Furnaces and Heat Treatment Plants for Processes under Protective or Reactive Gases or Vacuum

Retort Furnaces
Continuous and Wire Annealing Furnaces
Tube Furnaces
Salt-Bath Furnaces
Nitriding and Caburizing Furnaces
Furnaces for Additive Manufacturing
Hardening Systems, Quenching Baths
Protective Gas Boxes

www.nabertherm.com
Made in Germany
Nabertherm with 500 employees worldwide have been developing and producing industrial furnaces for many different applications for 70 years. As a manufacturer, Nabertherm offers the widest and deepest range of furnaces worldwide. 150,000 satisfied customers in more than 100 countries offer proof of our commitment to excellent design, quality and cost efficiency. Short delivery times are ensured due to our complete inhouse production and our wide variety of standard furnaces.

Setting Standards in Quality and Reliability
Nabertherm does not only offer the widest range of standard furnaces. Professional engineering in combination with in house manufacturing provide for individual project planning and construction of tailor-made thermal process plants with material handling and charging systems. Complete thermal processes are realized by customized system solutions.

Innovative Nabertherm control technology provides for precise control as well as full documentation and remote monitoring of your processes. Our engineers apply state-of-the-art technology to improve the temperature uniformity, energy efficiency, reliability and durability of our systems with the goal of enhancing your competitive edge.

Global Sales and Service Network – Close to you
Nabertherm’s strength is one of the biggest R&D department in the furnace industry. In combination with central manufacturing in Germany and decentralized sales and service close to the customer we can provide for a competitive edge to live up to your needs. Long term sales and distribution partners in all important world markets ensure individual on-site customer service and consultation. There are various reference customers in your neighborhood who have similar furnaces or systems.

Large Customer Test Center
Which furnace is the right choice for this specific process? This question cannot always be answered easily. Therefore, we have set up our modern test center which is unique in respect to size and variety. A representative number of furnaces is available for tests for our customers.

Customer Service and Spare Parts
Our professional service engineers are available for you worldwide. Due to our complete inhouse production, we can despatch most spare parts from stock over night or produce with short delivery time.

Experience in Many Fields of Thermal Processing
In addition to furnaces for thermal process technology, Nabertherm offers a wide range of standard furnaces and plants for many other thermal processing applications. The modular design of our products provides for customized solutions to your individual needs without expensive modifications.
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Generally, metals are heat treated under protective or reaction gases or in vacuum to prevent or minimize oxidation of the components.

Nabertherm offers an extensive range of graduated solutions for the heat treatment of metals. This catalog provides a description of the different furnace concepts and the accessories that are available for the different processes.

Which Furnace is Suitable for Which Application?

Essentially, the requirements with respect to the furnace type depend on following factors:

- Required temperature range
- Charge dimensions
- Type of protective or reaction gas
- Required leak rate of the work space/required surface quality of the charge
- Safety requirements, i.e. when working under flammable gases
- Required heating and cooling times

Depending on the process requirements, adapted solutions can be offered for heat treatment, including quenching.

Sealed Furnace

Sealed furnaces are standard furnaces with a protective gas connection in which the housing is sealed and the door design is adapted. These furnaces are suitable for processes without high requirements with respect to residual oxygen, or for heat treatment of components that are to be processed afterwards.

Furnaces with Protective Gas Boxes, Protective Gas Boxes with an Evacuation Lid, or Annealing Bags

Heat treatment furnaces with protective gas boxes or annealing bags offer a good price/performance ratio and can be used for many processes that have to be carried out in a non-flammable protective or reaction gas atmosphere.

By using a protective gas box with the corresponding process gas supply, a standard furnace can be upgraded to a protective gas furnace. Depending on the type of process gas, the preflushing rate, the process flushing rate, and the condition of the box, it is possible to achieve residual oxygen concentrations in the low ppm range.

Depending on the application, the protective gas boxes are removable, remain in the furnace, or are especially designed for heat treatment of bulk materials. Annealing bags are another gassing variant.
For charges with complex shapes or drilled holes, bulk materials, or sensitive materials, such as titanium, it is recommended to use a protective gas box with an additional evacuation lid for cold stage evacuation.

Protective gas boxes can be used in forced convection furnaces at temperatures up to 850 °C and in radiation heated furnaces for working temperatures up to 1100 °C. This catalog describes in detail the different furnace ranges and the associated accessories.

**Hot-Wall Retort Furnaces**  
Retort furnaces are the perfect solution if the process requires a furnace chamber with a pure atmosphere. The retort is not water cooled and is therefore restricted in maximum temperature. Water cooling is used only for the door seal. Hot-wall retort furnaces can be used for maximum working temperatures of 1100 °C, and with special retort material, up to 1150 °C.

These gas tight retort furnaces are ideal for heat treatment processes that require a defined protective or reaction gas atmosphere. The compact models can also be designed for heat treatment in vacuum up to 600 °C. Equipped with corresponding safety technology, retort furnaces are also suitable for applications under reaction gases such as hydrogen.

**Cold-Wall Retort Furnaces**  
Cold-wall retort furnaces can be used for heat treatment processes in defined protective or reaction gas atmospheres or high temperature processes under vacuum. The VHT retort furnaces are designed as electrically heated chamber furnaces with graphite, molybdenum, tungsten, or MoSi₂ heating.

The vacuum-tight retort is completely water-cooled and allows for heat treatment processes either in protective or reaction gas atmospheres or under vacuum up to 10⁻⁵ mbar.

This furnace series can also be equipped with suitable safety packages for flammable gases.

**Furnaces for Continuous Processes**  
Nabertherm also has compact furnaces for continuous processes that require a protective or reaction gas atmosphere.
## Which Furnace for Which Process?

This catalog describes furnaces working under non-flammable or flammable gases or under vacuum. For furnaces working under air please see our catalog „Thermal Process Technology I“.

