

Application of Detection Instruments in 1810mm Hot Rolling Line of Tang Steel Co., Ltd

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Keywords: Detection Instrument, 1810mm hot rolling Line, Detecting Principle, Tang Steel Co. Ltd

Abstract. Taking the Tang steel's 1810mm hot rolling line as an example. This paper first gives an overview of this hot rolling line. And then, describes the general and special instruments used in details. Finally, combining theory with practice, this paper is concluded to help for using instruments in varied applications.

Introduction

Detection instruments are basic and important parts of the information industry. They are also on the bottom of CIMS (Computer Integrated Manufacturing System) of iron and steel enterprises. Based on enterprises production technological process, the first level of CIMS driver components includes sensor, transmitter, actuator, and robot, et al, for the technological process parameters. Therefore, it is very important to study the application of detection instruments in real production case [1-2]. Industrial instruments are divided into two categories, general instruments and special instruments. On the top of that, general instruments are classified into four main kinds: thermocouple, flow transmitter, pressure sensor and level gauge, while special instruments includes five types in this paper: measuring-speed element & phototube, photo-electrical encoder, laser ICS5000, width gauge and thickness gauge. These instruments guarantee yield and quality of production in the 1810mm hot rolling line. They help the Tang steel to energy saving and production increasing, and meet the market demands.

1810mm Hot Rolling Line of Tang Steel

The technological process chart of 1810mm hot rolling line of Tang Steel is shown in Fig.1. The key equipments in this line are DANIELI FTSC (Flexible Thin Slab Casting), Bricmont tunnel furnace, DANIELI roughing mill, Mitsubishi finishing mill, IHI high speed shear, and high speed down coiler. Application of Detection instruments in 1810mm hot rolling line of Tang Steel are also shown in Fig.1. Legend of Fig.1 is shown as Fig.2. All instruments introduced in this paper are included Fig.1 and Fig.2.

General Instrument

S-Thermocouple. Hot rolling requires billet to be at temperature 1100°C, therefore, tunnel furnace is used to heat up the billet to meet the temperature requirement. The tunnel furnace contain two lines, namely A line and B line. Each of the lines is divided into three parts, namely 1st tunnel furnace, 2nd tunnel furnace and 3rd tunnel furnace. Each tunnel furnace uses five S-thermocouples (Platinum-Rhodium-10 Platinum Thermocouple) to measure temperature. Three of these S-thermocouples are installed on the top of the tunnel furnace, and are placed evenly on left, middle and right. Two of these S-thermocouples are installed at bottom of the tunnel furnace, and are placed symmetrically on left and right. These S-thermocouples are featured as: stability thermoelectric properties, strongly oxidation resistance, highly precision grade, and long-term working temperature

up to 1400°C (this temperature is up to 1300°C in China). It can guarantee production running safely by double cross limit control.

