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Analysis and Response of Steel Stacking Accidents in Hot Rolling Coilers

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Abstract: Through long-term production and maintenance practice, various types of stacking steel in the 2250mm hot rolling coiler of Ma Steel were tracked and analyzed, and the causes of stacking steel were summarized. Corresponding measures were formulated to effectively reduce the probability of stacking steel.
Keywords: coiler; stacking steel; cause analysis; measure

Introduction

Today, with the influence of upstream and downstream industries on the steel industry, the survival and development space is becoming increasingly severe, and competition among enterprises is intensifying. To adapt to the market environment, Ma Steel Hot Rolling Plant has proposed goals such as "reducing costs and increasing efficiency" and improving product yield. However, in the hot rolling 2250mm production line of Ma Steel, the frequent stacking accidents in the coiling area are an important factor affecting cost reduction and efficiency improvement. Stacking not only reduces hourly production but also lowers the yield rate; In 2015, there were more than ten incidents of steel stacking accidents in the coiling area due to various reasons, seriously restricting production efficiency [1]. The author has sorted and analyzed the causes of various steel stacking accidents in the coiling area of the hot rolling plant in recent years, and proposed corresponding measures.

1 The causes of steel stacking accidents

1.1 Steel stacking caused by damage to electrical components

After many years of production on some production lines, a large number of templates in the PLC cabinet begin to age, and there is a lot of dust accumulation inside. Some templates may have been used for a period close to or exceeding their expected lifespan. These templates may malfunction at any time, and PLC control templates are the core of automatic control [2]. When the template malfunctions, the production line will inevitably shut down. In addition, the on-site environment in the coiling area is extremely harsh, with high temperatures, high impact vibrations, and water vapor corrosion, making on-site components extremely vulnerable to damage. The strip steel coiling is a fully automatic production process, and the judgment of equipment status and the output of actions rely entirely on on-site input and output of electrical components. Damage to certain important components may immediately lead to steel stacking accidents [3].

1.2 Misinduction of electrical components

The on-site environment in the coiling area is complex, and sensors are highly susceptible to impact. If the on-site cleaning work is poorly managed, the discarded bolts and iron sheets may cause false signals from the proximity switch; The cold metal detection in front of the coiling machine is a very important sensor for correcting the tracking signal of the strip steel. In the cold winter, the cooling water for the strip steel generates very dense mist during the switching process, which affects the normal use of the cold

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metal detection switch and may cause the coiler to malfunction, leading to steel stacking accidents; The cooling water and glycerol widely used on site will splash everywhere during high-speed operation of the equipment, and the ultrasonic position sensor used on the core shaft is also easily affected, etc [4].

1.3 Steel stacking caused by mechanical clearance

The coiler is an equipment that operates under extremely harsh conditions with high speed and significant impact force, and its structure is complex with a high failure rate. To maintain a stable and good production state, equipment manufacturing accuracy, equipment management system, and equipment maintenance are very important [5]. According to the working characteristics and environmental conditions of the coiling machine, there are special requirements for the performance of the coiling machine, such as high stiffness and not easy to deform; High strength structure resistant to repeated impacts; Maintain high mechanical precision in the structure, etc. The guide, pinch roll, and auxiliary roll equipment of the coiling machine will inevitably have wear gaps after a period of use. If this gap is too large, it may cause steel stacking accidents.

1.3.1 The impact of guide gap

The function of the side guide is to smoothly guide the strip steel deviating from the center of the output roller onto the centerline of the coiler, ensuring that it enters the pinch roller and coiler in an aligned manner. The side guide guard is the first gateway for the strip steel to enter the coiling machine. Experience has shown that the entrance of the guide guard is a high-risk area for steel stacking accidents [6]. The impact caused by the gap between the guide and guard mainly includes the following aspects:

(1) There is a gap between the guide beam and the pin, and the guide cannot move in and out tightly with the hydraulic cylinder. This will cause the guide to fail to calibrate accurately, and the position sensor will not display the actual position of the guide correctly.

(2) There is a gap between the gears and racks of the two hydraulic cylinders of the guide, resulting in a deviation between the head and tail of the guide. This means that the roller gap values on the inlet and outlet sides of the guide are always or sometimes inconsistent (positive or negative bell mouth), making it difficult to calibrate accurately. The guide is also difficult to play a corrective role, resulting in poor coil shape and even the steel strip head hitting the guide inlet and directly stacking steel. In addition, the characteristics of the bell mouth result in inconsistent wear of the wear-resistant plate by the strip steel.

(3) Wear of guide wear-resistant plates. When the wear is greater than a certain value, there may be steel coil edges or stuck stacking of steel.

(4) The installation gap between the wear-resistant plate and the guide beam is too large (as shown in Figure 1), and the steel strip head may not pass smoothly, causing jamming.



