The Teaching Practice of Converter Steelmaking Simulation System

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Abstract. This article introduced the application of converter steelmaking simulation system in teaching practice. This system includes introduction of production equipments and production processes, and students' operation and examination. The application of this system has a better promoting effect on specialized teaching.

The specialized courses of metallurgical engineering mainly contain the processes of iron-making and steelmaking, which include many process equipments, operation systems, data and charts and so on. Hence the knowledge inevitably has strong engineering background, and is hard to avoid boring and abstract. With the modern teaching method innovating and developing, the computer assisted instruction (CAI) was introduced into the class teaching. The uses of pictures, animation, etc. make the class more interesting and vivid. But the iron and steel production process and their equipments are very complex, which result in the theory teaching has defects on the intuition and practicalness [1-5].

The converter steelmaking simulation system can make simulation demonstration of the converter process. By this system, the theory teaching can be combined with the animations showing of the equipments and processes which belong to converter steelmaking. On the other hand, the students can practice the operation of steelmaking by the system.

The application of the converter steelmaking simulation system is putting the theory of "teaching-learning-doing" into practice. It can enhance the students learning interest, and also obtained the good teaching result.

The introduction of converter steelmaking simulation system

The converter steelmaking simulation system consists of the pretreatment of hot metal, converter steelmaking, refining outside the furnace and continuous casting. Among these, the converter steelmaking is the hard-core, and is also the most complex. There are three operation interfaces of this system that respectively are converter steelmaking simulation interface, converter operation control interface and data variation simulation interface.

The application of the converter steelmaking simulation system on teaching

A Introduction of production equipments

The converter equipment has many types and their structures are complex. If only dependence on some illustrations to explain them in class, the knowledge is difficult to understand and accept. The simulation interface of converter steelmaking simulation system adopts three-dimensional animation to analog display the converter equipments, such as converter noumenon, tilting mechanism, supporting system, oxygen lance system, charging system and so on. When the system

used on the professional teaching, the vividness and interest of knowledge are improved markedly. For example, as the converter tilting mechanism is introduced, the simulation interface can show its position, type and structure, furthermore how to rotate the converter.

B Introduction of manufacturing technique and operating practice

The converter manufacturing technique is difficult to describe tersely by language, and the words are hard to avoid boring. This is one problem on the teaching of specialized course. The concepts and theories can be memorized mechanically, but the concrete steps of operation are not easy to learn. This is contrary to the training objective about improving the practical ability of students.

The converter steelmaking simulation system can simulate the whole converter production process, which are consist of five process systems, namely charging system, oxygen supplying system, temperature system, slagging system, tapping and deoxygenation alloying system. By this system, the steelmaking operation can be reproduced well in the classroom.

For example, when teaching the charging system, the knowledge points such as the charging order and its reasons, the converter tilting angular, the choice of scrap ratio, the influence of charging time on productivity and so on, are introduced, at the same time the simulate animation of the charging process can be shown to students. When necessary, the results of wrong operation can also be shown to deepen the understanding.

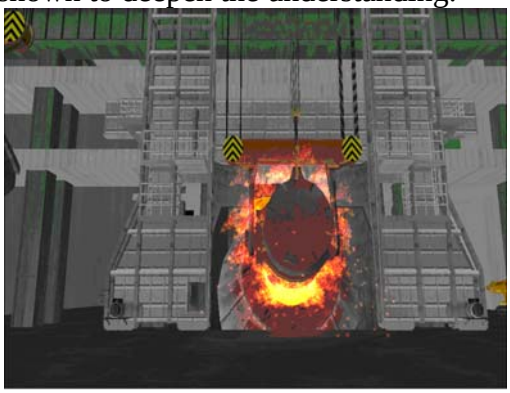

Figure 1. Charging hot metal

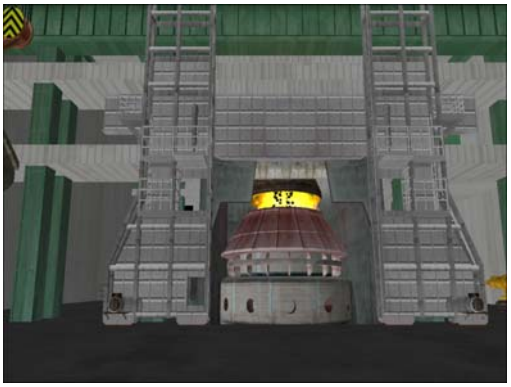

Figure 2. Charging slag materials

The simulation system has the operating floor, the same as which the steelmaking workshop has. Students can practice the steelmaking operation. The practice steps are following:

1) Charging. First, the suitable ratio of hot metal and scrap should be calculated based on a given total metal amount. Then tilt the converter to appropriate angle by controlling operating lever for adding the scrap and hot metal into converter according to the charging order. If the angle is not appropriate, the system will give a prompting of “angle is too large” or “angle is too little”, even stop charging, as shown in figure 1. The tilting angular of charging hot metal is different from that of charging scrap. So the angle of converter should increase, after scrap added. If the angle is not appropriate, the system will give prompting or stop the operation of adding hot metal.

2) Calculating the slag addition amount. The slag amount needs to be calculated, which is depending on the hot metal composition. The slag materials are composed of lime, dolomite, magnesium globe and iron ore etc. And their additions are set in the operation interface, namely weighing slag charge.

