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Upgrade and Renovation of Steel Billet Scale in front of High-speed Wire Furnace

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Abstract: This article briefly introduces the weighing device for steel billets in front of the heating furnace of the high-speed wire rod unit, and analyzes and summarizes the problems existing in the original weighing device for steel billets in production and use. Based on on-site installation conditions, design a new weighing method, match a large range weighing sensor, upgrade the automation control of the weighing device, and remotely transmit the billet weighing data to the MES system of the group. The automatic, stable, reliable, and accurate measurement of steel billet raw materials has been achieved, providing important guarantees for the accurate measurement of production line billet and product yield.

Keywords: weighing device; gate type boom type; weighing sensor

Introduction

In the production process of bar and wire, the raw material billet needs to go through the feeding and weighing process before entering the heating furnace. Many production enterprises often use the measurement and weighing of continuous casting steel billets in the steelmaking process as the basis for raw material weight in actual production, and omit the weighing and measuring process before the steel billets are put into the furnace. But with the increasing demand for precise cost accounting and ultimate control in the entire industry, the weighing of raw material billets in the rolling process has become an important basis for calculating the yield and length of steel billets, and an indispensable link in the production process of bar and wire rods.

During the construction of the high-speed production line in the company where the author works, a hydraulic lifting steel billet scale was designed at the second section of the roller conveyor. However, in actual use, due to the insufficient weighing and measurement accuracy of the steel billet scale equipment in front of this furnace, as well as the complex structure and frequent faults of the equipment that are not suitable for maintenance, it affects the production rhythm and the equipment utilization rate is not high. Secondly, due to the low requirements for measuring the yield of steel billets, the rolling process is based on the theoretical weight of the steel billets used for steelmaking as the basis for measuring the billets. Due to various factors, the steel billet weighing equipment in front of the furnace has been abandoned and used since 2014 until before this renovation [1].

1 The composition and existing problems of existing steel billet weighing equipment

The weighing equipment for the steel billets in front of the original furnace of the high-speed line unit where the author is located is arranged below the roller conveyor behind the cold billet stand. The equipment mainly consists of six parts: lifting arm, weighing platform, weighing sensor, base, driving hydraulic cylinder, and pull rod.

The operating process of the equipment is as follows: the small square billet that falls from the cold billet platform onto the conveyor roller is transported by the roller to the weighing roller. The steel billet detection device on the weighing position detects the presence of steel signal, which is

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transmitted to the main control. The main control output controls the weighing platform to drive the hydraulic cylinder to lift, and the steel billet is 70-90mm away from the roller surface. The weighing sensor measures the billet weight and transmits the data to the company's MES system, which records the batch number and weight information of the billet, The main control system drives the hydraulic cylinder to lower and return to its original position, completing the entire weighing process. However, the existing weighing device is located below the furnace roller conveyor mechanism, and the roller conveyor base and weighing device base are installed together on the same base. Due to the shaking caused by the steel billet during transportation, this shaking is transmitted to the scale body through the base, resulting in the scale body needing to wait for the entire device to stabilize before obtaining the correct weight value [2]. This leads to a long weighing time, large numerical fluctuations, and measurement deviations. Secondly, the driving hydraulic cylinder of the equipment is located at the bottom of the roller conveyor and weighing platform, and the entire scale body is located in the "pit". The iron oxide scale shaken off by the steel billet often buries it, and the cooling water of the roller conveyor leaks into the pit, soaking it in water. The harsh operating environment causes the hydraulic cylinder to frequently malfunction and malfunction. The limited operating space makes its maintenance and repair very inconvenient. Due to frequent malfunctions, difficulties in equipment maintenance, and significant measurement deviations, this equipment severely restricted production. Therefore, shortly after being put into operation, it was discontinued and the steel billet weight measurement was changed to theoretical weight measurement. However, this method of measuring steel billets has a significant impact on the accuracy of the yield rate of the production line, resulting in high production costs for the unit. Therefore, upgrading and renovating the equipment is imperative [3].

2 Determination and implementation of renovation plans

2.1 Determination of renovation plan

By referring to Table 1 and summarizing the characteristics of three common types of billet weighing equipment, we found that the roller conveyor integrated billet scale uses the roller conveyor and base as the lifting platform, and the entire equipment has both the function of conveying steel billets and weighing. However, it involves changes in the overall layout of the equipment, requiring the removal of the entire roller bed and redesign of the civil foundation. The entire equipment operation and control are relatively cumbersome, occupying a large space, requiring a lot of equipment investment, and taking a long time to shut down for renovation. At the same time, due to the steel billet stopping weighing on the roller conveyor, the steel billet passing through the roller conveyor has a significant impact on the sensor, and there is also a risk of inaccurate measurement. Therefore, due to limitations in venue, funding, and time, it is not suitable for this on-site upgrade and renovation.

