Advanced Heat Treatment Equipment Technology And Product Development of Metal Materials

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Abstract: From the current analysis of steel materials in the field of heat treatment and offline heat treatment, the implementation of advanced heat treatment equipment and processes for automated metal materials in China has carried out numerous innovations. In order to improve the technical level of localized equipment and promote the continuous development of new industrialization processes, the use of green manufacturing processes to achieve heat treatment of steel and non-ferrous metals is the focus of current research. This paper focuses on the analysis of advanced heat treatment equipment, process and product development of metal materials, and proposes to adopt green manufacturing concept and carry out research and development on advanced heat treatment equipment and technology of metal materials. It is expected to have reference value for improving rolling technology and continuous rolling automation in China.

1. Introduction
China's high-end value-added plate products are manufactured. At the present, the heat treatment is used to do equipment processes and product development. Most of them use traditional processes for online and offline processing. In the heat treatment products, the annual output of the medium shield has reached tens of millions of tons. In the general application, the online heat treatment technology is adopted. For the low-pressure vessel steel plate engineering machinery steel plate high-rise building steel plate, etc., the modulation and normalizing method are needed. Improve the distribution of the structure, use the strengthening and toughening mechanism to improve the overall mechanical properties, reduce the composition in the processing performance, and carry out the heat treatment of the high-end plate in the core processes such as heating and cooling.

2. Advanced Heat Treatment Equipment for Metal Materials
Through the treatment of the plate type and performance uniformity, the heating method is adopted to control the furnace temperature to ensure that the deviation is less than plus or minus 5 °C. In the production of high-end products, the setting of low-alloy wear-resistant high and ultra-high-strength engineering machinery steel requires that the temperature of the tempering furnace be below 300 °C, and the domestic steel enterprises in the heat treatment heating, in order to achieve temperature control of precision, must meet the needs of high quality steel production. Adopting higher precision and stable production quality for heat treatment furnace temperature and low temperature control, adopting new high-precision treatment method, upgrading the technical level of heat treatment equipment, such as roller quenching machine, in the thickness of quenching, the general requirement is in the range of 10-120 Between millimeters, when materials are used to set the core process equipment of the processing line, conventional roller quenching agents are generally used, and a few foreign companies...
such as Japan have long-term monopoly on this technology, especially the core quenching process technology. Bundling the price of the supply, the supply cycle is also very long, which has greatly hindered the adjustment of the industrial structure of China's steel companies.

Therefore, in order to achieve the bulk supply of enterprises, improve the production capacity of high-quality thin plates, and exert the performance limitations of production technology, the development of high-end equipment manufacturing in China must be improved. At present, the production of equipment is carried out on a special thick steel plate using a conventional quenching tank, and the heat exchange efficiency of the steel sheet surface in the cooling water is improved. The problem that the quenching device is easily restricted in the advanced heat treatment process is solved. With the development of quenching equipment technology, the continuous roll quenching method, the thickness of the steel plate is less than 12 cm, more than four millimeters.

The quenching production process must be introduced into the quenching production of extra-thick steel plates with the development of quenching equipment technology. According to the actual process quenching and uniform cooling requirements, the special thick steel plate quenching production process is combined, and the special continuous roll cooling system is adopted. The application is currently a blank in the technical field. Therefore, research is needed on the field of special steel plate quenching.

Under the premise of major national demand, China has carried out the construction of the State Key Laboratory of Continuous Rolling Automation, carried out research and development of process technology and products, and carried out research and development of advanced heat treatment through high-end medium-thick steel plates to meet the engineering machinery, hydropower, nuclear power, national defense military, etc. The needs of the construction field.

For example, in the medium-thick steel plate advanced heat treatment equipment, in order to achieve high-strength uniform quenching of thick steel plates, special continuous roll quenching agents are used to develop extra-thick steel plates, quenching machines, water supply systems, and conveyor roller system frame lifting systems, etc. The process model has been reinforced, and equipment with strong continuous cooling capacity has been used to instantly improve the cooling technology.