### Preheating for Forging
- Press Hardening
- Heating of sheet metals
- Preheating of molds

### Hardening, Annealing
- Ageing
- Austempering
- Diffusion annealing
- Pack hardening
- Recovery annealing
- Coarse grain annealing

### Quenching
- Hardening
- Solution annealing
- Annealing
- Recrystallization annealing
- Stress-relieving
- Soft annealing

### Preheating for Forging in Air
- Bogie hearth furnaces*
- Bogie hearth furnaces gas-fired*
- Chamber furnaces gas-fired*
- Chamber furnaces*
- Top hat furnaces*
- Rotary hearth furnaces*
- Continuous furnaces*

### Hardening, Annealing in Air
- Forced convection pit-type furnaces*
- Pit-type and top-loading furnaces*
- Chamber furnaces gas-fired*
- Chamber furnaces*
- Chamber furnaces gas-fired*
- Top hat furnaces*
- Rotary hearth furnaces*
- Continuous furnaces*

### Hardening, Annealing under Protective Gases, Reaction Gases or in Vacuum
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### Quenching in Salt Bath
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### Quenching in Bath
- Quench tanks page 80 - 81
- Water quench tanks*

* See also catalog Thermal Process Technology I
Tempering, Annealing

- Tempering
- Precipitation annealing
- Ageing annealing
- Recovery annealing

Solution annealing
- Preheating
- Reduced hydrogen annealing

Tempering Plants

- Solution annealing
- Quenching
- Artificial ageing

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Semi-automatic tempering plant with retort furnace NR 50/11 and water quenching
# Which Furnace for Which Process?

## Brazing/Soldering
- **Soft soldering**
- **Brazing**
- **High-temperature brazing**

### in Salt Bath
- **Salt-bath furnaces**
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### in Vacuum
- **Hot-wall retort furnaces**
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### under Protective Gases
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- **Composites**
- **Molds**
- **Adhesive**
- **Plastics**
- **Lacquers**
- **PTFE**
- **Silicone**
- **Surface Drying**
- **Preheating**
- **Vulcanizing**
- **Conditioning**

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- **Chamber dryers**
- **Forced convection chamber furnaces**
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### Water Based
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- **Ovens**
  - *
- **Forced convection pit-type furnaces**
  - page 60 - 68*
- **Rotary hearth furnaces**
- **Continuous furnaces**

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* See also catalog Thermal Process Technology
** See also catalog Laboratory
*** See also catalog Advanced Materials
Thermal/Thermo-Chemical Processes
Surface Treatment, Cleaning

- Carburizing
- Blueing (e.g. with water steam)
- Nitriding/nitrocarburizing
- Boriding
- Deoxidizing under hydrogen
- Pyrolysis
- Heat cleaning
- Oxidizing
- Siliconizing

Thermal Separation Processes

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Blueing of drills in water steam atmosphere in a furnace of the NRA range see page 16

Sintering & Debinding

- Additive manufacturing
- Debinding
- MIM
- CIM
- Sintering
Hardening, Carburizing, Nitriding, Brazing, MIM

Hardening

Hardening is one of the most common forms of heat treatment of metallic materials, with the aim of increasing mechanical resistance by converting the microstructure.

The hardness and strength increase resulting from the hardening are the main reasons for the increased resistance against wear, tension, pressure and bending.

Hardening is generally understood to mean the transformation hardening, i.e. austenitization of the material followed by quenching. When quenching, the critical cooling rate of the respective material must be exceeded in order to obtain a martensitic structure. The quenching is carried out in different quenching media (water, air, oil or gas).

Depending on the application, the material is allowed to quench, for example to obtain the desired toughness, and the hardness is again reduced.

Carburizing

Steels with a low content of carbon can usually be poorly cured. By increasing the carbon content to a certain percentage, the hardenability can be significantly improved. This property is used for carburizing. The edge layer is enriched with carbon so that this carburized part of the material can subsequently be cured. The non-edge, non-carburized area of the material remains tough and soft. A known example of this process is the carburizing and subsequent hardening and tempering (case hardening) of gears wheels for all types of gearing. The toothing has the necessary hardness after the hardening in order to minimize wear, but the core of the gear wheel remains ductile and machinable.

Nitriding

As in carburizing, nitriding is also a thermochemical treatment. During nitriding, nitrogen diffuses into the edge layer. Depending on the steel or cast alloy, an increase in hardness can be achieved. A greater advantage of nitriding is the achievement of a wear-resistant edge layer. For low-alloy steels the corrosion resistance can be significantly increased by nitriding.

Carburizing and nitriding can be carried out with solid, gaseous or liquid media.

The following furnace concepts are suitable for curing, carburizing and nitriding:

Hardening

- Hardening in the protective gas box/protective gas annealing bag or annealing box in chamber furnaces with or without protective gas atmosphere. The quenching can take place in different media like oil, water or air.
- Hardening in the hot-wall retort furnace with protective gas or reaction gas up to 1150 °C. The quenching is done manually or semi-automatically in oil, water or air.

Carburizing/Nitriding

- Carburizing/nitriding in the annealing box with appropriate granulates
- Controlled or uncontrolled nitriding/carburizing in the hot-wall retort furnace with combustible reaction gases. The quenching is done manually or semi-automatically in oil, water or air.

Annealing

- Annealing in a forced convection chamber furnace with or without a protective gas atmosphere
- Annealing in the protective gas box in a forced convection chamber furnace under protective gas atmosphere
**Powder-Pack Annealing Processes**

As a cost-effective alternative to the thermochemical processes which take place in a gas atmosphere, the powder packing annealing is suitable for certain processes.

With this method, the parts, which are appropriately prepared, are charged into an annealing box together with the process powder. The annealing boxes are then closed with a cover.

Possible application examples are carburizing, neutralizing, nitriding or boriding.