Figure 1 Excessive gap between wear-resistant plate and guide beam

1.3.2 The influence of gap between pinch rollers

The pinch roller is located at the entrance of the coiler, and its main function is to guide the head of the strip steel smoothly into the guide plate of the coiler chute, and after the strip steel is thrown out of the finishing mill at the tail end, the required coiling tension is formed between the pinch roller and the core shaft [7]. If the gap deviation between the two sides of the pinch roller is caused by uneven wear on the roller surface, loose oil cylinder sleeve, and poor levelness of the lower roller, there will be a certain angle between the pinch roller and the strip steel. During the coiling process, horizontal lateral force will be generated, pulling the strip steel to one side, causing the steel coil to form a tower or overflow. Even when the wear of the roller surface exceeds the thickness of the strip steel, the pinch roller will not provide effective clamping force, resulting in loose coil stacking of steel.

1.3.3 The influence of gap between auxiliary rollers

Three auxiliary rollers are evenly distributed around the core shaft, and their main function is to accurately send the head of the strip steel to the position of the core shaft, and apply bending processing to the strip steel to make it easy to roll, and then press the strip steel onto the core shaft with appropriate clamping force to assist in forming effective tension between the core shaft and the strip steel. In the process setting, strip steel with a specification exceeding 4 mm will be controlled by the step control of the winding roller. From Figure 2, it can be seen that during the stepping process, 2 out of 3 auxiliary rollers are simultaneously pressed against the steel coil. If these two auxiliary rollers are unable to provide timely and effective clamping force due to poor stiffness at this time, the steel strip head will become loose. There

is not enough static friction between the loose steel strip head and the core shaft, which prevents tension from forming between the core shaft and the clamping roller, ultimately leading to a steel stacking accident [8].

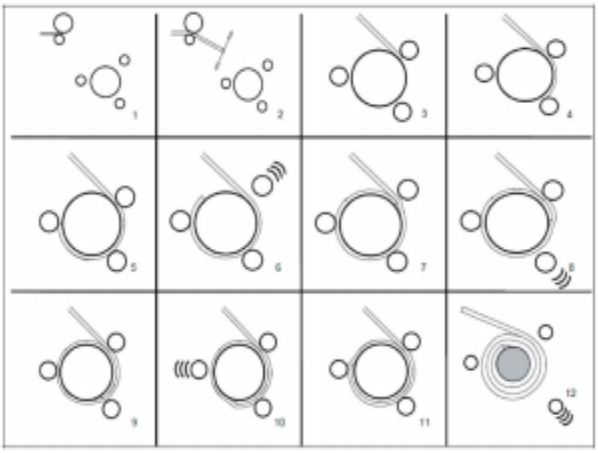

Figure 2 Step action of the auxiliary roll

1.3.4 The influence of core shaft clearance

The service life of the core shaft is generally measured by the total weight of the produced strip steel, and its expected life is generally around 1.5 million tons depending on the strength of use. The moving parts of the core shaft have varying degrees of wear from the upper to the lower thread, and the internal clearance is also increasing.

When the core shaft rotates at high speed, under the action of centrifugal force, the gap between the core shaft sector plate and the connecting rod is eliminated, and the actual outer diameter of the core shaft increases. However, at this time, the actual position of the expansion and contraction cylinder does not change, and the sensor detection distance does not change, resulting in the actual diameter being greater than the displayed diameter [9].

1.4 Pump trip due to medium system leakage

The medium system is an important power source for hot rolling equipment. During the operation of the rolling line, due to various reasons, oil leakage occurs in the medium system pipeline. When the oil tank level drops below a certain value, the system will automatically stop pumping. At this time, if there is still steel strip moving on the rolling line, especially in the laminar flow area, it will inevitably cause a steel stacking accident.

1.5 Abnormal back pressure of the pinch roller

In order to ensure the stability of the hydraulic cylinder of the pinch roller of the coiling machine during up and down movements, back pressure control has been added in the design of the hydraulic system to avoid phenomena such as loss of control and stall. But in production, there may occasionally be stable back pressure situations. The impact of unstable back pressure is directly proportional to the degree of pressure fluctuation. Slight pressure fluctuations may cause a decrease in the automatic position control or pressure control response speed and accuracy of the pinch roller; Large pressure fluctuations, even jamming of the back pressure valve, causing the back pressure value to drop to 0 or rise to system pressure, resulting in the inability of the pinch roller to move. If there is a moving strip in the coiling area at this time, a steel stacking accident is inevitable.

1.6 Abnormal incoming materials

Due to the complex environmental conditions during the rolling process of strip steel, there are many factors that affect plate shape, such as billet wedge shape, uneven temperature distribution, differences in stiffness on both sides of the rolling mill, and inappropriate adjustment of the rolling mill, which can easily lead to plate shape defects. Common defects in plate shape include sickle bending, wave shape, and curling. The bending shape of the sickle has the greatest impact on the coiling process. After being rolled by the finishing mill and entering the laminar roller conveyor, the bending degree becomes more severe, making it easy to block the stacking of steel at the coiling inlet.

