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Test Analysis of the 60 tons Converter

Qiang Yin[1,a], Gongfa Li[2,b]

[1]College of Mechanical Engineering, Wuhan Polytechnic University, Wuhan 430023,China

[2]College of Machinery and Automation,Wuhan University of Science and Technology, Wuhan 430081, China

[a]email:ydqking1210@sina.com, [b]email:ligongfa@yahoo.com.cn

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Abstract. Converter is the main equipment in steel making, and its work reliability decides the security and economy of steel production. Therefore, how to design and test analysis of converter has been an important subject of industry research. Through the static centric calculation of converter, combining independent software, compute dynamic center and dynamic torque of mass in the process of sampling and the tapping of converter. The reliable operation of converter through qualitative analysis are guaranteed by taking necessary measures.

Introduction

In recent years, the steel industry is developing rapidly, and pneumatic steelmaking is an important component in the steel industry. Therefore, the quality and output of the steel is directly related to the steel industry. To ensure the quality and yield of the steel, first of all ensure the safe operation of the converter equipment, especially the tilting part of the converter, it is not only the focus of the design converter, but also the difficulty.

The slag influent the converter deeply when the converter is tapping and sampling. The slag not only erodes the mouth of the converter, but also accumulates greatly. The slag is a long distance from the trunnion centerline of the converter which has a great influence to the dumping moment. Therefore, the slag is an important consideration when we design the converter.

There are four converters in the PUYANG factory and the converter is a 60-ton converter, during the converter tapping or sampling, a lot of problems occur to this converter in the actual production process, such as the accelerating the down – dip of the converter. According to statistics, this situation occurs 1-2 times per year. Once the molten steel poured out, which brings not only the economic losses but also the accidents of life. Many lessons have been learned at home and abroad from the accidents of converter "pouring steel". Now, the planning is carrying out that is to adjust the production structure of excess industry and improve the resource utilization. All these measures are carrier out to make sure the safety of the production. The content of this paper is the converter and the goal is to reduce the hidden trouble during the production through the analysis and calculations, finally, the feasibility of the measures are given to make sure the safety of the converter.

At first, this paper calculated the converter parameters during normal work (there were 60 tones of refractory brick and static centric). Then combined with independent software, calculate dynamic curve of converter when tapping and sampling. The curves of dynamic curve include the center of mass and moment curves; Finally through the qualitative change of converter parameters such as counterweight and the oven slagging, reasonably come to the dynamic curve and perform in the implementation and ensure the safety of the converter production.

Static Centric Calculation of Converter

Internal converter is often covered by a certain thickness of the refractory brick for molten steel smelting as Converter production. The centric position of converter is dynamic change as well as the torque converter as the sampling and tapping process of converter. It is easy to cause over steel and dumping and lead to serious accidents if not reasonable. This paper tells that the centric parameters of converter are calculated by using the software. Then according to the software, rendering out curve reflects the problems arising from the production process of converter and finally puts forward the measures to solve the problem.

Three-dimensional Model of Converter

There is light and shade spacing rules of mark on support roll surface which is shown as Fig. 1.

Fig.1 is for the converter drawings, mechanical structure of converter is mainly composed of six parts: the cold front of water-cooling pipe, furnace, converter, gear plate, small furnace body, furnace bottom slag and the tapping clamp. Through the PROE 3D modeling, using its centric calculation function can get static centric parameters of converter. Since the six basic parts of the body is revolution, the modeling process can be simplify the structure on the premise of ensuring the quality within the scope of error at the same time, which can increase the work efficiency and ensure the parameter accuracy. Table 1 is the PROE 3D modeling error quality table. From the table, the error is about 2.3% between the 3D model for total quality and the actual converter assembly quality.

