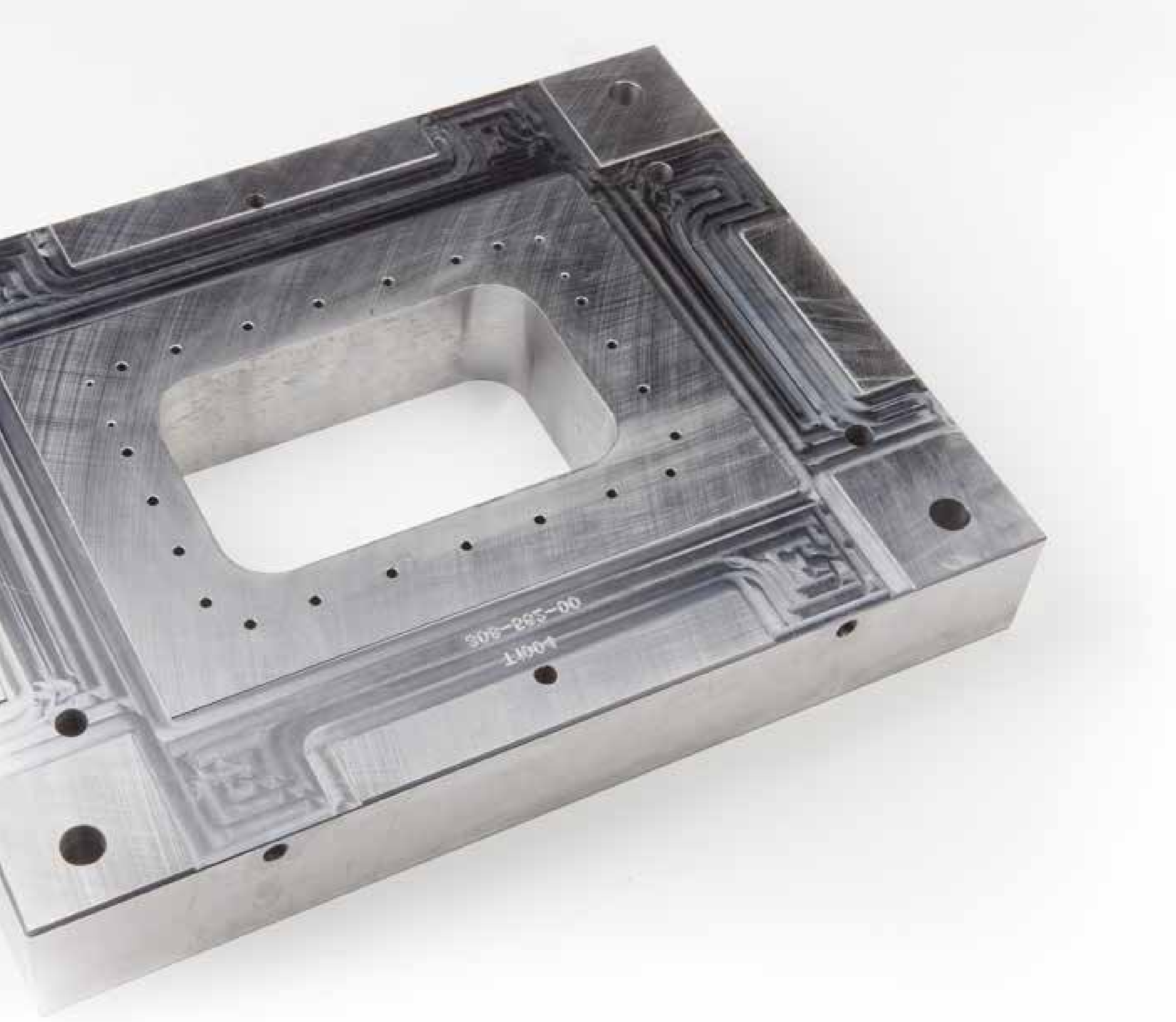
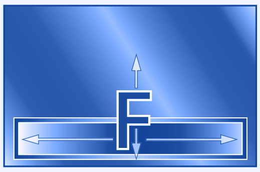


