International Journal of Research Studies in Science, Engineering and Technology
Volume 9, Issue 1, 2022, PP 21-25
ISSN 2349-476X
DOI : https://doi.org/10.22259/2349-476X.0901004

Development and Application of Continuous Casting Billet Weight Model

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ABSTRACT

*Based on the cutting transformation practice of a 4-machine 4-strand continuous caster in a factory the continuous casting billet weighing model development, weighing equipment design, processing, production and installation, weighing effect and stability of the 220 mm *220 mm section billet of the billet continuous caster in the factory are studied and introduced in detail. Through the input of the continuous casting slab weight setting system, the slab weight deviation within plus and minus 3 kg accounted for 97.26 %, and the weight deviation within plus and minus 4 kg accounted for 98.19 %. After the fixed weight and fixed rolling, the yield of tracking different specifications of fixed weight billet increased by 0.64 to 0.91 %.*

Keywords: *Continuous casting; billet; Fixed weight; Scale rate*

Background

With the development of steel production technology, our requirements for high-quality steel are increasing constantly and it is the basic need to explore the different ways to improve the steel quality[1].The accuracy of weighing equipment is ensured, so as to ensure the control accuracy of billet weight determination[2]. The accuracy of billet weight determination directly affects the yield of rolled steel, and has a significant impact on the economic benefits of screw steel production enterprises. The stable and reliable on-line cutting technology of slab is the basis for realizing the precise re-production of slab[3] . The precision of weight setting is affected by many factors, such as the density of steel, the change of section size with the amount of mold copper wall, the lubrication performance of continuous casting slag, the shrinkage of slab caused by different superheat and so on. Therefore, it is the technical difficulty of field control. Extensive numerical and experimental studies have been proved that soft reduction (SR) technology could effectively reduce the internal voids and cracks defects during the continuous casting process[4].

The factors affecting the precision of weight setting are complex and diverse, including equipment conditions, production rhythm, tundish temperature, casting speed, slag lubricity, mold deformation, steel grade change, casting section, etc. The investment of the constant weight slab supply system can greatly improve the pass rate of the slab after rolling and effectively reduce the production cost of the steel rolling process[5]. In this paper, various factors are systematically studied, and the main factors that can be quantified are summarized. By establishing the online model of billet weight determination, the length of billet sizing is accurately predicted. Then, according to the weight data of billet fed back by the weighing system in real time, the length of sizing is dynamically adjusted to stabilize the weight of billet and improve the accuracy of billet weight determination.

Test Conditions and Improvement Measures

Process Conditions

The No. 8 continuous caster in a certain factory is one of the main bases for product transformation and upgrading, and its main section is 220 mm × 220 mm. Subsequently, the small and medium-sized bars are mainly rolled. In the early stage, the pure ruler system is used to control the billet weight, which has a large deviation from the requirement of rolling. The accuracy of billet weight determination directly affects the yield of rolling, and has an inestimable impact on the economic benefits and production efficiency of enterprises[6] . The weight of the plant is confirmed by the way of vehicle weighing. The weight adjustment is lagging and cannot be adjusted in single flow, which affects and restricts the improvement of rolling scale rate and yield rate. Therefore, through the weight-fixing transformation of the caster, the on-line intelligent control model of slab weight-fixing was developed, and the field test was carried out to stably put it into use for cutting the continuous casting slab by weight.

Test Principle

In the process of continuous casting billet production, the length of continuous casting billet is accurately predicted by the weight control model according to the target weight. When the billet reaches the corresponding position, the signal is sent to the PLC of the fire cutting machine. The PLC of the fire cutting machine receives the signal and performs the corresponding action to complete the accurate cutting of the billet. After the cutting of each strand slab, the weighing data are calibrated by the subsequent weighing equipment, which is used for the self-learning of model big data to make the weight of the slab after cutting approach the target weight to the maximum extent [7], as shown in Fig. 1. The cutting module mainly consists of image acquisition module, algorithm module, brightness contrast module and adjustment module [8].

For each cutting, the information of the billet length, actual length, target weight, width, thickness, steel grade, cutting time, operator, team and other information will be stored in the database ; after weighing system, the data input system is used for analysis automatically. The system provides a flexible query interface, which can query and count production records ; the system introduces the flow, scale, actual length, weight and actual weight into the secondary system of continuous caster production control. The existing resources are fully utilized to form a relatively complete cutting control system, which has the advantages of less investment, simple installation, debugging and operation, and basically maintenance-free[9].