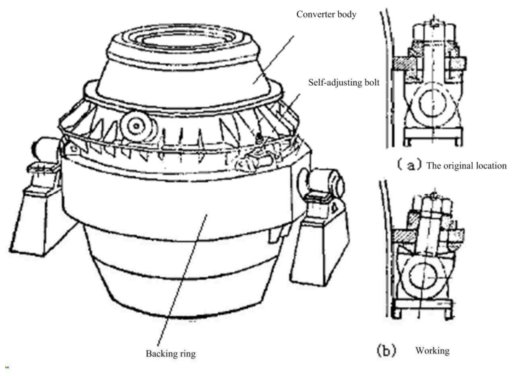

Fig. 1. The Converter

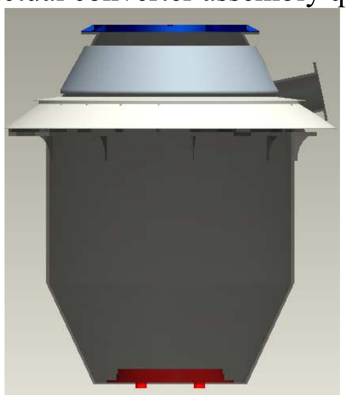

Fig. 2. 3D Model Converter

Table 1. Quality error table of the 3D modeling in PROE

Name	Total	PROE	error%
Tapping hole clamp	211	356	68.7%
Small bottom	3206	3158	-1.5%
Furnace body	58336	57834	-0.86%
Slag converter gear plate	3257.6	3149.8	-3.3%
The water-cooling pipe of furnace	914.4	963.3	5.3%
Water front	2951	2734.6	-7.3%
The general converter	69412	67840	-2.3%

Static Centric Calculation of Converter

The calculation of center of gravity position and weight of parts is overall coordinate to furnace body itself coordinate, length units: mm, weight: Kg. The contrast in table 1 found error of converter is 2.3%. We can conclude that the actual amount of converter and converter model is consistent which can ensure that the converter static mass center position is consistent with the actual. Centric position parameter can be calculated by PROE centric function. Table 2 is the center of mass position of the converter, table 3 is static centric position parameter of the converter. Due to the structure of converter for symmetric structure, only show values X, Y direction in the table , the Z direction is 0.

Table 2. The center mass position of Converter（unit:mm）

Project	Empty Furnace	Refractory	60 Tons Steel	Center Position
Center Position(X,Y)	(20,3936.7)	(10.3,3452)	(0,1625)	(0,3640)

Table 3. Static centric position parameter table of Converter（unit:mm）

Project	Empty Furnace	Furnace with Firebrick and 60 Tones Steel	Trunnion Center Position
Center Position(X,Y)	(19.96,3936.7)	(10.2,3203.3)	(0,3640)

Results of Analysis

From table 2, the centric mass position of converter cushioned the refractory in the furnace and equipped with 60 tones of steel is (10.2, 3203.3, 0), which is in the center of the trunnion, a distance of 436.7 mm.

Center of mass relative to the center line of the trunnion distance will be reduced only by furnace bottom weight. This is what makes the scene to improve the 4 # converter splashing steel.

Dynamic Centric Calculation of Converter

In this paper, the design of the software is base on VC + + , the main function is to imitate the converter operation; describe dynamic center curve of the converter and dumping moment curve and torque curve. The software can quickly and accurately get the center position of converter no matter what state it is, the converter tilting moment curve is gotten much more easily. Observe dumping moment curve of the converter to find out the reason for pouring steel.

According to Eq. 1and Eq. 2, the center of mass coordinates formula:

$$x=\frac{M_{x1}+M_{x2}+M_{x3}+\cdots+M_{xi}}{Z_1+Z_2+Z_3+\cdots+Z_i}\quad i=1,2,3\cdots \tag{1}$$

$$y=\frac{M_{y1}+M_{y2}+M_{y3}+\cdots+M_{yi}}{Z_1+Z_2+Z_3+\cdots+Z_i}\quad i=1,2,3\cdots \tag{2}$$

Software Introduction

The two functions of this software include the static center of mass and dynamic center of mass. The slicing method and integral method is applied to calculate the center position curve of converter dynamically. First determine the intersection position between the steel surface and the furnace wall, and then calculate the center position of the steel, finally the results are obtained by the cumulative.

It is very easy to run the software. Before running the software, please enter the specific parameters of the converter in parameters dialog box as fig.5. According to the data stored in TXT files, the curves of the steel center and molten steel dumping moment , then the curves are displayed in the view of the software. You can see the picture of molten steel and converter rotation when software is running, which is shown in Fig. 3.

