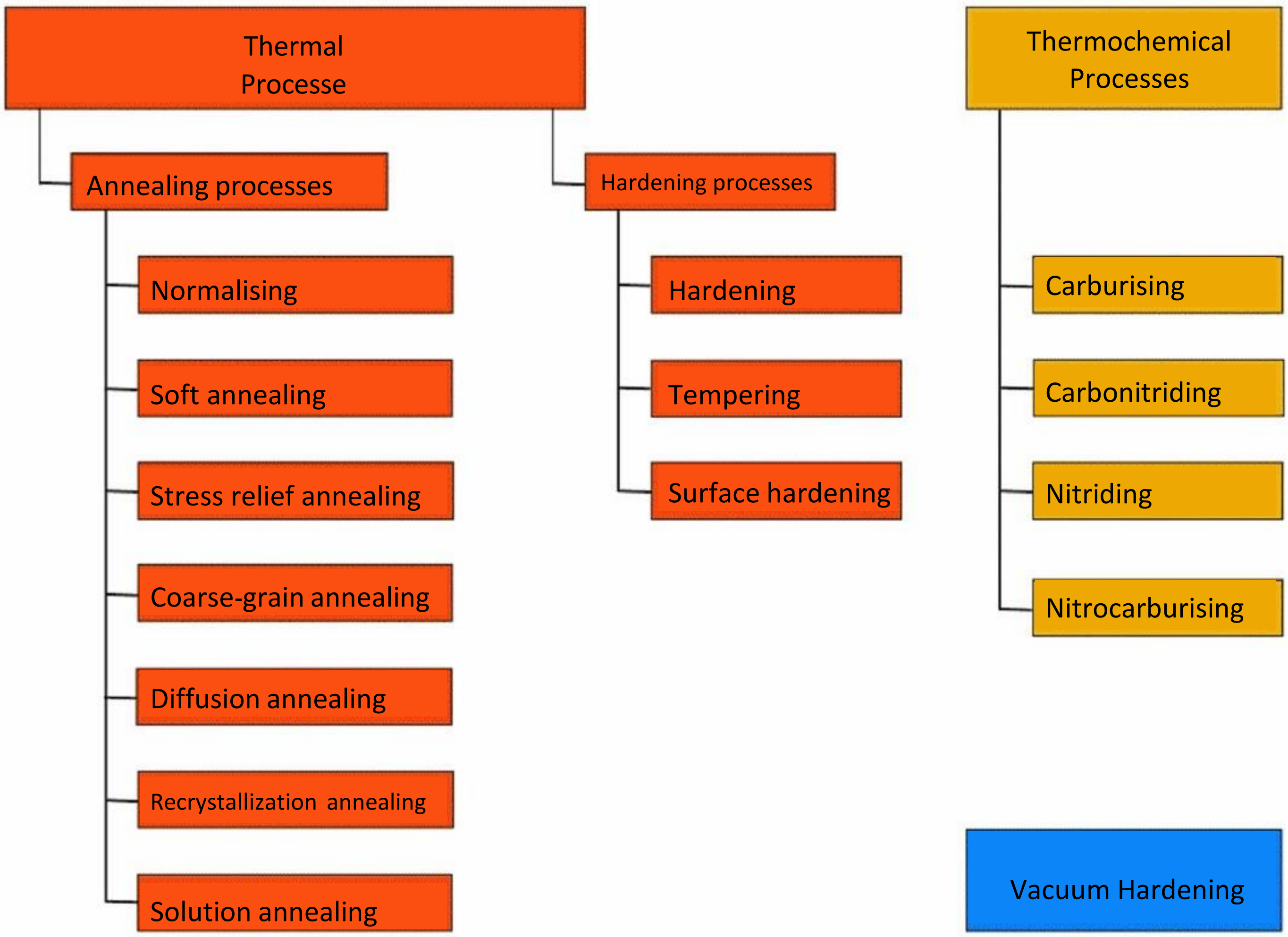

Thermal Processe
Annealing processes
Normalising
Soft annealing
Stress relief annealing
Coarse-grain annealing
Diffusion annealing
Recrystallization annealing
Solution annealing
Hardening processes
Hardening
Tempering
Surface hardening
Thermochemical Processes
Carburising
Carbonitriding
Nitriding
Nitrocarburising
Vacuum Hardening