Looking at the gantry crane arm type steel billet scale again, it sets the entire weighing equipment above the roller conveyor. The supporting arm of the scale is a gantry crane arm structure, which is fixed to the scale platform through bolts. The entire scale platform is lifted up by a driving hydraulic cylinder located on the side of the roller conveyor. The platform lifts the billet off the roller conveyor through the gantry crane arm to achieve billet weighing. This type of equipment is arranged separately from the steel billet conveying roller conveyor to isolate the impact of steel billet operation vibration on measurement. The design structure of this equipment is simple and reliable, with low equipment investment and relatively short processing and production cycles. At the same time, this type of equipment renovation does not require civil construction, and its shutdown requires a short installation and debugging time, which has a small impact on production. It is the preferred model for this furnace front steel billet weighing equipment renovation.

2.2 Implementation of renovation plan

The modified weighing device is mainly used for weighing steel billets of steel rolling production lines, wire rods, or other steel billets. It belongs to the category of metallurgical equipment and is the mechanism for weighing steel billets in the rolling equipment roller conveyor, used for weighing steel billets. Before entering the furnace, it is often necessary to weigh the steel billets on the roller conveyor. In the past, in addition to weighing steel billets, the total weight of roller assembly, roller conveyor frame, and cover plate was also included in the weighing device. As a result, the weighing weight was greatly increased, and the impact of the steel billet counterweight system was also significant. As a result, the requirements for counterweight sensors were increased, resulting in a decrease in service life and a significant increase in manufacturing and maintenance costs. And this new type of weighing scale only measures the total mass of the mechanism itself and the steel billet, greatly reducing the weight of the weighing sensor, increasing its durability, and greatly reducing costs [4].

2.3 Equipment composition and working principle

Install the weighing device in the middle of the roller conveyor that needs to be weighed. The device consists of a lifting arm, weighing frame, base, hydraulic cylinder, weighing sensor, etc. The lifting arm and hydraulic cylinder are

Table 1 Comparison of characteristics of three forms of steel billet scale equipment

Type	Integrated roller conveyor	Hydraulic lifting type	Gate type boom type
Scale form	Large overall size, weight, and ease of use	Long size, heavy weight, easy alignment, stable	High requirements for center positioning, relatively complex
Weigh	Reliable operation, heavy overall equipment, and difficult calibration	The action is reliable, the overall equipment is heavy, and calibration is difficult	Stable movement, lightweight overall equipment, and convenient tuning
Driving form	Hydraulic cylinder drive	Hydraulic cylinder drive	Hydraulic cylinder drive
Scale lifting height	300-350mm, high	200-250, short	150-200m, short
Equipment weight	35t	7.5t	5t
Invest	Big	Big	Small
Construction difficulty	Civil construction and equipment installation shutdown for 15 days	Civil construction and equipment installation shutdown for 15 days	No civil construction, equipment installation workers stop for 1 day
Maintenance	More complex	Complex	Simple

pressed onto the weighing sensor through the weighing frame, and the weighing sensor is supported on the base. After the steel billet enters the weighing area, the hydraulic cylinder lifts the lifting arm, connects the steel, weighs it, and then sends the steel to complete the weighing action. The entire weighing process is completed through a hydraulic cylinder, which is fast and convenient. The weighing sensor is installed between the base and the weighing frame, and is equipped with guiding screws.

Support I and Support II are respectively installed on the weighing frame. The flat head at one end of the hydraulic cylinder is connected to Support I through a pin shaft, while the flat head at the other end of the hydraulic cylinder is connected to one end of the lifting arm through a pin shaft. The other end of the lifting arm is connected to Support II through a pin shaft.

A guide wheel is installed on the weighing frame. The weighing device is installed between the roller tracks within the weighing range. When the steel billet is fed into the roller tracks within the weighing range, the hydraulic cylinder lifts the lifting arm in the waiting steel position. Under the guidance of the guide wheel, the lifting arm rises to the steel receiving position, and the entire steel billet falls onto the lifting arm. At this time, the entire weight of the steel billet is pressed onto the weighing sensor through the weighing frame, and the weighing sensor can weigh the total weight of the steel billet, thereby achieving the purpose of weighing. As the weighing is completed, the hydraulic cylinder retracts, the lifting arm returns to the waiting position, and the steel billet falls onto the roller conveyor and is sent to the next process, ending the weighing process of one steel billet. When moving on to the next one, simply repeat the above operation to achieve automated continuous operation.