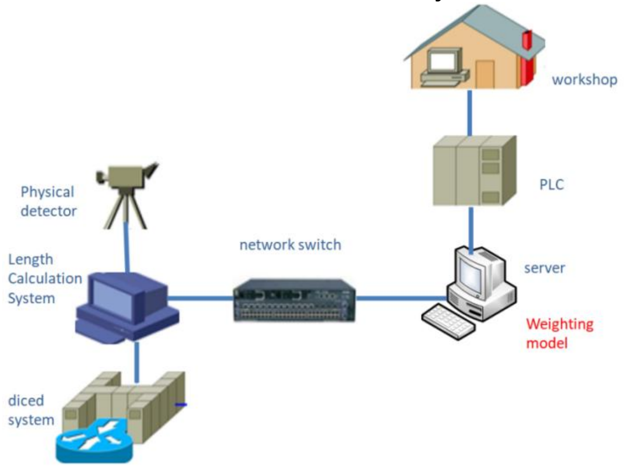

Figure1. *Schematic diagram of fixed weight model and weighing system*

Equipment Development

When selecting the weighing sensor device, the harsh working environment and immobility of the sensor are fully considered, and the high-temperature resistant and waterproof weighing is adopted [10]. The weighing device is installed between the billet storage frame and the rack of the cold bed. The automatic spraying machine can directly judge the flow number and branch number of the weighing billet and achieve accurate tracking. After debugging, exploration and analysis, equipment modification and system improvement are carried out from the following aspects : the cooling water of the scale body is improved to ensure that the internal cooling water of the scale body is not affected by the pressure and the total water storage is not changed. Accuracy is an important performance index of the sensor, which is an important link related to the measurement accuracy of the entire measurement system [11].The water cooling pipeline is added at the position of the scale sensor to ensure that the sensor temperature is not higher than 70 °C. The cooling water of the beam below the weighing device is changed from the original series mode to the parallel mode. The sensor line is extended and directly connected to the weighing data transmitter to realize the automatic acquisition and automatic feedback of weighing data, so as to form the closed-loop control of continuous casting billet fixed weight cutting by the continuous casting billet Internet. Through the reasonable design of the site position, a weighing body is realized to control the weight of the billet of four streams at the same time, which changes the drawbacks of the previous single weighing body to control the weight of the billet of a single stream. The implementation of slab constant weight cutting can significantly improve the rolling yield and enhance the overall economic benefits of enterprises[12] .The installation position of weighing equipment is shown in the red frame line area in the diagram below.

Figure2. *Installation location of weighing equipment*

TEST EFFECT AND DISCUSSION

Qualified Rate of Billet Weight Determination

Table1. *Qualified Rate Statistics of Continuous Casting Billet Weight*

index	Qualified expenditure	Qualified rate of test	Target qualified rate	compliance situation
≤±3kg	92	92%	≥80%	compliance
≤±4kg	92	92%	≥85%	compliance

A total of 100 billets were weighed in the acceptance test, and the total number of unqualified billets was 8. The number of unqualified billets appeared in the early transition stage of fixed weight input. After the first acceptance, the weighing system is put into use again, and the accuracy compliance rate and distribution are counted. From the data, the index is stable and improved.

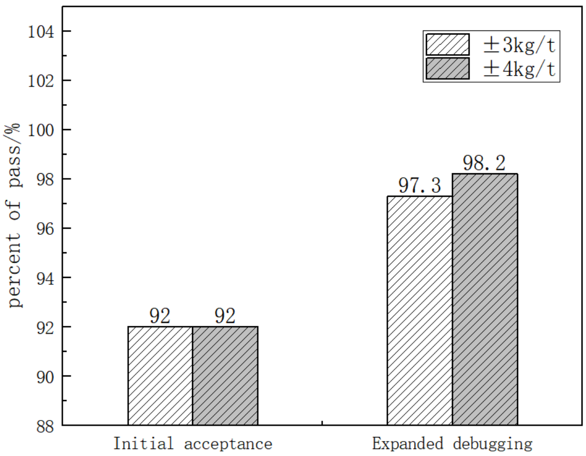

Figure3. *± 3 kg error rate of fixed weight model after batch input*

After batch input, the weight accuracy compliance rates increased by 5.3 % and 6.2 % respectively under the conditions of ≤±3 kg and ≤±4 kg. From the perspective of slab single deviation, the single deviation distribution is mainly concentrated in ±2 kg. The factors affecting slab weight include slab length, section size, casting speed and mouldlife[11].