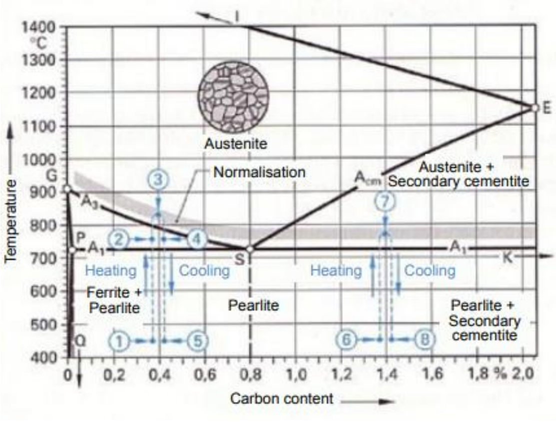
Annealing

Annealing refers to the treatment of a workpiece at a specific temperature, with a specific holding time and subsequent cooling adapted to achieve the desired material properties.

We offer the following annealing processes:

<ins>Normalising:</ins>

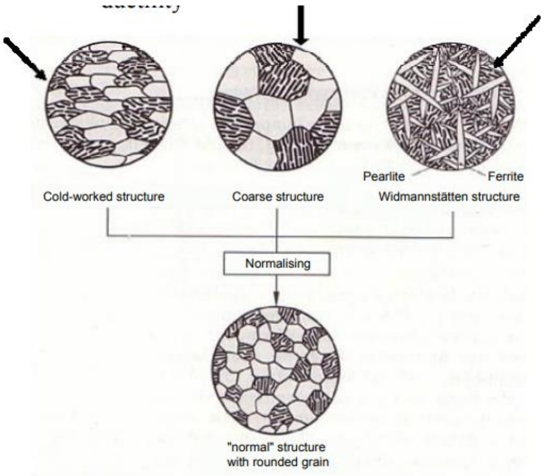
Is intended to restore an even and fine grained structure after a pretreatment (casting, hardening, forging). This condition can always be restored.



By welding, coarse-grain annealing after recrystallisation annealing – low strength, toughness, ductility

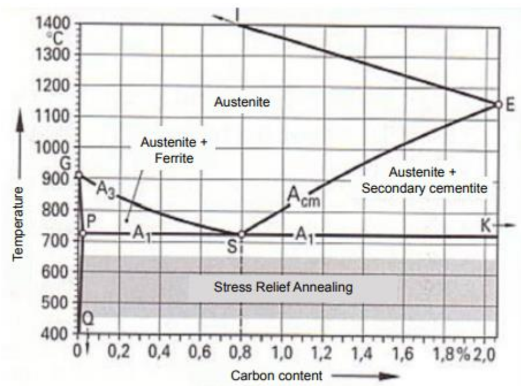
Through rolling, forging, drawing – poor toughness

In the case of cast steel (0,15 to 0.35%C), ferrite and ductility are developed, in between is pearlite – poor toughness



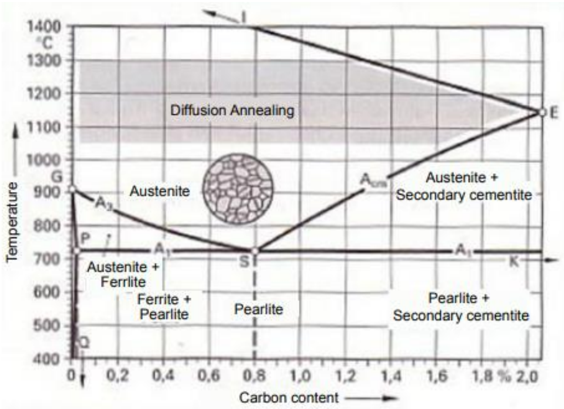
<ins>Stress Relief Annealing:</ins>

The purpose of stress relief annealing is to reduce stresses inside a tool. As a result of the annealing, the material begins to become malleable.



Causes of internal stresses:
-Uneven colling
-Cold working
-Machining (turning, milling,..)
-Welding
-Forging

Diffusion Annealing:

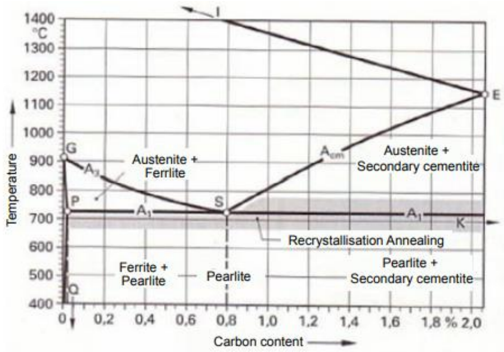


Is annealing at very high temperatures with a very ling holding time.

