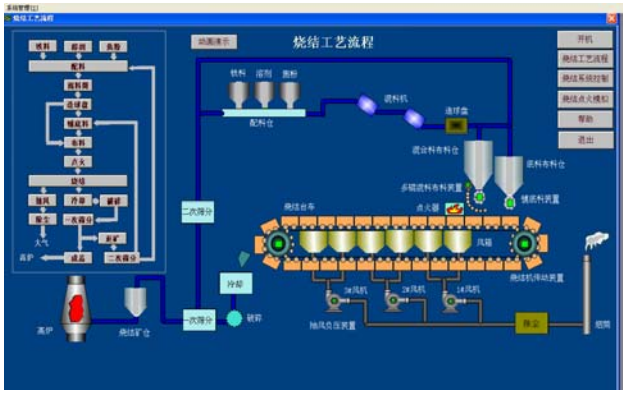

FIGURE II. MAIN INTERFACE OF THE SINTERING TRAINING SYSTEM

FIGURE III. CONTROL INTERFACE OF THE SINTERING MACHINE TEACHING SYSTEM

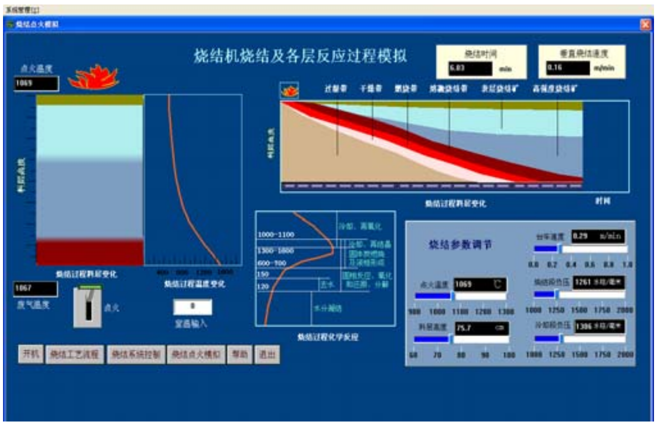

FIGURE IV. SIMULATION INTERFACE OF THE IRON ORE SINTERING PROCESS

(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