**Brazing**

In general, when speaking of brazing it has to be distinguished between soft-soldering, brazing and high-temperature brazing. This involves a thermal process for forming substance-to-substance bonds and material coatings during which a liquid phase is generated by the melting of the solder. Based on their melting temperatures, the solder processes are classified as follows:

- **Soft-solders**: $T_{\text{liq}} < 450 \, ^\circ\text{C}$
- **Brazing**: $450 \, ^\circ\text{C} < T_{\text{liq}} < 900 \, ^\circ\text{C}$
- **High-temperature brazing**: $T_{\text{liq}} > 900 \, ^\circ\text{C}$

Beside the right selection of the solder, the flux if necessary, and ensuring that the surfaces are clean, the choice of the right brazing furnace is also key to the process. In addition to the actual brazing process, Nabertherm has furnaces for the preparation process in their range such as for metallizing ceramics in preparation for brazing ceramic-to-metal bonds.

The following furnace concepts are available for brazing:

- Brazing in an annealing box in the forced convection chamber furnace up to 850 °C in a protective gas atmosphere
- Brazing in an annealing box in a chamber furnace up to 1100 °C under a protective gas atmosphere
- Brazing in a hot-wall retort furnace NR/NRA product line under protective gases or reaction gas up to 1100 °C
- Brazing in a cold-wall retort furnace VHT product line under protective gases, reaction gases or under vacuum up to 2200 °C
- Brazing in a salt bath up to 1000 °C salt bath temperature
- Brazing or metallizing in a tube furnace up to 1800 °C under protective gases, reaction gases or in a vacuum up to 1400 °C

In the Nabertherm Test Center in Lilienthal, Germany, a range of sample furnaces is available for customers testing applications which is the best approach to define the right furnace for a specific application.

**MIM - Metal Powder Injection Molding**

The metal powder injection molding is based on the same principle as the plastic injection molding. At MIM, a metallic feedstock, i.e. a metallic powder with a binder system, is produced by means of an injection molding machine and an injection mold. The result is a so-called green part, which does not yet have its final size and density.

In the subsequent debinding process, which takes place under metallic conditions either under an inert atmosphere, under hydrogen or else catalytically under a nitric acid-nitrogen atmosphere, the green part loses a large proportion of the binder.

In the subsequent sintering process, which is also carried out again in a protective gas or reaction gas atmosphere or in a vacuum, the brown part is sintered to the finished component, which in most cases does not have to be further processed.
Additive manufacturing allows for the direct conversion of design construction files into fully functional objects. With 3D-printing objects from metals, plastics, ceramics, glass, sand or other materials being built-up in layers until they have reached their final shape.

Depending on the material, the layers are interconnected by means of a binder system or by laser technology.

Many methods of additive manufacturing require subsequent heat treatment of the manufactured components. The requirements for the furnaces for heat treatment depend on the component material, the working temperature, the atmosphere in the furnace and, of course, the additive production process.

Nabertherm offers solutions from curing for conservation of the green strength up to sintering in vacuum furnaces in which the objects of metal are annealed or sintered.

Also, concomitant or upstream processes of additive manufacturing require the use of a furnace in order to achieve the desired product properties, such as heat treatment or drying the powder.
In additive manufacturing, a distinction is made between printing with and without binder. Depending on the manufacturing process, different furnace types are used for the subsequent heat treatment.

Apart from the factors described above, the previous processes from the heat treatment also have an influence on the overall result. One important criterion for a good surface quality is that the components are cleaned properly before the heat treatment.

This also applies to processes that are carried out in vacuum or in furnaces where a low residual oxygen concentration is important. For these furnaces, it is important that they are cleaned and maintained regularly. Even the smallest leak or contamination can produce an unsatisfactory result.

**Binder-Free Systems**

In binder-free additive manufacturing, in most cases, the components are produced in a laser melting process.

The tables below show typical materials and construction platform sizes of laser-based systems that are available on the market with suggestions with respect to furnace sizes, required temperature and atmosphere in the furnace.

### Aluminum Components

Generally, aluminum is heat treated in air at temperatures between 150 °C and 450 °C.

Due to the very good temperature uniformity, forced convection chamber furnaces are suitable for processes such as tempering, aging, stress-relieving or preheating.

<table>
<thead>
<tr>
<th>Platform sizes</th>
<th>Forced convection chamber furnaces, see page 60 up to 450 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>210 x 210 mm</td>
<td>NA 30/45</td>
</tr>
<tr>
<td>280 x 280 mm</td>
<td>NA 60/45</td>
</tr>
<tr>
<td>360 x 360 mm</td>
<td>NA 120/45</td>
</tr>
<tr>
<td>480 x 480 mm</td>
<td>NA 250/45</td>
</tr>
<tr>
<td>600 x 600 mm</td>
<td>NA 500/45</td>
</tr>
</tbody>
</table>

*Also available for 650 °C and 850 °C

### Stainless Steel and Titanium Components

In many cases, certain stainless steels and titanium are heat treated in a protective gas atmosphere at temperatures below 850 °C.

By using a protective gas box with the corresponding process gas supply, a standard furnace can be upgraded to a protective gas furnace. Depending on the type of process gas, the preflushing rate, the process flushing rate, and the condition of the box, it is possible to achieve residual oxygen concentrations of up to 100 ppm.

The forced convection chamber furnaces with protective gas boxes described below have a working temperature range between 150 °C and 850 °C. If the protective gas boxes are removed from the furnace, aluminum components can also be heat treated in air.