Meaning and purpose

-Elimination of soluble ohases at the grain boundaries
-Changing the geometry of insoluble carbides or nitrides
-Roundish instead of needle-like or elongated.
-Compensation for local differences in chemical compositions.

Soft Annealing:

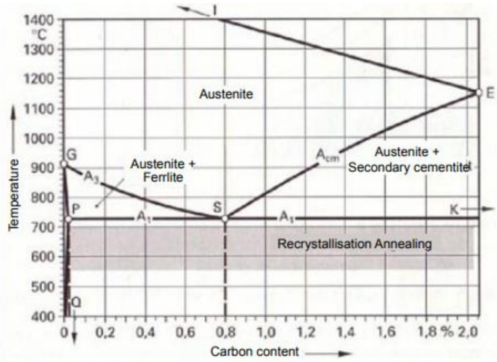


Soft annealing is intended to give the steel low strength and hardness and high formability. Machining and reshaping is improved

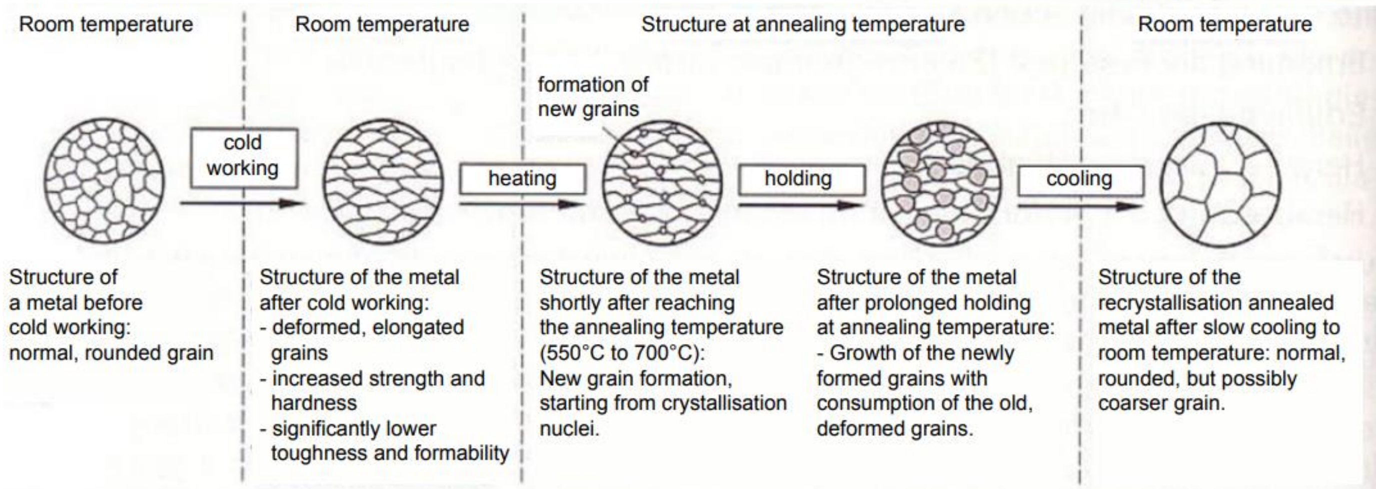
Lower pearlitic steels: annealed in the range of the PSK-line
Hyper pearlitic steels: annealing temperature fluctuates around PSK

Cooling takes place slowly up to 600°C, then as required

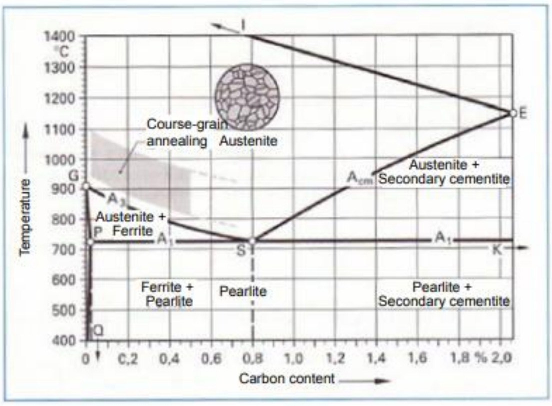
Recrystallisation annealing:

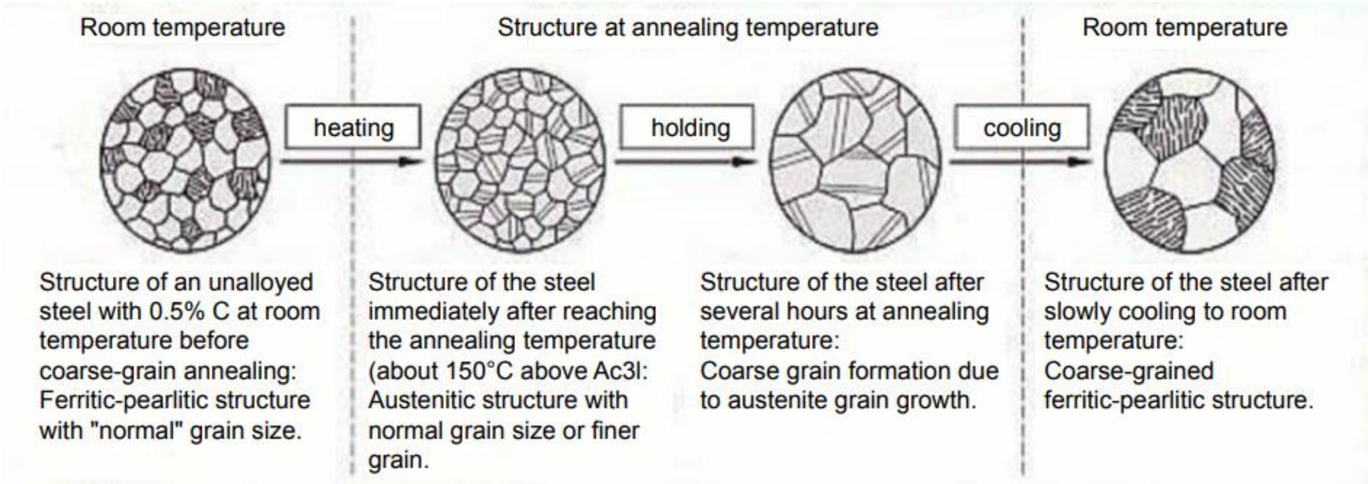


Is annealing at temperatures above the recrystallisation temperature of the material to eliminate strain hardening. This makes further reshaping possible.



Coarse-grain annealing is used to produce a coarse structure, which has less strength and is therefore easier to machine.





Benefits of annealing:

- Improvement of the mechanical properties
- Optimisation of mechanical processing
- Improvement of the structural conditions for cold forming
- Reduction of the machining and processing stress
- Restoration of the initial state

Case Hardening

Through this process, the surface layer of components and tools is carburized with a carbon-releasing medium and then quenched. This improves the mechanical properties of the surface layer of the component.

After the components have hardened, tempering is usually necessary in order to alleviate the stresses caused by hardening and to set the required service strength. For case hardening, the heat treater has various plant technologies such as chamber furnaces, conveyor furnaces, salt baths, low-pressure systems, etc. available. Partial case hardening is also possible thanks to suitable insulation techniques.

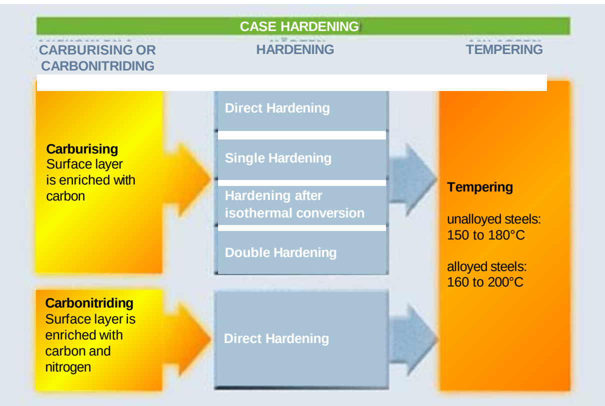
Benefits of this type of heat treatment:
Case hardening is used to give the surface layer of steel workpieces and tools a much higher hardness and better mechanical properties. Case-hardened components and tools are characterised by increased wear resistance, a tough core and increased flexural strength. These properties are particularly desirable for transmission parts.