3) Lance position control. The oxygen blowing time needs to be calculated too. The calculation is based on the carbon content of hot metal and the target carbon content of molten steel.

After setting the initial oxygen lance position, descend the lance to blow. The lance position should be adjusted at any time according to the situation in the converter during the whole blowing process.

At the beginning of blowing, the lance position should be high in order to slugging. In the interim of blowing, the oxygen lance should be descended in order to decarburization. At the end of blowing, the lance should be descended more lowly for deep decarburization and catch carbon.

Adjusting and changing the lance position is a very important operational process. The operations are completed by setting parameters on the interface which is named lance position control. If the lance position control operation missed, there would be likely to cause accidents,

such as splashing, returning dry etc.

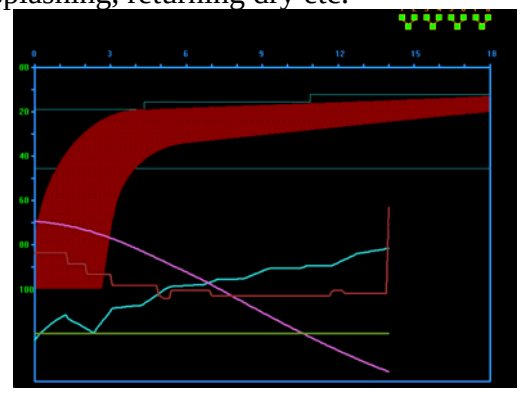

Figure 3. Converter end-point curves

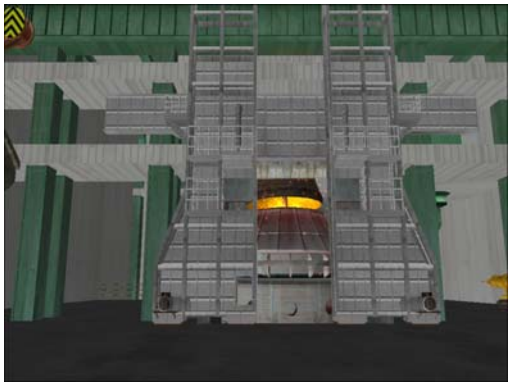

Figure 4. Slag splashing

4）Adding slag materials. It is also important to add the slag materials reasonably during blowing. The adding batch and amount of slag materials are first needed to ensure, and then add them into the furnace. As shown in the figure 2, the simulation system can also display the process of slag materials added into the converter, besides of the operation interface.

If the slag material was charged unreasonable, it would be a serious impact on the production process. For instance if the lime amount was not enough, it couldn't have the satisfying function of desulfurization and dephosphorization, and the converter lining would also be eroded. If the slag materials amount charged into converter were too much, it would lower the furnace temperature rapidly, thus the splash is prone to happen.

5) The end point control. Before the end of blowing, like in reality, the sublance was descent to measure temperature and take samples in order to decide whether it reaches the end point. The result is obtained through the calculation of the simulation system based on the above operation. If the temperature and carbon content of molten steel double hit, the tapping operation should be carried out, at the same time deoxidizing and alloying. Otherwise the reblow and other operations must be done. The interface of end point control is shown in figure 3.

The alloy amount was calculated depending on the steel requirement and weighed. Then the alloys were added the alloys into the furnace during tapping steel. The order depends on their deoxidizing capacity.

6) Splashing and tapping. After steel tapping, the converter should be turn to the vertical position, in order to splash slag, as shown in figure 4.

In practice, the work needed to be calculated include of the charging amount, blowing time, alloy amount and so on which mainly depend on the hot metal and steel composition. In addition the slag amount and the lance position need to be controlled during the blowing process, at the same time various operations completed, such as charging, tapping steel, slag splashing, tapping slag etc. All above make the students to review the relevant theoretical knowledge, and exercise their practice ability.

C As an examination for students

The teacher can use the converter steelmaking simulation system examine the students. The system will give score table after completing the whole operation which can show the details of operation during practice, such as the addition amount of each batch slag former, blowing time, the converter tilting angle, the rising-falling of lance, whether splashing or returning drying etc. Based on the details the system can give the final score. This score can be credited to the student's total grade as the evaluation of his practical abilities. This evaluation mode has been used on the course of steelmaking in two years. After a term of training, most students can relatively master the steelmaking operation process, and obtain a good score in examination.

The teaching practice showed that most students were more willing to accept this way of teaching and examination.

In fact, the chance of professional teachers to contact the operation is also less. Most researches about production process are done by means of the simulation. Therefore, with further development of the system, it will become a powerful tool for scientific research.

Conclusion

The advantages of introducing the converter steelmaking simulation system to the specialized course teaching of metallurgical engineering are following:

(1) On theory teaching, by three-dimensional animation simulation of field equipment and technological process, it can attract the student's attention and thus greatly improve the students learning interest.

(2) On practice teaching, the system creates a chance for students to hands-on operate the whole converter production process. The practical ability are trained, at the same time promote professional knowledge mastered. In this way, the applied talents training goal of metallurgical engineering comes closer to implementation.

(3) Performance appraisal objective, the students finished the examination by themselves, the performance obtained was real and objective and they were recognition and convincing.

However, this system also has many disadvantages, for examples, the pretreatment of hot metal adopts KR process, which is used less widely than powder spraying method, and the refining process only simulates LF method, which is so single. There are many widely used refining methods, e.g. RH and VOD etc. The system should be perfected and developed continually.

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