<table>
<thead>
<tr>
<th>Platform sizes</th>
<th>Forced convection chamber furnaces, see page 60 up to 850 °C with protective gas box</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 x 100 mm</td>
<td>N 30/85 HA</td>
</tr>
<tr>
<td>200 x 200 mm</td>
<td>N 60/85 HA</td>
</tr>
<tr>
<td>280 x 280 mm</td>
<td>N 120/85 HA</td>
</tr>
<tr>
<td>400 x 400 mm</td>
<td>N 250/85 HA</td>
</tr>
<tr>
<td>550 x 550 mm</td>
<td>N 500/85 HA</td>
</tr>
</tbody>
</table>
Inconel or Cobalt Chromium Components

Materials such as Inconel and cobalt-chromium are generally heat treated at temperatures from 850 °C up to between 1100 °C and 1150 °C. Various furnace families are used for these processes. In many cases, the chamber furnaces of the LH . . or NW . . series with protective gas boxes are sufficient to provide an outstanding price/performance ratio. Both furnace groups are suitable for temperatures between 800 °C and 1100 °C.

Examples for Chamber furnaces see page 54 and 58

Platform sizes

- 100 x 100 mm
- 250 x 250 mm
- 400 x 400 mm
- 420 x 520 mm
- 400 x 800 mm

Hot-wall retort furnaces see page 16

- 180 x 180 mm: NR(A) 17/..
- 280 x 280 mm: NR(A) 50/..
- 400 x 400 mm: NR(A) 150/..

Cold-wall retort furnaces are used for processes in protective gas at temperatures above 1100 °C or under vacuum above 600 °C.

Examples for Cold-wall retort furnaces see page 26

Platform sizes

- 100 x 100 mm: VHT 8/12-MO
- 250 x 250 mm: VHT 40/12-MO
- 400 x 400 mm: VHT 100/12-MO

With sensitive materials, such as titanium, the component may still oxidize due to the residual oxygen concentration in the protective gas box.

In these cases, hot-wall retort furnaces with a maximum temperature of 950 °C or 1100 °C are used. These gas tight retort furnaces are ideal for heat treatment processes that require a defined protective or reaction gas atmosphere. The compact models can also be designed for heat treatment under vacuum up to 600 °C. The risk of oxidation on the component is considerably reduced with these furnaces.
Systems with Binder

In 3D printing, organic binders, which evaporate during heat treatment, are used to build-up the part. The printed parts can be made of ceramic, metal, glass or sand. Depending on the evaporation volume, furnaces with graduated safety systems for debinding and sintering are used.

Debinding and Sintering in Air

This table shows examples of furnaces with the respective safety technology for debinding in air and the corresponding sintering furnaces for high temperatures, which are suitable, for example, for sintering many oxide ceramics.

<table>
<thead>
<tr>
<th>Printing dimensions up to</th>
<th>Debinding furnaces</th>
<th>Sintering furnaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 x 100 x 100 mm</td>
<td>L 9/11 BO LHT 4/16</td>
<td></td>
</tr>
<tr>
<td>200 x 200 x 150 mm</td>
<td>L 9/11 BO HT 40/16</td>
<td></td>
</tr>
<tr>
<td>300 x 400 x 150 mm</td>
<td>L 40/11 BO HT 64/17</td>
<td></td>
</tr>
</tbody>
</table>

1 Values for debinding like max. organic content, or evaporation rate have to be considered
2 The furnaces are available with different max. furnace chamber temperatures

Debinding and Sintering in Protective or Reaction Gas or under Vacuum

To protect metal components that were printed using a binder-based system against oxidation, two process steps, debinding and sintering, are carried out in an oxygen-free atmosphere.

Depending on the material and the binder system, debinding is carried out either in a non-flammable protective gas (IDB), under hydrogen (H2), or catalytically in a mixture of nitric acid and nitrogen. Adapted safety systems are used to ensure the safety of these processes.

The table contains examples of furnaces which can be equipped with suitable safety technology. Hot-wall retort furnaces are used as debinding furnaces and cold-wall retort furnaces as sintering furnaces. Under certain circumstances, depending on the application, it is possible to use the same furnace for both processes.

<table>
<thead>
<tr>
<th>Printing dimensions up to</th>
<th>Hot-wall retort furnaces</th>
<th>Cold-wall retort furnaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>150 x 150 x 150 mm</td>
<td>NRA 17/09</td>
<td>VHT 8/16-MO</td>
</tr>
<tr>
<td>300 x 300 x 300 mm</td>
<td>NRA 50/09</td>
<td>VHT 40/16-MO</td>
</tr>
<tr>
<td>400 x 400 x 400 mm</td>
<td>NRA 150/09</td>
<td>VHT 100/16-MO</td>
</tr>
</tbody>
</table>

1 Safety systems see page 18
2 Parts without residual binder. In case of a low content of residual binder we recommend an inner process chamber.

The models listed in the table above are just a few examples.
Hot-Wall Retort Furnaces up to 1100 °C

These gas tight retort furnaces are equipped with direct or indirect heating depending on temperature. They are perfectly suited for various heat treatment processes requiring a defined protective or a reaction gas atmosphere. These compact models can also be laid out for heat treatment under vacuum up to 600 °C. The furnace chamber consists of a gas tight retort with water cooling around the door to protect the special sealing. With the corresponding safety technology, retort furnaces are also suitable for applications under reaction gases, such as hydrogen or, in combination with the IDB package, for inert debinding or for pyrolysis processes.