Carbonitriding

Through this process, the surface layer of components is enriched with carbon and nitrogen and the mechanical properties of the component surface layer (e.g. wear) are improved.

This process, therefore, sits practically in between case hardening and nitriding, as carbonitriding temperatures are lower than those of case hardening, but higher than those of nitrating. Enrichment of nitrogen reduces the hardening temperature and the critical cooling rate, so that quenching can be carried out more gently. Both factors reduce the risk of distortion. The desired surface hardness is set with a subsequent tempering treatment. If partial carbonitriding is required, the areas not to be carbonitrided can be isolated.

Benefits of Carbonitriding:
This process is used to give the surface layer of steel workpieces and tools a significantly higher hardness and better mechanical properties. Furthermore, there is increased wear resistance with simultaneous low distortion.

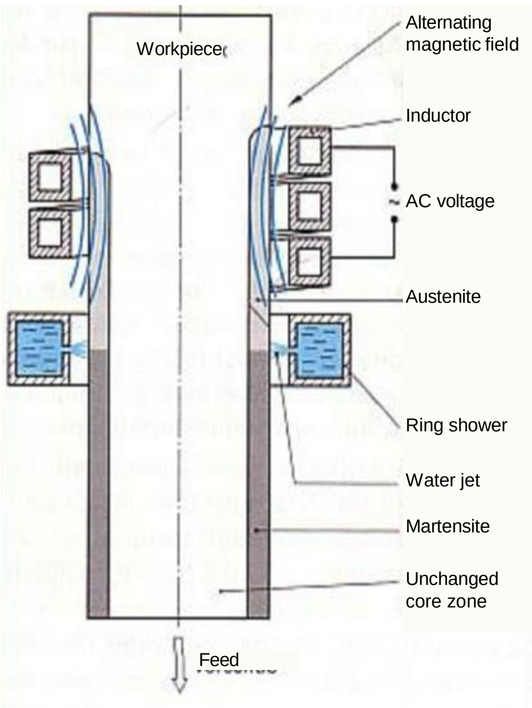


Induction Hardening

Induction hardening is surface layer hardening and belongs to the group of structure-transforming processes. The chemical composition is not changed. As a rule, therefore, only steels with a sufficiently high carbon content can be treated.

The high heating rates make it possible to harden only the surface layer of workpieces. Furthermore, the heat treatment can be concentrated on a localised zone (partial hardening).

Since most structural parts in mechanical engineering are not evenly stressed across the workpiece cross-section, rather wear and rolling pressure are directed towards the workpiece surfaces, induction surface hardening therefore influences the surface zone properties of the material in such a way that the component can better withstand the stresses. What is primarily important is an increase in the hardness of the entire workpiece surface or part thereof. This increases wear resistance and resistance to high local surface pressure.

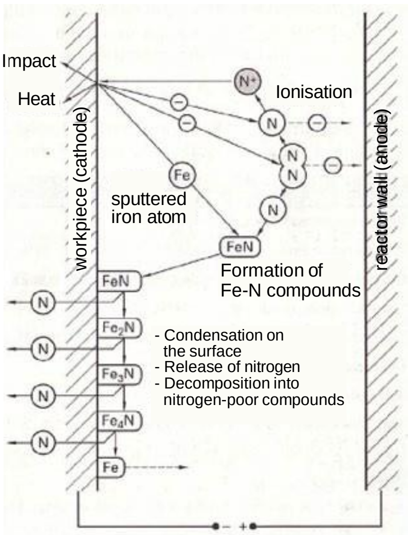


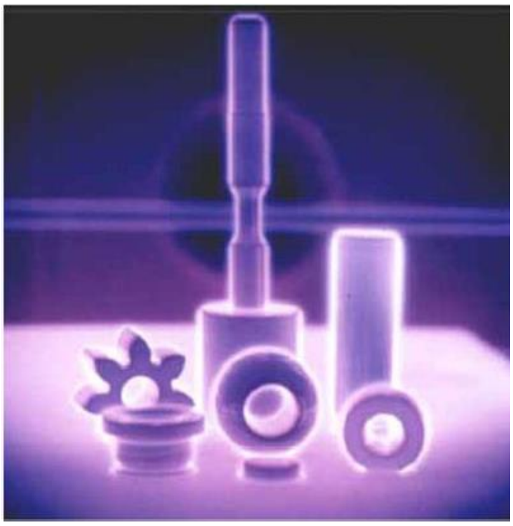
Benefits of induction hardening:
- low scaling
- low surface decarburisation
- easily reproducible
- partial hardening
- environmentally friendly process