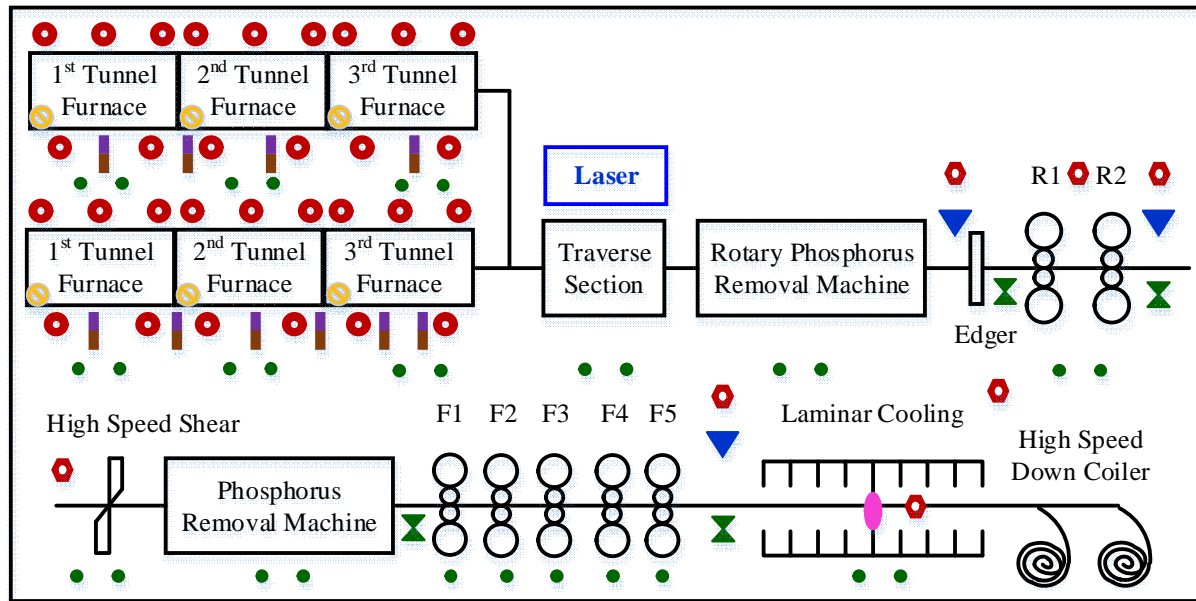


Fig.1 Application of Detection Instrument in 1810mm Hot Strip Line of Tang Steel CORP

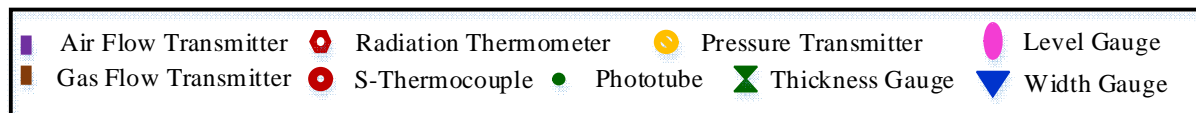


Fig.2 Legend of Fig.1

Radiation Thermometer. After being heated to required temperature of rolling in the tunnel furnace, billet is then transferred to edger. During the transportation, the temperature of the billet decreases, because of thermal radiation and heat exchange with roller table. Since the temperature of billet directly influence on rolling force, and is the key factor on thickness, stereotype and width in mathematical model, it is necessary to detect temperature without contacting the billet. Therefore, it is not suitable for the S-thermocouples. Instead thermal radiation infrared pyrometers are used. Radiation thermometers are installed at entry of edger, exit of roughing mill R1 and R2, entry of high speed shear, exit of finishing mill, middle segment of roller table, entry of high speed down coiler [3].

Flow Transmitter. Flow Transmitters is applied in fuel system of heating furnaces. Each of heating furnace has two control valves, air valve and gas valve. The valves are driven by electric actuator to control air and gas flow. To detect air and gas flow in full lines, each sections have air and gas flow Transmitters.

Pressure Sensor. There are two pressure flashboards and two pressure tap/sensors in tunnel furnace. They can measure the pressure of the tunnel furnace on designated places. The two pressure flashboards can maintain the pressure of tunnel furnace. Average pressure and pressure algorithm are used to detect the flashboards position and to avoid one flashboard's position deviating from another that needs to be solved for stable pressure of tunnel furnace. There is a short chimney on the top of the traverse section of heating furnace. And a pressure sensor is installed on the traverse section to measure pressure. A pressure flashboard is installed on traverse section and a pressure sensor is used to control this pressure.

Level Gauge. Cooling system is installed on the side of driving rolling mill between roughing mills and finishing mills and is used to cool off billet during ferrite cooling. Pressure adjusting system is an elevated water tank system on the side of rolling lines, which can turn over the sprinkling part on the top though hydraulic cylinder. Hydraulic level gauge is used to detect water level of cooling system and the tank capacity of water is 12 m³.

Special Instrument

Measuring-Speed Element & Phototube. Measuring speed element is used to measure speed of billet, while phototube is used to detect position of billet in the hot rolling line. When the top of the billet enter the area of the phototube, billet is monitored by tracking system of plate billet. Billet model is built by using top and tail detecting data first, then being updated with more positional data collected in furnace.

