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21-ton gear traveled over 7000 km to be hardened in Bochum

Holger Seybold

Europe's largest plant for protective gas hardening is located in Bochum-Riemke. Machine parts up to 5.2 m in diameter and 5.0 m height are engulfed in one furnace. Gears can even be treated vertically therein and thereby remain highly customized and dimensionally stable. Reason enough to send for an American gear manufacturer to send their 21 -ton gear on the long journey from the USA to Germany. Antriebstechnik was there live during quenching.

Hard to believe — but for the American Gear Manufacturer Horsburgh & Scott from Cleveland, Ohio USA, it made good economical and engineering sense to harden a 21-ton gear not in their own country, but more than 7000 km away in Bochum-Riemke. The delivered spur gear with 3 m diameter and a face width of 781 mm is the second of its kind. The first distorted during the heat treating process in the U.S. so badly, that extensive gear machining was

required to correct the dimensional errors. Therefore, the Americans decided to entrust the next good piece with Härterei Reese Bochum GmbH. "As a specialist for the heat treatment of large components, we have worked on the edge of our capabilities during the past years. In order to keep our technological leadership and expand, we had to step to the development of a new large furnace plant, for which there are currently no prototypes. " commented Managing Director Dipl.-Ing. Gerhard Reese his early considerations.

Lower grinding costs due to vertical hardening

Since then, the company invested a total of around 23 million Euros into the new 4000 m² (43,000 sq ft) workshop and is now operating the largest installation for gas carburizing in the Europe. The furnace with a diameter of 5.2 m and a depth of 5.0 m is custom built and has been developed in cooperation with the German company Rohde. It can be loaded with up to 100 tons of material, so that, at the same time, multiple batches can be treated. In this way even large quantities can be handled and processed in a short time. The weight of a single component is only limited by the existing crane with a maximum load capacity of 50 t.

To bring this great volume of material to temperature requires a highly-capable heating system. The 24 gas burners, distributed in the furnace wall, produce through soft catalytic combustion heating a capacity of 1920 kW. An electric auxiliary heating in the floor adds another 140 kW. This sum is enough to meet the heating requirements of about 300 single family homes (new construction , approx. 100 m²). Along with the required protective gases, energy costs alone for one hour of operation under load amount to 300 to 400 Euros per hour, or extrapolated from 7200 to 9600 Euro per day.

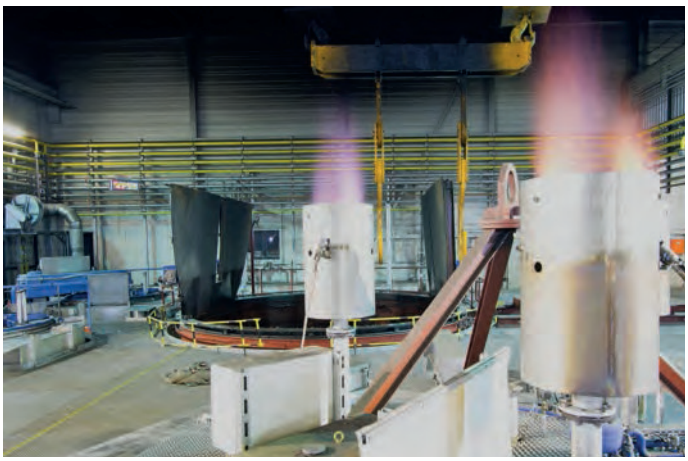
Ovens with such a large diameter were existing even before, however not to this enormous depth. Very distortion sensitive components, such as the USA gear, can now be treated vertically. In the established flatter ovens such components fit horizontal only and must be charged on hardening racks that are themselves unstable at high temperatures. In this way horizontal charging leads to higher dimensional and shape changes - such as runout, ovality and tapering. The resulting higher hardening distortions need to be corrected in the subsequent machining and grinding processes, in which the hardened layer is again more or less removed depending on the amount of the distortion.