Thermal processes I Heat Treatments

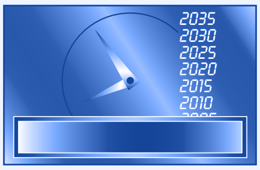
Hardening / Tempering

Making steel hard and wear resistant

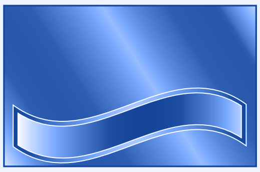
High wear resistance



Increased mechanical properties

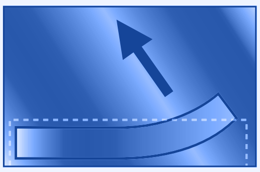


High stability

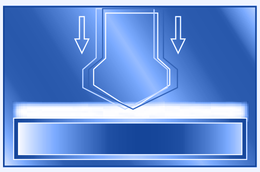


Improved fatigue strength

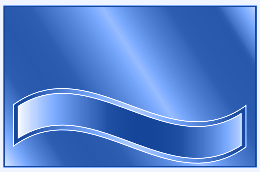
High hardness



Improved ductility



Increased impact resistance



Increased bending fatigue strength

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Hardening / Tempering

How does Hardening take place?

What is Hardening?

Hardening and tempering of engineering steels is performed to provide components with mechanical properties suitable for their intended service. Steels are heated to their appropriate Hardening temperature, held at temperature, then "quenched"(rapidly cooled) . This is followed by tempering (a soak at a lower temperature) to develop the final mechanical properties and relieve stresses.

How does Hardening take place?

The hardening process of components can be divided into three technical steps:
First, the component is heated so that the micro structure transforms into an austenitic structure. The austenitisng temperature depends on the material used (750 °C – 1210°C).
Then the component is maintained at this temperature so that alloying elements can be incorporated homogenously in the austenitic structure.
The final step is quenching the component at such a cooling rate that a so-called martensitic structure is originated.

The heating and temperature dwell should be performed in a protective atmosphere to protect the material from oxidation and decarburisation. Cooling can be performed in different media. The most common are: water, saline water, oils, polymers, salt bath, nitrogen or argon.

After hardening, steel is relatively brittle. Therefore, directly after Hardening it must be tempered at least once, though multiple tempers are more beneficial. Tempering relieves stress at relatively low temperatures, when the internal stresses that are present following hardening, decrease. This decreases the hardness in most cases, but on the other hand, the toughness increases significantly.

The Theory behind Hardening

Steel has (in an unhardened state) a body centered cubic (BCC) structure, in which it can dissolve very little carbon. After heating to approx. 720 °C austenite is developed that has a face centered cubic (FCC) crystal structure that can dissolve considerably more carbon, which occurs at the Hardening temperature. By then rapidly cooling the material, converting it from a cubic face centered crystal structure back into a cubic spatially centered structure, oversatured carbon remains and martensite is formed. Due to the presence of supersaturated carbon, the BCC (body centered cubic) lattice is stretched out to a tetragonal lattice. The martensite thus possesses high internal stresses and a larger volume than non-hardened steel at room temperature. As a consequence, the high internal stresses produce a high hardness in the material.
Upon tempering, a little carbon will be diffused from the tetragonal lattice. Consequently stress and volume, but also hardness decrease and the toughness increases significantly.

Hardening Processes

The most common hardening processes applied by the Hauck HT are carried out under protective gas or vacuum.

By hardening under protective gas, we mean hardening of a component in an inert gas atmosphere. This process serves to protect the surface of the component against oxidation as well as against decarburisation and carburising. Modifying the adjustable carbon potential of the protective gas atmosphere, decarburisation and carburising can be reversed.

Vacuum Hardening is the hardening of components in a controlled vacuum atmosphere, in which temperatures up to 1300°C can be achieved. The benefit of this treatment is to prevent any oxidation or to avoid other reactions, on the surface of the component. The advantage of Vacuum Hardening is that metals remain bright and further mechanical treatment is often unnecessary.

Properties

- Higher wear-resistance
- Higher hardness
- Improved resistance to deflection
- Improved resistance to fraction/tearing
- Improved resistance to chipping
- Improved ductility

Hardenable steels

Hardenable steels contain at least 0.3% carbon. Examples of steels that can be hardened are: spring steel, cold work steel, high alloy steel, roller bearing steel, hot work steel and tool steel.

A large number of high-alloy, stainless steels and alloys of cast iron can be hardened.W