Schematic presentation of a hot-wall retort furnace with additional equipment

1 Retort
2 Heating
3 Insulation
4 Gas management system
5 Vacuum pump
6 Fan for indirect cooling
7 Outlet indirect cooling
8 Exhaust torch
9 Fan for gas circulation (NRA models)
10 Charging frame
11 Emergency flushing container

Different model versions are available depending on the temperature range:

Models NRA ../06 with Tmax 650 °C
- Heating elements located inside the retort
- Temperature uniformity up to +/- 5 °C inside the work space see page 84
- Retort made of 1.4571
- Gas circulation fan in the back of the retort provides for optimal temperature uniformity
- Insulation made of mineral wool

Models NRA ../09 with Tmax 950 °C
Design like models NRA ../06 with following differences:
- Outside heating with heating elements around the retort
- Retort made of 1.4828
- Multi-layer insulation made of fiber materials classified as non-carcinogenic

Models NR ../11 with Tmax 1100 °C
Design like models NRA ../09 with following differences:
- Retort made of 1.4841
- Without gas-circulation

Short and long-term durability of retort materials
Basic version
- Compact housing in frame design with removable stainless steel sheets
- Controls and gas supply integrated in the furnace housing
- Welded charging supports in the retort resp. air-baffle box in the furnaces with atmosphere circulation
- Swivel door hinged on right side
- Open cooling water system
- Depending on furnace volume for 950 °C- and 1 100 °C-models the control system is divided in one or more heating zones
- Furnace temperature control with measurement outside the retort
- Gas supply system for one non-flammable protective or reaction gas with flow meter and magnetic valve
- Port for vacuum pump for cold evacuation
- Operation under vacuum up to 600 °C with optional vacuum pumps
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 88

Additional equipment
- Upgrade for other non-flammable gases, H₂ version for flammable gases see page 18
- Automatic gas injection, including MFC flow controller for alternating volume flow, controlled with process control H3700, H1700
- Vacuum pump for evacuating of the retort up to 600 °C, attainable vacuum up to 10⁻⁵ mbar subject to selected pump
- Indirect cooling see page 33
- Direct cooling see page 33
- Heat exchanger with closed-loop cooling water circuit for door cooling
- Measuring device for residual oxygen content
- Door heating
- Temperature control as charge control with temperature measurement inside and outside the retort
- Retort, made of 2.4633 for Tmax 1 150 °C
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 88
**H₂ Version for Operation with Flammable Process Gases**

When a flammable process gas like hydrogen is used, the retort furnace is additionally equipped with the required safety technology. Only certified and industry proven safety sensors are used. The furnace is controlled by a fail-safe PLC control system (S7-300F/safety controller).

- Supply of flammable process gas at controlled overpressure of 50 mbar relative
- Certified safety concept
- PLC controls with graphic touch panel H3700 for data input
- Redundant gas inlet valves for hydrogen
- Monitored pre-pressures of all process gases
- Bypass for safe flushing of furnace chamber with inert gas
- Thermal post combustion of exhaust gases

**IDB Version for Debinding under Non-flammable Protective Gases or for Pyrolysis Processes**

The retort furnaces of the NR and NRA product line are perfectly suited for debinding under non-flammable protective gases or for pyrolysis processes. The IDB version of the retort furnaces implements a safety concept by controlled inerting the furnace chamber with a protective gas. Exhaust gases are burned in a thermal post combustion. Both the purging and the torch function are monitored to ensure a safe operation.

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Model</th>
<th>Tmax °C</th>
<th>Work space dimensions in mm</th>
<th>Useful volume in l</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRA 17/..</td>
<td>650 or 950</td>
<td>NR 17/11</td>
<td>1100</td>
<td>225 w</td>
<td>350</td>
</tr>
<tr>
<td>NRA 25/..</td>
<td>650 or 950</td>
<td>NR 25/11</td>
<td>1100</td>
<td>225</td>
<td>500</td>
</tr>
<tr>
<td>NRA 50/..</td>
<td>650 or 950</td>
<td>NR 50/11</td>
<td>1100</td>
<td>325</td>
<td>700</td>
</tr>
<tr>
<td>NRA 75/..</td>
<td>650 or 950</td>
<td>NR 75/11</td>
<td>1100</td>
<td>325</td>
<td>700</td>
</tr>
<tr>
<td>NRA 150/..</td>
<td>650 or 950</td>
<td>NR 150/11</td>
<td>1100</td>
<td>450</td>
<td>750</td>
</tr>
<tr>
<td>NRA 200/..</td>
<td>650 or 950</td>
<td>NR 200/11</td>
<td>1100</td>
<td>450</td>
<td>1000</td>
</tr>
<tr>
<td>NRA 300/..</td>
<td>650 or 950</td>
<td>NR 300/11</td>
<td>1100</td>
<td>590</td>
<td>900</td>
</tr>
<tr>
<td>NRA 400/..</td>
<td>650 or 950</td>
<td>NR 400/11</td>
<td>1100</td>
<td>590</td>
<td>1250</td>
</tr>
<tr>
<td>NRA 500/..</td>
<td>650 or 950</td>
<td>NR 500/11</td>
<td>1100</td>
<td>720</td>
<td>1000</td>
</tr>
<tr>
<td>NRA 700/..</td>
<td>650 or 950</td>
<td>NR 700/11</td>
<td>1100</td>
<td>720</td>
<td>1350</td>
</tr>
<tr>
<td>NRA 1000/..</td>
<td>650 or 950</td>
<td>NR 1000/11</td>
<td>1100</td>
<td>870</td>
<td>1350</td>
</tr>
</tbody>
</table>

*Please see page 89 for more information about supply voltage
With their high level of flexibility and innovation, Nabertherm offers the optimal solution for customer-specific applications.

Based on our standard models, we develop individual solutions also for integration in overriding process systems. The solutions shown on this page are just a few examples of what is feasible. From working under vacuum or protective gas via innovative control and automation technology for a wide selection of temperatures, sizes, lengths and other properties of retort furnaces – we will find the appropriate solution for a suitable process optimization.
Manual or Semi-Automatic Tempering Plants for Hardening in Protective Gas with Subsequent Quenching outside the Furnace

Processes such as hardening of titanium or hardening/carburization, carburizing of steel, which require a controlled gas atmosphere with a subsequent quenching process, can be carried out with protective gas quenching and tempering plants. Such a system consists of a hot-wall retort furnace and an external quenching bath. Depending on the arrangement and design of the components, quenching delay times of up to 10 seconds can be achieved, so that the components are exposed to air for a short time only.