1.7 Foreign object jamming in the steel channel

After passing through the precision rolling process, the hot rolled billet reaches its maximum speed on the laminar roller conveyor, and the speed of thin specification strip steel generally exceeds 12 m/s. At this time, if there are foreign objects on the roller conveyor or in the coiling channel that slightly hinder the head or edge of the strip steel, it may cause folding and jamming of the strip steel head. Sometimes, after a short period of obstruction, although the head of the strip breaks free from the obstruction, due to the inconsistency between the strip body and the tracking signal at this time, the equipment moves, especially the abnormal timing of the step control of the auxiliary roll, and the strip head eventually gets stuck in the coiler.

2 Measures to avoid steel stacking

2.1 Ensure that electrical equipment is functioning properly

(1) Strictly manage the PLC room lock and prohibit external personnel from entering. Doors and windows should be kept closed to minimize indoor dust.

(2) The temperature in the PLC room should be maintained below 25 °C.

(3) On maintenance days, carry out planned cleaning and maintenance or replacement of the PLC cabinet templates.

(4) Improve inspection standards and strictly enforce them. Based on the fault time records of on-site equipment,

scientifically and reasonably develop a detailed electrical component replacement cycle table, and replace according to the cycle.

(5) Set redundant protection for important sensors.

2.2 Weakening the impact of adverse environmental conditions on the site

(1) Strengthen on-site management work and promptly remove waste bolts, gaskets, rags, and other items unrelated to production on site.

(2) In response to the impact of large water mist on CMD during low temperatures in winter, technical optimization is carried out by appropriately increasing the number of fans and adding limiting conditions in the control program to enable the system to have the ability to distinguish true and false signals, thereby enhancing its ability to resist fog interference.

(3) Adjust the size and spray direction of the cooling water to meet production needs without affecting the use of electrical components. If it is impossible to have both, add a baffle in front of the electrical components for protection.

(4) Implement insulation protection for cables and sensors directly exposed to high temperature radiation from steel coils.

2.3 Strengthen equipment accuracy management

(1) Based on the characteristics of each device, use trend graph software to focus on monitoring key data.

(2) Develop effective equipment stiffness testing methods and conduct weekly mechanical clearance evaluations. Replace devices that are not in good working condition in a timely manner. Observe, analyze and record the wear and tear of the replaced equipment, summarize the patterns based on trend chart data, and further optimize the gap evaluation.

2.4 Setting oil level monitoring and implementing oil leakage warning

To prevent sudden pump shutdown and emergency shutdown, a fast and effective oil level monitoring and warning system should be established. When the system is working, the liquid level of the oil tank is in a floating state. The liquid level values of the hydraulic system and lubrication system have their own characteristics, and even for the same hydraulic system, due to the different flow rates of the actuator, the characteristics also differ. If the liquid level value is monitored in real time, different features are identified, the characteristic values at the time of leakage are identified, the leakage is accurately judged, and an alarm signal is issued in real time, it can achieve real-time detection of leakage. After discovering oil leakage, it can be determined whether to continue production based on the leakage situation at that time. If there is an emergency high-speed leakage situation, the system should automatically prohibit the strip steel from entering the finishing mill area.

2.5 Maintaining stable backpressure

The abnormality of back pressure is most closely related to the back pressure valve. Backpressure valves are more susceptible to contamination from impurities in the oil, which can affect their performance. Therefore, it is necessary to maintain the cleanliness of the oil. In addition, the back pressure signal of the pinch roller will be monitored using trend chart software, and the electrical on duty engineer will record each shift or use PLC to directly detect and warn the fluctuation range. Timely inspect and handle problematic pressure reducing valves to avoid sudden failures that may cause steel stacking accidents.

2.6 Measures to prevent the steel strip head from being stuck

(1) Prevent the sickle from bending and deviating from stacking steel. By improving the accuracy of computer model setting, improving the manufacturing and grinding accuracy of rolling mills, adopting a balance method of reduction rate distribution, improving the temperature condition of strip steel, adjusting the lining plates of each frame window and rolling mill bearing seat, using deviation control technology and deviation detection devices, etc., the degree of strip steel sickle bending is minimized as much as possible. For larger sickle bending shapes that have been discovered, operators should promptly open the guide and intervene manually to prevent the steel strip head from getting stuck at the entrance of the coiler.

(2) Any obstacles that may hinder the advancement of the steel strip head should be promptly addressed.

3 Conclusion

Since the hot rolling production line was put into operation, with the continuous improvement of operational proficiency and accident judgment level, the phenomenon of steel stacking has significantly decreased. Through production practice, it has been proven that if steel stacking accidents can be quickly and accurately judged during the production process of hot rolling lines, not only can the processing time of accidents be effectively reduced, but also effective preventive measures can be formulated to address these phenomena, fundamentally reducing the occurrence of steel stacking accidents. The above is only a brief introduction and summary of some common phenomena and causes of steel stacking. In the actual production process, there are various forms of steel stacking accidents, and we still need to continuously learn and improve our technical level to identify the causes and take corresponding measures.

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