

# Metallurgy - Heat Treatment

Many metals are only rendered useful through heat treatment. The spectrum of product characteristics obtained in this way includes hard, ductile, soft and differently colored surfaces. As glowing metals react readily with air, protecting gases in the furnace atmosphere are indispensable. In many cases, nitrogen is used as the inert medium.

## Competence through gas technology

If a particular metallurgical effect is to be achieved with the gas, however, reactive gases must be added. The addition of small quantities of propane to the nitrogen, for example, has proved particularly effective. This is regulated with the help of an integrated sensor system so that only the amount of propane needed is used. This optimized technology of using propane in nitrogen or hydrogen and hydrogen mixtures is protected by a number of patents, again emphasizing the competence of Messer in this field.

## Hydrogen - reactive and effective

Hydrogen is mainly used for the annealing of high alloy steels. Here, not only is its reductive capacity utilized, but also its cleansing effect on surfaces. Its high thermal conductivity and thermal capacity also appreciably improve the economic efficiency of high convection annealing in bell furnaces.

## Advantages through innovation

In the Endolin® process, a special shielding gas atmosphere of endogas/nitrogen mixtures is used for the heat treatment of steel and NF alloys in industrial furnaces. Endolin® gas mixtures are an economical alternative wherever a supply of pure hydrogen is too costly and self-generated exogas or monogas no longer meets the stricter quality requirements for the finished products. As opposed to exogas, the carbon level in the furnace gas can only be set and regulated with diluted endogas. A major advantage, however, is that endogas and nitrogen can be introduced separately in different regions of the furnace. In addition to the recrystallization annealing of steel, Endolin® can be used in sintering, soldering and tempering processes, offering the user the advantages of cost reduction, quality enhancement and increased safety.

## The cold that came out of the nitrogen

Through the regulated cooling of hardened steel with liquid nitrogen, the structure of steel is selectively modified. The transformation of retarded austenite into martensite caused in this way improves the wear resistance of cutting tools and the dimensional stability of precision parts. A variant of this technique is cryo-stretching. Here, stainless steel containers are submerged in liquid nitrogen and "inflated" with a pressure of 700 bar. The result is a steel with considerably higher strength.

## Oxidation? - yes, but defined!

In the patented Blackrapid® process, however, the furnace gas atmosphere is specifically composed to define the oxidation of the components to be hardened in order to form a fast adhering and decorative oxide layer which renders subsequent burnishing unnecessary.

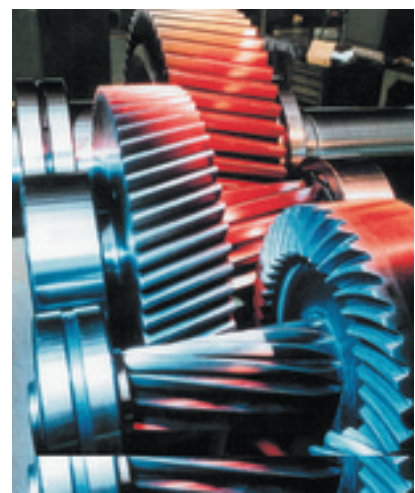
## Hardness – the right recipe

In order to produce extremely hard and wear-resistant surfaces, components are treated with ammonia and carbon dioxide, for example, at medium temperatures. Very hard nitrides are formed in this process which can be modified in their structure and composition through the composition of the furnace gas, while nitrogen atoms are also dissolved in the surface zone of the alloy, further contributing to the marked increase in hardness.

## Partnership through know-how

The use of technical gases in industrial furnaces and the effects achieved are dependent on many parameters, so that cooperation between the Messer specialists and their users is not only desirable, but absolutely essential to ensure the further development and optimization of our customers heat treatment processes.

*Heat treatment, a linking process step in the production chain*





Tempering of special wire in a tubular wire drawing furnace



Case hardened components for the production of gear boxes

Application:	Know-how from Messer:	Advantages:
<p><b>Heat treatment</b> Tempering, case hardening, low surface oxidation carburizing, carbonitriding, sintering  nitrocarburizing, nitriding</p>	<p>Annealing under reaction gases of methanol, propane, H<sub>2</sub>, NH<sub>3</sub>/nitrogen mixtures, hydrogen, nitrogen, argon, helium, Variocarb-therm®, Hydrocarb®, direct injecting, Vario-Nitrocarb®</p>	<p>No start-up or idling losses, constant quality, high flexibility, alternative to environmentally harmful applications</p>
<p>Production of decorative surfaces</p>	<p>Defined short-time oxidation during hardening (Blackrapid® process) and controlled oxidation processes (Variospectrox® process)</p>	<p>Environmentally friendly process, decorative, uniform surfaces, increased corrosion resistance</p>
<p>Vacuum hardening processes and plasma carburization</p>	<p>High pressure gas quenching with N<sub>2</sub>, He, Ar, H<sub>2</sub> or mixtures, pure reactive gases H<sub>2</sub>, N<sub>2</sub>, CH<sub>4</sub>, C<sub>2</sub>H<sub>2</sub></p>	<p>Environmentally friendly process and clean, low-warp workpieces</p>
<p>Increase in the wear resistance and dimensional stability of steel parts</p>	<p>Retarded austenite conversion through cooling of parts in cryogenic refrigeration chambers</p>	<p>Optimum dimensional stability and wear resistance, improved hardness and homogeneity of structure</p>
<p>Bright, stress-free, recrystallization and normalization annealing</p>	<p>Annealing under shielding and reactive gases (nitrogen, nitrogen/reactive gas mixtures Endolin®-process)</p>	<p>Quality improvement through simple, safe, flexible shielding gas supply, reduction of operating costs</p>
<p>Residue-free and cleansing annealing</p>	<p>Defined purging with Hydroclean® and Turboclean®</p>	<p>Clean, bright metal surfaces, low investment costs, easy handling</p>
<p>Glueless annealing of cold rolled steel in the bell furnace</p>	<p>Annealing under regulated reaction gases, Defox® process</p>	<p>sticker free surfaces, less scrap, increased output, automatic process sequence</p>
<p>Increased output on continuously working heat treatment plants</p>	<p>Cryogenic Rapid Cooling with liquid nitrogen</p>	<p>Increased output, double utilization of nitrogen as shielding atmosphere in the furnace and as coolant medium</p>



Various parts, treated by the patented Blackrapid® process