Photo-electrical encoder. Photo-electrical encoder is uniformly distributed on the motor of tunnel furnace. It is installed on the tail of the motor to measure roller table speed. The position of slab in the furnace is calculated by program, and is corrected by phototube. On the other hand, another function is width shearing, which is shown as Fig.3. The whole system is composed of plate shearing machine, pusher machine, playing machine and roller table, et al. When phototube detects the arrival of steel, the roller table starts up, and slab enters to pusher machine. Then, pusher machine starts to make sure the billet stop at desired position. At last, playing machine clamps the billet and plate shearing machine begins to work [4-5].

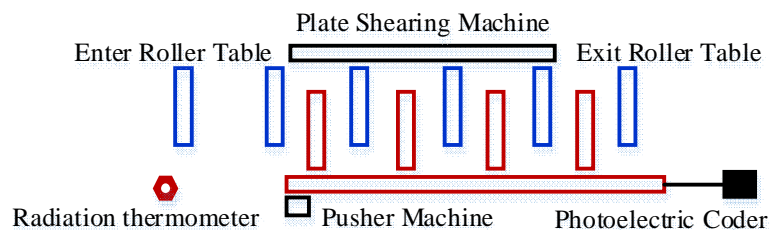


Fig.3 Technologic Diagram of System

Laser ICS5000. The laser ICS5000 is used to measure distance of traverse section. The laser ICS5000 is shown in Fig.4. The laser sensor works as follows. Firstly, laser diode shoots laser pulse aiming at the target, and reflection laser scatters at every direction. Then, a part of scattering laser arrives at the receiver of laser ICS5000, and is imaged on avalanche photodiode in optical system receiver. The internal of avalanche photodiode is an optical sensor with amplification function, so it can detect weak optical signal. Finally, the time for optical pulse round trip elapse is recorded to calculate the distance is detected.



Fig.4 Laser ICS5000

Width Gauge. The width of strip steel is a critical problem that needs to be solved by width gauge. There are many factors influencing width variation of strip steel in hot strip line. One factor is roller table gas due to rolling around. Another is high temperature creep generated between machine units. Hence, it is necessary to measure width in order to accomplish width control of billet. Install location of width gauge in Tang Steel CORP 1810mm hot strip line is shown as Fig.1. The distribution location of three width gauge are exit of tunnel furnace, exit of roughing mill, and entry of high speed down coiler [6].

X-Ray Thickness Gauge. The quality of slab is mainly determined by longitudinal thickness tolerance of slab. Thickness gauge is a key part of basic automation and plays an important role in thickness control. Thickness gauge can signal the deviation between measure value and set value,

which guarantees precision, a basic condition for rolling mill thickness control [7]. When X-ray from generator passes through strip, a part of X-ray is absorbed by strip, and the rest of the unabsorbed X-ray goes directly into ionization chamber. After ionization chamber, X-ray is ionized into a regular signal, and amplified to be converted into DC 0~10V voltage signal, and then sent to controller for calculating and doing data processing. Finally, the thickness value is obtained [8].

Summary

Product shape from heating furnace to high speed down coil goes through these forms: slab, bar, strip and coil. Detecting instrument is key method to ensure production quality and efficiency. This paper mainly introduces the application of detecting instruments in Tang Steel CORP 1810mm hot rolling line. Detecting instruments in iron and steel industry mainly consists two parts, namely, general instrument and special instrument. The application of instruments are introduced respectively in terms of reason, principle and position distribution. It is helpful to master detection technique and automation instrument, and to solve practical problem.

Acknowledgements

This work was financially supported by the Key Project of Sichuan Provincial Department of Education (13ZB0200), Tangshan Technology R & D Program (15110202a), Doctoral Scientific Research Foundation of North China University of Science and Technology, Research and Practice of Teaching Reform in Education of North China University of Science and Technology (QZ-1536-09), Hebei Provincial Natural Science Foundation (F2014209192) and Educational Commission of Hebei Province of China (ZD20131011)

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