In contrast, by hardening such a gear vertically, the shape errors are significantly reduced. As a result, the machining and grinding effort are significantly reduced, saving excessive labor and material costs. Customers report up to 60% lower grinding costs.

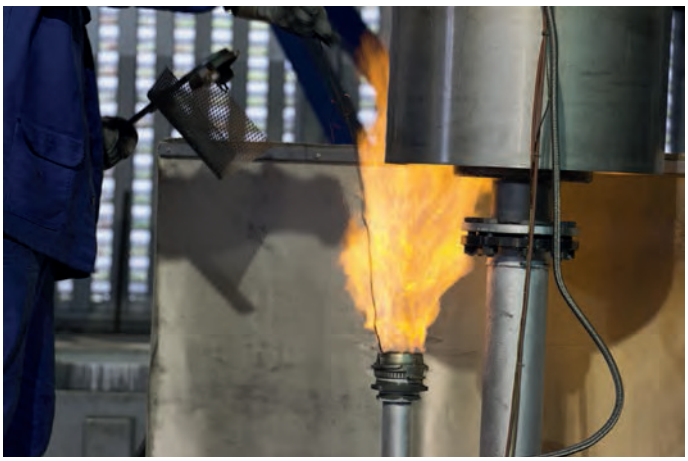
The Hardening Process

Not only is the proper fixturing in an oven crucial, the metallurgical and hardening process is a science in itself and requires a lot of expertise, and experience. Through specific time and temperature variations during carburizing, hardening and tempering processes, the material properties can be optimized according to the desired goal. And all that togther is the "Art of Hardening."

The hardening components are to be cleaned at the beginning of the process. Those areas of the workpiece, which should



01 The heating capacity of the furnace of 2060 kW could supply enough heat for 300 family homes



02 During the carburizing process material samples are brought into the furnace to control the atmosphere

not be hardened, will be coated with a carbon stop off paint. In the protected areas the carbon cannot penetrate. Thus during the subsequence carburizing process these areas are excluded from the hardening process and remain soft .

The next step is charging the components on hardening racks whereby the parts are moved to the furnace using a crane system, and then heated... now the carburizing begins. During this time a specific protective carbon gas atmosphere is set. The carbon diffuses into the surface layers of the component with the exception of the previously protected surfaces.

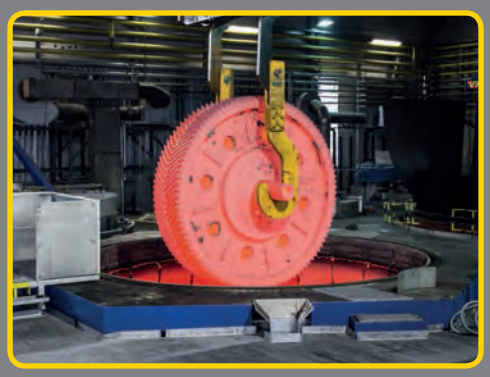
Zaim Alili, Director of the Reese Quality Management, says: "An online — diffusion computer controls continuously the exact gas composition in dependence on the material and the alloying elements and determines the required time and calculates the corresponding C-level-history."

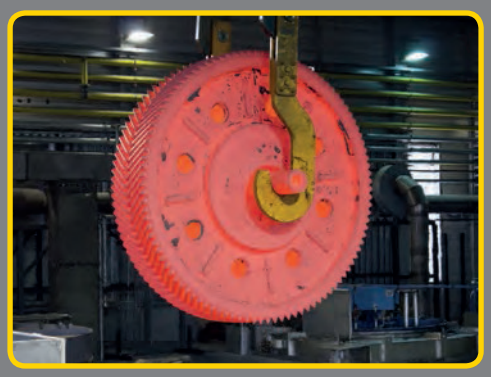
Not only the gas composition, but also the gas distribution within the furnace is a key factor, to allow the components to uniformly enrich with carbon. The same applies to the temperature which, according to Mr. Alili, varies at each point in the furnace within a tolerance range of ±5 °C. For extra control the employees take carbon shim samples at regular intervals samples . These samples are metal strips which spend 20 minutes in the oven atmosphere absorbing the carbon from the atmosphere during the carburizing process. Then the strips are burned to measure the previously absorbed carbon content.