The main features of the device are characterized by finite element simulation and test analysis. The medium-pressure nozzle adopts multiple rows of overall tilting, and when the high-pressure nozzle adopts the overall ultra-wide slit, a large thickness gradient is formed. After the slit nozzle is cooled for an instant, heat is transferred to the surface.

The continuous cooling capacity of the central nozzle is enhanced. The gradient of the thickness of the steel sheet is maintained at a large temperature, and the temperature of the core of the steel sheet is continuously lowered rapidly. In the flexible configuration, the development flow segmentation adopts the method of residual water control to improve the surface subcooling of the steel plate. The development gap improves the heat exchange efficiency under the cooling strategy, high quenching and medium pressure side fire zone, and realizes the adjustable design of the roll gap of the ignition zone according to the principle of flexible production mode. Using the method of lifting the frame in the quenching zone, the use of the cooling zone can be flexibly selected to achieve uniformity of the surface of the steel plate, high-strength cooling, rapid drainage, rapid release, and transition between frames.

In order to obtain higher strength, a high-precision low-temperature tempering furnace is used to temper the strength and thickness of the Keppel Steel plate. At present, the domestic roller-type low-temperature tempering road adopts the requirement of high-strength thin plate temperature uniformity, effectively solves the high-speed hot air circulation heating, and adopts the forced convection heating technology to heat the metal under the direct impact of the high-speed road gas. After the exchanged vessel is recovered and heated, a high-speed circulation of the gas flow in the furnace is formed. The main technical feature is that the heating temperature ranges from 100 to 600 degrees Celsius, the heat exchange efficiency is high at low temperature, and the high-speed hot air forced convection heating, and the heating speed is very fast. The effect is also very good, the furnace
temperature can be controlled at about 2 °C, after heating, the surface quality of the steel plate is very good, the heater can be used gas burner and electric heater, equipped with a certain number of high-temperature circulating fans, to meet High-performance steel for high-efficiency, low-cost production.

In the development of high-grade medium-thick steel plate heat treatment process, a steel plate flow zone division control technology has been developed, which has high sensitivity and high strength steel plate. The typical specifications of the high-strength steel plate are ultra-wide and thin, and the thickness is 4-10 mm. The difficulty of quenching is reflected in the consistency of the structure performance, and it is easy to produce cold-formed deformation rebound. In the case of large quenching deformation, it is difficult to carry out the agitation by conventional correction means. For the first time in China, the continuous stable production of 4-10 mm ultra-thin steel plate is realized. Under the premise, the problem that the traditional thin steel plate is easy to produce the side waves and the like after quenching is solved, and the mechanical properties and the processing performance are better than the physical level of the imported steel plate.

In the uniform quenching technology of extra-thick steel plates, the industry-recognized technical method is adopted to realize the backward high uniform quenching technology. With the support of national and enterprise projects, through the continuous combination of production, education and research, we have developed a wide-thickness steel plate tubular quenching equipment with strong cooling capacity, high cooling intensity and uniform bonfire, which has realized technological innovation and built a wide and thick steel plate to accelerate. According to the cooling theory, the calculation model of the tissue stress field is generated. Under the multi-field coupling condition, the temperature field is set up, and the multivariate multi-dimensional calculation model is established. Repeated cooling and intermittent cooling are used to lay the high-quality high-quality plate. The quenching process of uniformity, and the process of improving the uniformity of the backward cooling and the uniformity of the cooling of the steel core, develop a high-pressure high-strength rapid cooling technology, greatly improve the uniformity of the rear foot cooling, the cooling uniformity of the core portion, and the cooling path The quenching technology is controlled, and a wide range of rapid cooling technology is also adjusted. The heat treatment process based on the quenching equipment technology is established, and the mechanical properties and the uniform welding performance are adopted to meet the customer demand and the enterprise demand.