Chamber retort furnaces or pit-type retort furnaces can be offered for heavy components, where the batch is removed by crane after heat treatment and transferred to the quenching bath.

Depending on the requirements, the degree of automation can range from a purely manual version to a fully automated system with manipulator.

The quenching medium shall be selected taking into account the material to be treated and may be water, polymer, oil or a salt.

Additional equipment required for the process, such as cooling or heating or circulation of the medium, can be offered as well.

In a manual quenching and tempering plant, the process control is carried out by means of a Nabertherm controller. For more complex requirements, the controller is replaced by a PLC control. Process documentation in accordance with current standards such as the AMS 2750 E (NADCAP) is also possible.
Retort Furnaces for Catalytic Debinding also as Combi Furnaces for Catalytic or Thermal Debinding

The retort furnaces NRA 40/02 CDB and NRA 150/02 CDB are specially developed for catalytic debinding of ceramics and metallic powder injection molded parts. They are equipped with a gastight retort with inside heating and gas circulation. During catalytic debinding, the polyacetal-containing (POM) binder chemically decomposes in the oven under nitric acid and is carried out of the oven by a nitrogen carrier gas and burned in an exhaust gas torch. Both retort furnaces have a comprehensive safety package to protect the operator and the surrounding.

Executed as combi furnace series CTDB these retort furnace can be used for either catalytic or thermal debinding incl. presintering if necessary and possible. The presintered parts can be easily transferred into the sintering furnace. The sintering furnace remains clean as no residual binder can exhaust anymore.

- Retort made of acid-resistant stainless steel 1.4571 with large swiveling door
- Four-side heating inside the retort through chromium steel tube heating elements for good temperature uniformity
- Horizontal gas circulation for uniform distribution of the process atmosphere
- Acid pump and acid vessel (to be provided by the customer) accommodated in the furnace frame
- Gas-fired exhaust gas torch with flame monitoring

- Extensive safety package with redundantly operating safety PLC for safe operation with nitric acid
- Large, graphic process control H3700 for entering data and for process visualization
- Emergency tank for flushing in case of a failure
- Defined application within the constraints of the operating instructions

Version NRA .. CDB
- Tmax 200 °C
- Automatic gas supply system for nitrogen with mass flow controller
- Adjustable acid volume and correspondingly adjusted gas supply volumes

Version NRA .. CTDB
- Available for 600 °C and 900 °C with atmosphere circulation

Additional equipment
- Scale for the nitric acid vessel, connected to the PLC monitors the acid consumption and visualizes the fill level of the acid vessel (NRA 150/02 CDB)
- Lift truck for easy loading of the furnace
- Cupboard for acid pump
- Process control and documentation via Nabertherm Control Center (NCC) for monitoring, documentation and control see page 88

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
<th>Outer dimensions in mm</th>
<th>Heating power in kW</th>
<th>Electrical connection*</th>
<th>Weight in kg</th>
<th>Acidic quantity (HNO₃)</th>
<th>Nitrogen (N₂)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRA 40/02 CDB</td>
<td>200</td>
<td>300 x 450 x 300 x 300</td>
<td>40</td>
<td>1400 x 1600 x 2400</td>
<td>2.0</td>
<td>3-phase¹</td>
<td>800</td>
<td>max. 70 ml/h</td>
<td>1000 l/h</td>
</tr>
<tr>
<td>NRA 150/02 CDB</td>
<td>200</td>
<td>450 x 700 x 450 x 450</td>
<td>150</td>
<td>1650 x 1960 x 2850</td>
<td>20.0</td>
<td>3-phase¹</td>
<td>1650</td>
<td>max. 180 ml/h</td>
<td>max. 4000 l/h</td>
</tr>
</tbody>
</table>

¹Heating only between two phases
²Depending on furnace design connected load might be higher

*Please see page 89 for more information about supply voltage
Bottom Loading Retort Furnaces up to 1100 °C

The bottom loading retort furnaces of the LBR series are suitable for production processes that are carried out in protective/reaction gas atmosphere. With regard to the basic performance data, these models are constructed like the SR models. Their size and design with electro-hydraulically driven lifting bottom make it easier to load heavy duties. The retort furnaces are available in different sizes and designs.

**Basic version (all models)**
- Tmax 650 °C, 950 °C or 1100 °C
- Frame-mounted housing with stainless steel sheets
- Charging from the front
- Electro-hydraulically driven furnace bottom
- Gas supply system for a non-flammable protective gas or reaction gas with flow meter and solenoid valve
- Temperature control designed as furnace chamber control, see control alternative page 87
- Connection possibility for an optional vacuum pump (cold evacuation or operation up to 600 °C under vacuum)
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controllers: recording of process data with USB flash drive

**Additional equipment, H₂ version and IDB version see models NR and NRA**
The retort furnaces SR and SRA (with gas circulation) are designed for operation under non-flammable or flammable protective or reaction gases. The hot-wall retort furnaces are loaded from above by crane or other lifting equipment provided by the customer. In this way, even large charge weights can be loaded into the furnace chamber.