2.4 Specific structural configuration

When not weighing, the steel surface of the lifting arm is lower than the roller surface. When weighing, the hydraulic cylinder lifts the lifting arm. Support I and Support II are respectively installed on the weighing frame. The flat head at one end of the hydraulic cylinder is connected to the support through a pin shaft, while the flat head at the other end of the hydraulic cylinder is connected to one end of the lifting arm through a pin shaft. The other end of the lifting arm is connected to Support II through a pin shaft, and the lifting arm is lifted and lowered through the hydraulic cylinder. Four weighing sensors are installed between the base and the weighing frame. The lifting arm and hydraulic cylinder are pressed onto the weighing sensors through the weighing frame. The weighing frame is guided by screws, and the weighing sensors are supported on the base. There are two guide wheels installed on the weighing frame, and the lifting arm moves up and down under the guidance of the guide wheels.

3 Conclusion

Through the modification of the weighing equipment for steel billets in front of the furnace and practical verification on site, the accuracy of steel billet weighing has been improved, meeting the requirements of production measurement. The overall equipment has been put into operation quickly, with reliable and practical actions, convenient operation, convenient equipment maintenance, and a low failure rate. The renovation has achieved good results. The renovated steel billet weighing equipment has been running

smoothly and without any faults during the 6-month operation period. It has effectively promoted the steady improvement of production and achieved the goal of upgrading and transformation.

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Reference

1. Zou Jiaxiang. Steel Rolling Machinery [M]. Beijing: Metallurgical Industry Press, 2006.
2. Editor in Chief Cheng Daxian. Mechanical Design Manual (Volume 1, Part 3, Fourth Edition) [M]. Beijing: Chemical Industry Press, 2002.
3. Wen Qingming, Cheng Zhiyan. Steel Rolling Machinery Equipment [M]. Beijing: People's Posts and Telecommunications Publishing House, 2005.
4. Cheng Zhisong, Xu Yandong, Su Jianhua. Design and process selection analysis of high-speed wire finishing and collection equipment [J]. *Metallurgical Equipment*, 2014 (01): 66-69.
5. Liu Jia, Sun Fuqing, Fu Xiuning. Design of hydraulic system for walking beam heating furnace in high-speed wire plant [J]. Metallurgical Equipment, 2023, (S2): 79-80.
6. Ning Zhonghe. The application of ultra-low emission combustion technology in the high wire heating furnace of Baosteel's long material plant [J]. Metallurgical Management, 2023, (15): 26-27.
7. Hao Deming, Meng Fanzhen, Zhao Shubin. Optimization design of chain hoist for heating furnace of hot rolling high speed wire [J]. Industrial Furnace, 2019, 41 (05): 50-52.
8. Zhu Shanhe, Song Zhonghua, Luo Wei, Ding Cuijiao, Chen Chao. Heat balance testing and energy-saving technology improvement of high-speed wire heating furnaces [A]. Proceedings of the 10th National Academic Annual Conference on Energy and Thermal Engineering [C]. Energy and Thermal Engineering Branch of the Chinese Society of Metals, Northeastern University, Energy and Thermal Engineering Branch of the Chinese Society of Metals, 2019: 4.
9. Bu Zhenhua. The principle and related knowledge of walking beam control for high-speed wire heating furnace [J]. Technology Wind, 2019, (09): 180.
10. Li Wen, Chen Dian, Wang Xiaolong, Miao Weiren, Liu Yanyan, Jiang Bo. The application of air gas dual thermal storage combustion technology in high-speed heating furnaces [J]. Industrial furnace, 2019, 41 (01): 25-28.
11. Deng Yuanjiang, Hong Jianzhong. Practice of Overhaul and Renovation of High Speed Line Heating Furnace [J]. Shanxi Metallurgy, 2018, 41 (04): 83-85+106.
12. Yang Yang. Improvement and optimization of the electrical system of Xuansteel's high-speed wire heating furnace [J]. Technology and Innovation, 2018, (11): 146-147.
13. Chen Wenyong, Zhang Haigang, Qu Zhanli. Technical transformation of regenerative heating furnace [J]. Industrial Furnace, 2017, 39 (03): 70-72.
14. Chen Jun. Practice of Enhanced Thermal Radiation Technology in Heating Furnaces [J]. Equipment Management and Maintenance, 2017, (05): 150.
15. Yue Xiang, Wang Yongqiang, Wang Anlong. A study on the shutdown and sealing mode of heating furnaces under extremely cold conditions [J]. Modern Manufacturing Technology and Equipment, 2016, (06): 5-6+26.
16. Wen Xulin, Feng Zuqiang, and Lu Yanhui. Monitoring and analysis of flue gas in the heating furnace of Liugang steel rolling mill [J]. Metallurgical Energy, 2016, 35 (02): 24-29.
17. Chen Yang, Rong Weiwei, Huang Zunyun. Practice of reducing oxidation and burning loss of steel billets in heating furnaces [J]. Tianjin Metallurgy, 2015, (04): 30-33.
18. Cao Liangliang. Temperature field simulation of flipped steel billets in a heating furnace [D]. Liaoning University of Science and Technology, 2015.
19. Wei Zhenhua. Working principle of stepper thermal storage heating furnace [J]. Electronic Production, 2015, (09): 243.