Micropulse Plasma Nitriding

Components, primarily machine parts subject to higher stresses such as shafts, axles, rods or gear wheels, are subject to particularly critical loads, especially in the area of their surface (edge layer).
It is often sufficient if these components have mechanically improved properties only in the surface area. The storage of nitrogen in this surface layer is called nitriding. Ammonia, nitrogen, methane
and hydrogen can be used as treatment gases. Plasma nitriding takes place in a vacuum chamber under an ionized gas atmosphere. Mixed gases are also used to form wear-oriented layers. The quality is determined by the gas composition, the pressure, the temperature and the treatment time.
Positively charged ions hit the workpieces, which are connected as cathodes, in front of the furnace wall (anode) with high impact speed. Initially, this ion bombardment causes an extremely intensive cleaning of the workpiece surface (sputtering), which is then followed by heating and nitriding of the surface.
Glow discharge below atmospheric pressure

Reaction medium:	reactor wall = anode workpieces = cathode
Temperature:	500 – 550°C
Duration:	4 – 100 hours





Benefits of this heat treatment:
- High wear resistance to abrasion and adhesion
- Low distortion
- Adaptation of the layers to the type of wear
- Reduction of friction coefficients
- Partial hardening
- Heat resistance and tempering resistance of the surface layer up to over 500°C

Salt Bath Nitriding

Salt bath nitriding (Tenifer) is a thermochemical treatment in which the surface layer of ferrous materials is predominantly enriched with nitrogen and at the same time with small amounts of carbon. The most important factors influencing the thickness of the compound layer are the material itself, the treatment time/temperature and the bath chemistry used. Under constant treatment conditions, an increasing content of alloying elements causes a decrease in the thickness of the compound layer, a decrease
in the overall nitriding depth and an increase in surface hardness.

Reaction medium: molten salt
Temperature: 500 – 580°C
Duration: 45 – 180 minutes

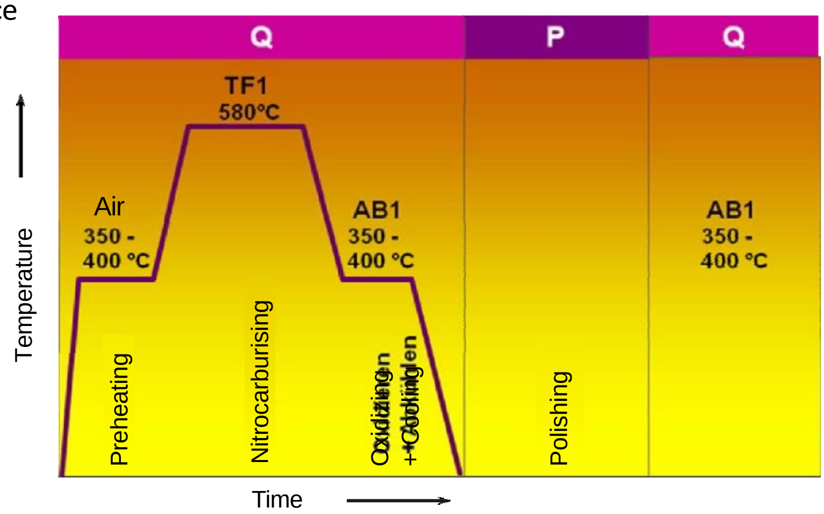
Process variants:

Tenifer® Q Salt bath nitrocarburising with oxidising cooling (Q)
Tenifer® QP Salt bath nitrocarburising with oxidising cooling + polishing (QP)
Tenifer® QPQ Salt bath nitrocarburising with oxidising cooling + polishing
+ oxidising post treatment (QPQ)

Q:
- Wear resistance
- Operating properties, heat resistance
- Corrosion resistance
- Fatigue strength, rolling resistance
- Tool service life

QP:
- Low roughness
- Even friction value
- Shiny metallic surface

QPQ:
- Low roughness
- Low coefficient of friction
- Highest corrosion resistance
- Dark finish
- Decorative appearance
- Low light reflection