Depending on the temperature range in which the furnace be used, the following models are available:

Models SRA ../06 with Tmax 600 °C
- Heating inside the retort
- Gas-circulation with powerful fan in the furnace lid
- Temperature uniformity up to +/- 5 °C inside the work space
- Single-zone control
- Retort made of 1.4571
- Insulation made of high-grade mineral wool

Models SRA ../09 with Tmax 950 °C
Design like models SR../06 with following differences:
- All-around heating from outside of the retort
- Multi-layer insulation made of materials, classified as non-carcinogenic
- Retort made of 1.4828

Models SR ../11 with Tmax 1100 °C
Design like models SR../09 with following differences:
- Without gas-circulation
- Top down multi-zone control of the furnace heating
- Retort made of 1.4841

Standard Equipment (all models)
Design like standard equipment of models NR and NRA with following differences:
- Compact housing in frame construction with inserted stainless steel sheets
- Charging from above with crane or other lifting equipment from customer
- Hinged lid with opening to the side
- Welded charging frame resp. gas-guiding box for furnaces with circulation
- Gas-supply system for one non-flammable protective or reactive gas with flowmeter and magnetic valve
- Furnace temperature control see control alternative page 87
- Possible connection of an optional vacuum pump (for cold evacuation or for processes up to 600 °C under vacuum)
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive

Additional equipment, H₂ version or IDB version see models NR and NRA

### Pit-Type Retort Furnaces up to 1100 °C

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Inner dimensions of alloy retort</th>
<th>Volume in l</th>
<th>Outer dimensions in mm</th>
<th>Electrical connection</th>
<th>Weight in kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR(A) 17/..</td>
<td>250</td>
<td>350</td>
<td>17</td>
<td>1300</td>
<td>1700</td>
<td>1800</td>
</tr>
<tr>
<td>SR(A) 25/..</td>
<td>400</td>
<td>450</td>
<td>25</td>
<td>1300</td>
<td>1900</td>
<td>1800</td>
</tr>
<tr>
<td>SR(A) 50/..</td>
<td>600</td>
<td>700</td>
<td>50</td>
<td>1400</td>
<td>2000</td>
<td>1800</td>
</tr>
<tr>
<td>SR(A) 100/..</td>
<td>600</td>
<td>1000</td>
<td>100</td>
<td>1400</td>
<td>2000</td>
<td>2100</td>
</tr>
<tr>
<td>SR(A) 200/..</td>
<td>800</td>
<td>1600</td>
<td>200</td>
<td>1600</td>
<td>2200</td>
<td>2200</td>
</tr>
<tr>
<td>SR(A) 300/..</td>
<td>1000</td>
<td>1000</td>
<td>300</td>
<td>1600</td>
<td>2200</td>
<td>2500</td>
</tr>
<tr>
<td>SR(A) 500/..</td>
<td>1200</td>
<td>1200</td>
<td>500</td>
<td>1800</td>
<td>2400</td>
<td>2700</td>
</tr>
<tr>
<td>SR(A) 600/..</td>
<td>1000</td>
<td>1400</td>
<td>600</td>
<td>1800</td>
<td>2400</td>
<td>2900</td>
</tr>
<tr>
<td>SR(A) 800/..</td>
<td>1000</td>
<td>1600</td>
<td>800</td>
<td>2000</td>
<td>2600</td>
<td>2800</td>
</tr>
<tr>
<td>SR(A) 1000/..</td>
<td>1200</td>
<td>1800</td>
<td>1000</td>
<td>2000</td>
<td>2600</td>
<td>3100</td>
</tr>
<tr>
<td>SR(A) 1500/..</td>
<td>1200</td>
<td>1800</td>
<td>1500</td>
<td>2200</td>
<td>2800</td>
<td>3300</td>
</tr>
</tbody>
</table>

*Please see page 89 for more information about supply voltage
Forced Convection Pit-Type Retort Furnaces up to 850 °C

The forced convection pit-type furnaces of the SAL series (technical data see page 66) can be extended by the use of gas tight retorts for processes with defined atmospheres.

These systems are very well suited for the heat treatment of bulk materials.

By means of an additional retort and cooling station, the retort can be removed after completion of the heat treatment process and cooled in a cooling station. In the case of sensitive components, further flushing with protective gas can also be carried out during the cooling phase.

The cooling station can be designed with or without forced cooling by means of a powerful fan.

When equipped with a vacuum pump, the retort is evacuated outside the furnace in cold state and then flushed with protective gas. This procedure is particularly suitable for heat treatment of bulk solids as well as for non-ferrous and precious metals. Residual oxygen is much better and faster removed by means of pre-evacuation.

Up to a maximum working temperature of 600 °C, the furnaces can also be operated under vacuum by connecting a vacuum pump depending on the type of pump, a vacuum of up to $10^{-5}$ mbar can be achieved.

The furnaces can be equipped with gas supply systems for non-flammable protective and reaction gases, as described on pages 74 - 75.

A gas supply system for operation under hydrogen, including safety technology, is also available as an additional equipment.
Pit-Type Furnace with Exchangeable Retort

Main advantage of the pit-type furnace design is that the retort can be taken out of the furnace by crane, in order to cool down outside the furnace while the inert gas flushing is still switched on. Cooling can be carried out naturally outside the furnace on a separate cooling station or forced in a cooling station with powerful cooling fan. The throughput can be increased by using a second exchangeable retort, which is loaded and inertised before the first retort is removed.
The compact retort furnaces of the VHT product line are available as electrically heated chamber furnaces with graphite, molybdenum, tungsten or MoSi₂ heating. A wide variety of heating designs as well as a complete range of accessories provide for optimal retort furnace configurations even for sophisticated applications.

The vacuum-tight retort allows heat treatment processes either in protective and reaction gas atmospheres or in a vacuum, subject to the individual furnace specs to $10^{-5}$ mbar. The basic furnace is suited for operation with non-flammable protective or reactive gases or under vacuum. The H₂ version provides for operation under hydrogen or other flammable gases. Key of the specification up is a certified safety package providing for a safe operation at all times and triggers an appropriate emergency program in case of failure.