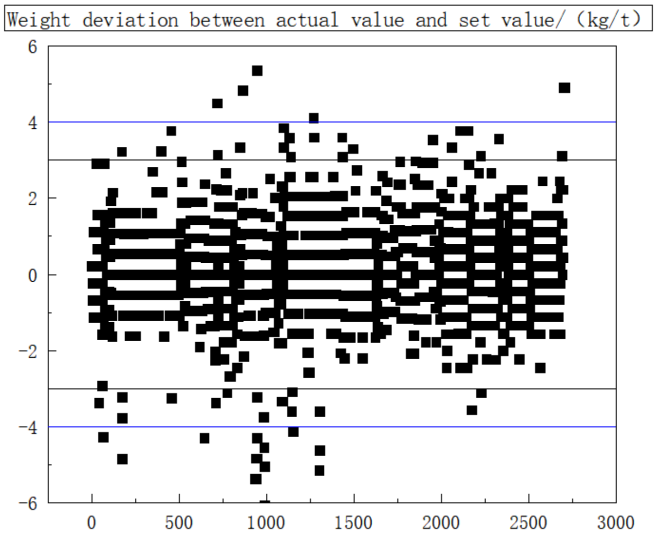

Figure4. *Single deviation distribution of fixed weight model after batch input*

Change of Rolling Yield

The change of rolling yield before and after constant weight rolling was compared. The yield before rolling was 97.14 %, and after rolling was 97.7 %. After constant weight rolling, the overall comprehensive yield increased by 0.56 % compared with that before rolling. Focus on tracking the specification of constant weight rolling, rolling yield increased to 0.64 to 0.91 %. It is conducive to improving production process operation and optimizing production process[14] .

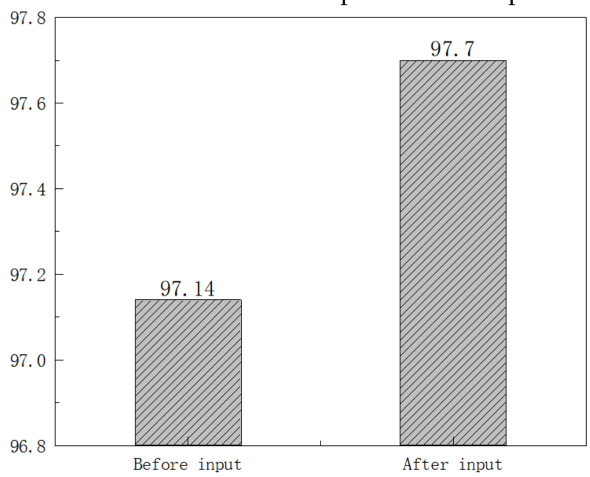

Figure5. *Comparison of rolling yield before and after constant weight input*

By controlling the previous process, i. e., the weight of the continuous casting slab in a certain precision range, the yield rate and the sizing rate of the rolled steel can be greatly improved, the waste of the cutting end can be reduced, and the sizing rate of the product can be improved. By accurately adjusting the length and weight of the continuous casting slab, the online real-time dynamic cutting can be realized[15] , creating great economic value for enterprises.

Conclusions

1) By developing the weight-setting model, the previous pure weight-setting mode is broken and changed, and the dynamic online precise control of weight-setting is realized. According to the weight-setting requirements of different steel grades, the weight-setting model can be switched at any time.
2) For the first time, a single weighing body is used to weigh four flow billets, which changes the previous model of single weighing body to control the weight of single flow billet. This not only reduces the maintenance effort and time of the equipment body, but also reduces the investment cost.
3) For the first time, the network connection between the weight-fixing system and the secondary system of a certain factory is opened. Each billet put into the weight-

fixing system can be traced back to a single weight and can be searched in the secondary system.

4) Through the input of the weighing system, the proportion of billet weight deviation within ±3 kg accounted for 97.26 %, and the proportion of billet weight deviation within ±4 kg accounted for 98.19 %. The yield of rolled products with different specifications of tracking constant weight billet increased by 0.64 % to 0.91 %, creating remarkable economic benefits for enterprises.

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Citation: *Sui Zhisong et al. "Development and Application of Continuous Casting Billet Weight Model", International Journal of Research Studies in Science, Engineering and Technology, 9(1), 2022, pp. 21-25.*