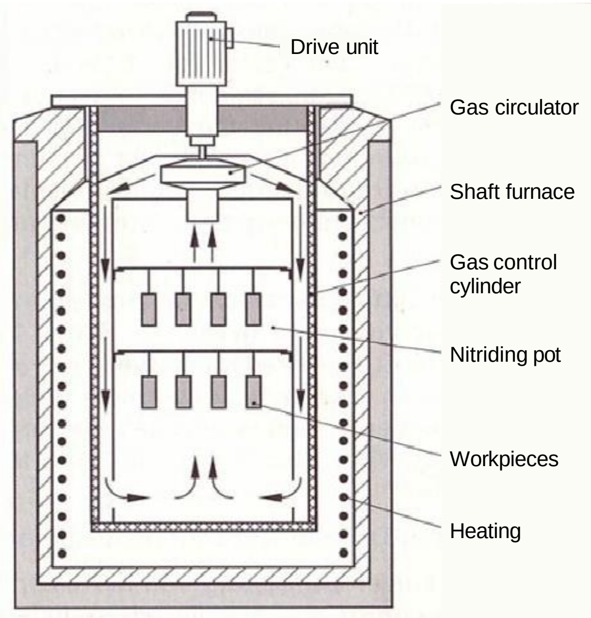


Benefits of the salt bath nitriding process:
- improved wear properties
- significant increase in corrosion resistance
- a higher fatigue strength
- better optics
- versatile application
- economical

Gas Nitriding

Gas nitriding is an economical process for surface hardening of components that are sensitive to distortion and subject to high loads. The diffusion of nitrogen into the steel surface significantly improves a large number of component properties.

Reaction gas: ammonia (NH_3);
$NH_3 \leftrightarrow \frac{1}{2} N_2 + 1 \frac{1}{2} H_2$
Temperature: 500 - 550°C
Duration: 4 - 100 hours (depending on layer thickness and material)



Benefits of gas nitriding:
- Improved wear resistance
- Increase in flexural strength
- Increase in rolling resistance
- Improved gliding properties

Vacuum Hardening

The vacuum heat treatment of tools and components is now state of the art. A wide range of materials can be heat treated in the vacuum furnace. Various heat treatment methods such as annealing, hardening and tempering can be carried out.

Vacuum hardening is the heating of the hardened pieces in a sealed vessel, while a vacuum is created by pumping out the air. The pieces are then gradually heated up to the hardening temperature using electrically heated graphite rods. The parts are quenched by blowing in nitrogen gas up to a pressure of 6 bar.

With each heating, the available atmospheric oxygen reacts with the surface of the workpiece (oxidation). This reaction is more intense, the higher the temperature. With a correspondingly long dwell time at high temperatures, scaling (from approx. 600°C) and decarburisation or partial decarburisation of the surface (from approx. 780°C) occurs, which appears as the so-called “soft layer” during subsequent hardening. This can only be removed mechanically. For this reason, a protective gas atmosphere is required for every heating above approx. 400°C. In most cases, nitrogen is perfectly adequate as a protective gas.

At higher temperatures, which usually occur in vacuum furnaces (usual temperature range during hardening: 850 - 1200°C), the vacuum offers significantly better protection (no decarburisation). Even at hardening temperatures of 1300°C, the workpieces are absolutely bare after hardening.

Vacuum heat treatment has a variety of benefits:
- low warpage
- decarburisation-free
- no oxidation of the components
- bare surfaces
- reproducible results

Deep Freezing

With our deep freezer, the temperature can be cooled down to minus 120°C using liquid nitrogen. This can lead to premature aging of steel and the conversion of retained austenite to martensite in hardened steel.

Leveling

Leveling is the correction of unwanted distortions of a workpiece. Such distortions are, for example, the result of heat treatment or forming processes. They are caused by an uneven residual stress distribution, for example due to an uneven cooling speed around the circumference of the workpiece. The straightening effect is achieved by targeted structural reshaping. Leveling is therefore one of the forming processes.

Benefits of the leveling process:
- Reduction of the grinding allowance
- Uniformly thick hardened layer after grinding

Blasting / Vibratory finishing

Our blasting and vibratory finishing systems are primarily used to improve the component surface.

For this purpose we have a dry and a wet grinding system, which are operated with a corundum blasting agent, as well as two vibratory grinding systems.