Advanced technologies for heat treatment of heavy plates

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In the past, steel plate was more or less a mass-produced commodity. However, over the past few years, increasing calls for high-strength, wear-resistant special steels from downstream industrial sectors have meant that steel plate has increasingly become a high quality product. The result has been the development of a new market sector, which is likely to remain the fastest growing sector in the steel plate industry. New material grades and increasingly, stringent strength, corrosion resistance and forming specifications are some of the requirements resulting from market trends towards leaner steel structures bringing greater benefits in use. In order to meet these requirements, it is necessary to deploy not only advanced rolling mill technology but also innovative heat treatment, allowing the specifications to be met in line with customers’ requirements and at reasonable cost.

Special steel plates are now normally available in thicknesses ranging from 3 to 150mm, width from 2.5 to 5m and lengths up to 25m. They are used in bridges and shipbuilding as well as for pressure vessels, line pipes, cranes, commercial vehicles and construction and earthmoving machinery. Depending on the individual application, the plates are quenched and tempered to obtain specified properties such as strength, hardness, wear resistance and abrasion resistance. Modern quenching and tempering lines reach throughputs of between 40 and 60 t/h. The largest quenching and tempering plant for steel plate built by Tenova LOI Thermprocess to date, for ThyssenKrupp Stahl, has a capacity of 105 t/h.

Tenova LOI Thermprocess is highly experienced to offer quenching and tempering lines precisely tailored to customers’ growing requirements for process security, quality and flexibility at exactly the right time. Market success in the future-oriented sector of quenching and tempering lines for high-quality steel plate is only possible with furnaces and quench facilities designed on the basis of comprehensive in-depth process expertise in combination with an effective overall automation concept based on mathematical modelling. Many years of experience in the construction of reheating and quenching and tempering plants for the automotive and machinery industries laid ideal foundations for the development of single-source solutions including plants and harmonised process models tailored to customers’ individual applications.

THE THERMAL PROCESS OF QUenchING And TEMPERING FOR STEEL pLATE

For rolled and moulded steel products, the thermal process of quenching and tempering consists of three stages:
- Austenitising
- Quenching
- Tempering

Quench facilities are installed at the furnace outlet. They are high-tech facilities which ensure martensitic hardening through very fast, controlled cooling.

Facilities consist of an oscillating roller hearth furnace and a stationary quench facility. This configuration allows throughputs up to 10 t/h. The length of the quench section is extremely short, making it easy to integrate into an existing production line.

Continuous facilities consist of a continuous roller hearth furnace with continuous quench to reach higher capacities. Each of the types of plant has its own advantages and it is always necessary to select the best plant for a specific application.

Water spraying is controlled by the process model.

ADVANCE TECHNOLOGIES FOR HEAT TREATMENT OF HEAVY PLATES

‘Advanced Technologies’ means that the plant can implement the various processes required in a targeted...
way, cost effectively and with high energy efficiency at the same time as offering the operator a high degree of flexibility in achieving individual properties.

However, there is another key element for the production of quenching and tempering plants for high-grade and special steel plate. At Tenova LOI Thermprocess, the furnace and the quench facility are both integral parts of a harmonised overall concept in which equal priority is given to improved mechanical engineering as well to automation and the use of process models.

For implementation, in-depth knowledge of the physical processes involved and treatment programmes developed on the basis of experience and stored in an in-house database where they are available to a dedicated team of highly qualified experts working only on technical questions connected with quenching and tempering.

The main characteristic of Tenova LOI Thermprocess process models is the ability to precisely define the results of heat treatment through the preliminary setting and dynamic adjustment of parameters. For this purpose, it is essential to know the actual condition of every plate in the furnace at all times; cooling parameters for the quench facility are defined on this basis.

The process model mainly consists of:

- A heating model, ensuring that the heat treatment process is properly completed at the plant outlet
- A preliminary open-loop temperature control function based on the calculated energy requirements and intended to make closed-loop temperature control more effective
- Fully automated material flow control
- Precise water control in the quench facility
- Dynamic parameter adaptation during the process for optimisation

These plants are designed for flexible, reliable reactions to operators’ requirements, which is especially important if plates with very different thicknesses are to be treated in succession.

Apart from its on-line model, Tenova LOI Thermprocess has recently introduced a program to predict the properties of finished products in advance on the basis of the steel grade concerned. This means that the operator of a quenching and tempering plant can provide customers with advance information on the feasibility of achieving product properties required (such as hardness distributions, wear resistance, etc.) on the basis of calculated structure fractions (martensite, bainite and/or ferrite-pearlite).

In a Tenova LOI Thermprocess quenching and tempering line for steel plate, the visible components (furnace and quench facility) are in accordance with the state of the art of furnace and quench system engineering. Together with the process models developed by Tenova LOI Thermprocess, they form a closely meshed system which operates in a highly harmonious way.