The United States spur wheel lingered around 150 hours at 930 °C — the equivalent of more than six days in the furnace, to achieve the desired diffusion depth. Finally, it was it brought to the appropriate hardening (austenitizing) temperature for the material of 820 °C. After lifting the furnace lid, the crane transported wheel next-door into the oil bath for quenching. Due to the drop in temperature in carbon enriched steel, a martensitic structure was created which is characterized by a high hardness. The quenching tank contains 320 000 l of a special hardening oil. An extremely powerful cooling system with plate heat exchangers ensured that the temperature of the hardening oil only rose only slightly from above 40 °C to just over 50 °C.

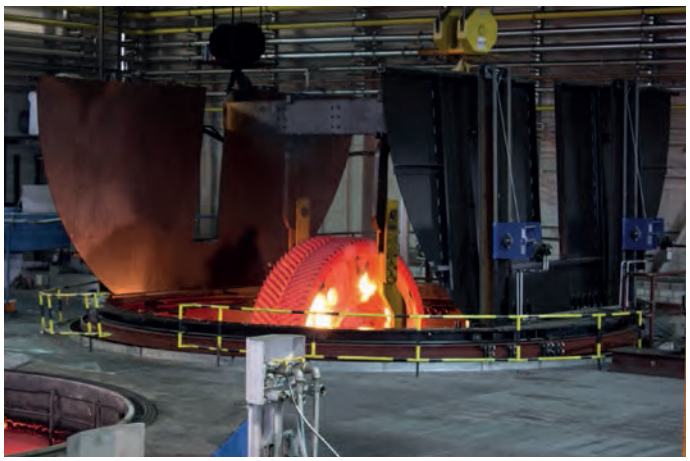
The oil also flows continuously through a filter system that permanently filters out contaminants. Every few months, the hardening oil is being analyzed at the manufacturer and postdosed with additives to retain its typical properties.

The wheel remains in the oil bath for about 6 to 8 hours before it will be moved out of the oil into a cleaning passage and then again into another annealing furnace. At around 170 °C it remains there for an additional 16 hours to reduce internal stresses which have arisen during the martensitic transformation. More treatment steps such as shot blasting and preservation can be made according to customer's request. The USA - made gear wheel was fit for the ship-





03 The 21 t gear from the USA stayed in the furnace for the enrichment of the boundary layer with carbon for over six days



04 In the quenching tank of 320,000 liters special hardening oil the enriched surface layer gets its final hardness

ment without additional treatment steps. A metallurgical sample of the same material as the workpiece went along through all hardening processes to give precise informations about the reached the degree of hardness at the end of the process. The parameters required by the customer in any case have been achieved in full.

New Dimensions in Engineering

"We create more freedom for designers. That causes an innovative impact on future constructions." The possibilities of the new hardening investment attracts not only new customers from around the world to the company in Bochum . "We create more freedom for the designers. In many areas of the machinery and plant construction business" says Gerhard Reese "we have to deal with dimensions ever larger, such as in steelmaking, rolling mills, energy plants, extraction of mineral resources, offshore engineering, shipbuilding and wind power.

05 Managing Director Gerhard Reese invested a total of around 23 million Euros in Europe's largest endothermic protection gas hardening system

Because now the case hardening of large gears and other system components in this order of magnitude is possible, this effects innovation on all types of constructions. "This investment in the the heat treating plant opens up new possibilities to the entire machine building industry, because the previous possibilities of a safe and reproducible heat treatment technology were brought forward a big step. The larger — scope for action has a direct effect on — the machines of the future.

Photos: Holger Seybold

www.hardening.com/en

About

Company name: Härterei Reese

Headquarters: Bochum, Germany

Employees: approx. 280

Services: Case Hardening, Surface Hardening, Vacuum Hardening, quenching, tempering, nitriding, annealing, straightening, Surface Treatment