In the research and development of heat treatment products for high-grade medium-thick steel plates, ultra-large construction machinery and mining machinery are applied to increase the production process of welding forming and type evaluation system. The highest production level of steel plates is required to have high strength and high strength structure. The steel generally emphasizes the production quality of the modulated steel plate, and the application of super large construction machinery for technical manufacturing, such as large crane shield machine cement ball mill, etc. At present, ss AB can be produced in the world. Through theoretical research and industrialization test, combined with the actual production situation of China's current steel enterprises, anti-oxidation control technology, ultra-high-strength steel technology, and technical research on the integrated microstructure of hot-press cooling treatment were carried out in the industrial production process. The plate shape control technology level in the heat treatment process of internal stress wave plate steel is greatly improved, and the wear-resistant steel welding technology is used to study and realize the anti-delay exercise performance.

Through the above research results, a complete set of hot-press cooling and heat treatment integrated tissue performance control technology for mass production was finally realized. After the above products are manufactured, they provide a basis for the large-scale and high-efficiency of China's equipment manufacturing industry.

3. Application of A New Generation of Controlled Rolling and Controlled Cooling Online Heat Treatment Process For Hot Rolled Steel

①Through research, the comprehensive application of ultra-fast cold controllable and infinite
adjustment technology for hot-rolled steel materials has been carried out, and the material strengthening has been achieved through the ultra-fast cooling technology of hot-pressed steel materials in the process technology and product life cycle evaluation. Achieve the plastic toughness and use properties of the material.

For example, the products obtained include medium and heavy plates, and the H-plates of the wire plate have achieved the overall improvement of the performance of steel materials under the premise of saving steel, greatly improving the impact toughness, and the contribution rate of energy conservation and protection has reached 10% to 15%. About the new generation of TMCP core equipment technology realizes the high-intensity uniform cooling of hot-rolled steel, and the core treatment of ultra-fast cooling technology. By effectively breaking the air-cooling equipment between the cooling water and the steel plate, the super-fast after pressure is adopted. The cooling technology achieves the technical goal of 3-4 mm plate cooling rate of 300-400 degrees Celsius, providing a means to control the organization and performance of steel press.

② The new generation of TMCP implements the cooling path control method in the organization control and strengthening mechanism. According to the complex phase features of the steel material during the cooling process, it is controlled on the cooled phase surface structure to achieve the required Material properties, providing different cooling rates from air-cooled to ultra-rapid cooling, ultra-long super-fast rate can provide a variety of suppression functions, using ultra-rapid cooling in the austenite region, inhibiting the crystallization of deformed two entities, preventing austenite Grain coarsening and softening occur in the body. In the following process, the fine crystal of the material is realized at a low cost, and the precipitation enhancement effect is enhanced by the low cost. For example, ultra-rapid cooling can be used to precipitate the crystallization of austenite in the austenite, increase the number of aspirating particles at ultra-low temperature, suppress the phase transition occurring at a higher temperature, and promote the intermediate-temperature or low-temperature phase transition at a higher temperature.

③ At the same time, using the above-mentioned strengthening mechanism, combined with the grain refinement control technology, the control technology in the ferrite is analyzed, and the organization and regulation mode of the new generation TMCP is generated. Through the promotion of the new generation of TMCP technology, in the process theory innovation, develop appropriate technologies for different steel types, such as ultra-fast cooling core technology, adopt new control cooling system, apply in large steel enterprises, for the petrochemical industry, etc. Low-carbon technology innovation provides technical support.

4. Conclusion
The company has developed advanced technologies such as high-precision low-temperature tempering furnace roller quenching machines by comprehensively utilizing industrial practices such as solid solution fine crystal precipitation and phase transformation. The technology of off-line heat treatment of medium and heavy plates is used to develop high-quality heat-treated products, improve the level of localization technology, and contribute to the realization of high-efficiency, lightweight and large-scale equipment manufacturing industry in China. At present, China's steel industry rolling technology has promoted the green manufacturing process around resource conservation and energy conservation. In order to realize the high-efficiency and energy-saving production of hot-rolled steel materials in China, the development of continuous heat treatment equipment technology, roller-type high-speed thermal non-circular heat treatment equipment, etc. have realized high-quality aluminum alloy automobile panels, and realize large-scale aircraft localization and automobiles for Chinese automobiles. Lightweight formed a series of localized production technology with independent intellectual property rights.

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