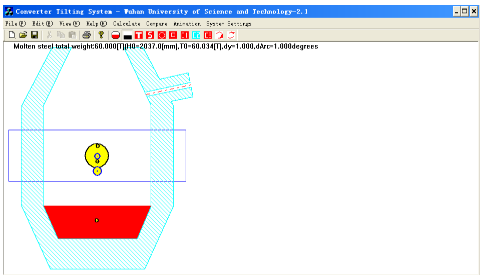

Fig. 3. 3d Layout of the Sensor

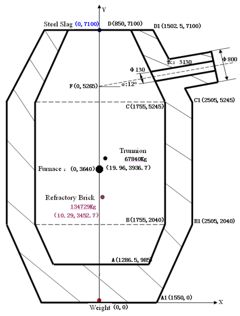

Fig. 4. Parameters Corresponding to the Data of Converter

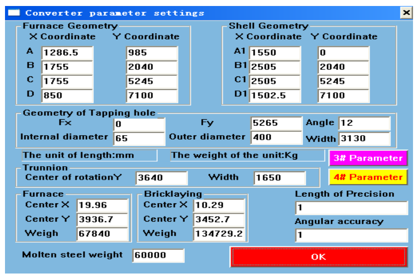

Fig. 5. Parameter Setting

Dynamic Centric Calculation of Converter

Through the set of parameters, the variation curve of centric of converter when tapping and sampling is depicted by using the software. The parameters are input according to the specific circumstances of the converter, such as counterweight, slagging and the presence of molten steel. For example, as shown in Fig. 6, the thin solid line is the graph of tilting moment of empty furnace and molten steel, the thick solid line is the graph of tilting moment of empty furnace and molten steel and slagging. As shown in Fig. 7, the thin solid line is the graph of tilting moment of empty furnace and molten steel, the thick solid line is the graph of tilting moment of empty furnace and molten steel and slagging. Fig.7 is the graph of tilting moment of the converter. The significance of the curve of tilting moment when sampling is the same as the tilting moment when tapping.

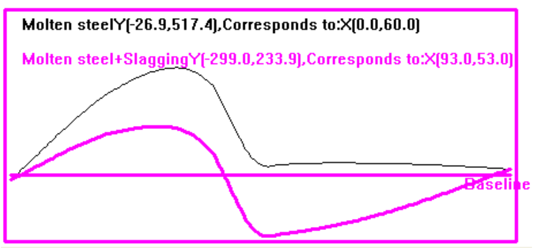

Fig. 6. The dumping moment curves of converter

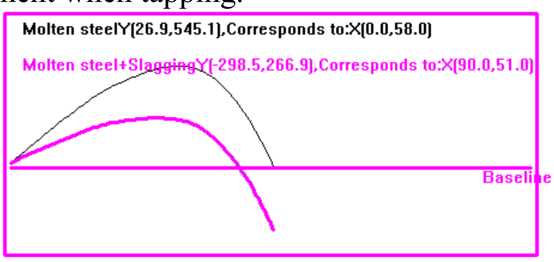

Fig. 7. The dumping moment curves of converter

Analyze the Test Result

As can be seen from Fig.7, when no slagging, the converter tilting moment is positive, the phenomenon of accelerated dipping of converter does not occur. Accelerated dipping is that the converter can not automatically reset under the action of its own gravity and friction when the motor torque is zero. When slagging, the converter tilting moment becomes negative. Sampling curve is in the same way. Through the distribution of curve, the various problems existed in the scene can be solved effectively, such as when to clean the mouth of the furnace, and when to add counterweight and regulation between each other.

Conclusions

The software is designed to get the dynamic centric curve of converter quickly and accurately, so as to solve the problem of accelerated dipping of converter quickly. The software design content includes a variety of situations, and the different types of dynamic centric curve of converter can be depicted for different situations. The basic principle is to compare the dynamic curve of tilting moment of force which is calculated by using the software, to determine whether the migration of total centric of converter is above the centerline of trunnion. Based on the above design and qualitative analysis, necessary response measures are taken to ensure reliable operation of converter.

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