**Alternative Heating Specifications**

In general the following variants are available with respect to the process requirements:

**VHT ..../-GR with Graphite Insulation and Heating**
- Suitable for processes under protective and reaction gases or under vacuum
- Tmax 1800 °C, 2200 °C or 2400 °C (VHT 40/../ - VHT 100/..)
- Max. vacuum up to $10^{-4}$ mbar depending on pump type used
- Graphite felt insulation

**VHT ..../-MO or VHT ..../-W with Molybdenum or Tungsten Heating**
- Suitable for high-purity processes under protective and reaction gases or under high vacuum
- Tmax 1200 °C, 1600 °C or 1800 °C (see table)
- Max. vacuum up to $10^{-5}$ mbar depending on pump type used
- Insulation made of molybdenum rsp. tungsten radiation sheets

**VHT ..../-KE with Fiber Insulation and Heating through Molybdenum Disilicide Heating Elements**
- Suitable for processes under protective and reaction gases, in air or under vacuum
- Tmax 1800 °C
- Max. vacuum up to $10^{-2}$ mbar (up to 1300 °C) depending on pump type
- Insulation made of high purity aluminum oxide fiber
Basic version

- Standard furnace sizes 8 - 500 liters
- Water-cooled retort made of stainless steel
- Frame made of stable steel profiles, easy to service due to easily removable stainless steel panels
- Housing of the VHT 8 model on castors for easy repositioning of furnace
- Cooling water manifold with manual tap, automatic flow monitoring, open-loop cooling water system
- Adjustable cooling water circuits with flowmeter and temperature indicator and overtemperature protection
- Switchgear and controller integrated in furnace housing
- Process control with controller P470
- Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2
- Manual operation of the process gas and vacuum functions
- Manual gas supply for one process gas (N₂, Ar or non-flammable forming gas) with adjustable flow
- Bypass with manual valve for rapid filling or flooding of furnace chamber
- Manual gas outlet with overflow valve (20 mbar relative) for over-pressure operation
- Single-stage rotary vane pump with ball valve for pre-evacuating and heat treatment in a rough vacuum to 5 mbar
- Pressure gauge for visual pressure monitoring
- Defined application within the constraints of the operating instructions

Schematic presentation of a cold-wall retort furnace with additional equipment

1. Retort
2. Heating
3. Insulation
4. Gas management system
5. Vacuum pump
6. Cooling water distribution
7. Controls
8. Integrated switchgear
9. Heating transformer
10. Charging frame inside the inner process chamber
Additional equipment housing/heater
- Housing, optionally divisible, for passing through narrow door frames (VHT 8)
- Lift door
- Individual heating concepts

Additional equipment gas management system
- Manual gas supply for second process gas (N₂, Ar or non-flammable forming gas) with adjustable flow and bypass
- Mass flow controller for alternating volume flow and generation of gas mixtures with second process gas (only with automation package)
- Inner process box made of molybdenum, tungsten, graphite or CFC, especially recommended for debinding processes. The box is installed in the furnace with direct gas inlet and outlet and provides for better temperature uniformity. Generated exhaust gases will be directly lead out the inner process chamber during debinding. The change of gas inlet pathways after debinding results in a clean process gas atmosphere during sintering.

Additional equipment vacuum
- Two-stage rotary vane pump with ball valve for pre-evacuating and heat-treating in a fine vacuum (up to 10⁻² mbar) incl. electronic pressure sensor
- Turbo molecular pump with slide valve for pre-evacuation and for heat treatment in a high vacuum (up to 10⁻⁵ mbar) including electronic pressure sensor and booster pump
- Other vacuum pumps on request
- Partial pressure operation: protective gas flushing at controlled underpressure (only with automation package)

Additional equipment cooling
- Heat exchanger with closed-loop cooling water circuit
- Direct cooling see page 33

Additional equipment for controls and documentation
- Charge thermocouple with display
- Temperature measurement at 2200 °C models with pyrometer in the upper temperature range and thermocouple, type C with automatic pull-out device for precise control results in the low temperature range (VHT 40/..-GR and larger)
- Automation package with process control H3700
  - 12" graphic touch panel
  - Input of all process data like temperatures, heating rates, gas injection, vacuum at the touch panel
  - Display of all process-relevant data on a process control diagram
  - Automatic gas supply for one process gas (N₂, argon or non-flammable forming gas) with adjustable flow
  - Bypass for flooding and filling the chamber with process gas controlled by the program
  - Automatic pre- and post programs, including leak test for safe furnace operation
  - Automatic gas outlet with bellows valve and overflow valve (20 mbar relative) for over-pressure operation
  - Transducer for absolute and relative pressure
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 80

Retort furnace VHT 40/22-GR with motor-driven lift door and front frame for connection to a glovebox

Heat treatment of copper bars under hydrogen in retort furnace VHT 8/16-MO

Thermocouple, type S with automatic pull-out device for precise control results in the low temperature range

Turbo-molecular pump
Single-stage rotary vane pump for heat treatment in a rough vacuum to 5 mbar

Two-stage rotary vane pump for heat treatment in a vacuum to 10⁻² mbar

Turbo-molecular pump with booster pump for heat treatment in a vacuum to 10⁻⁵ mbar

Process Box for Debinding in Inert Gas

Certain processes require charges to be debinded in non-flammable protective or reactive gases. For these processes we fundamentally recommend a hot-wall retort furnace (see models NR .. or SR ..). These retort furnaces can ensure that the formation of condensation will be avoided as thoroughly as possible.

If there is no way to avoid the escape of small amounts of residual binder during the process, even in the VHT furnace, the retort furnace should be designed to meet this contingency.

The furnace chamber is equipped with an additional process box that has a direct outlet to the exhaust gas torch through which the exhaust gas can be directly vented. This system enables a substantial reduction in the amount of furnace chamber contamination caused by the exhaust gases generated during debinding.

Depending on the exhaust gas composition the exhaust gas line can be designed to include various options.

- Exhaust gas torch for burning off the exhaust gas
- Condensation trap for separating out binding agents
- Exhaust gas post-treatment, depending on the process, via scrubbers
- Heated exhaust gas outlet to avoid condensation deposits in the exhaust gas line

<table>
<thead>
<tr>
<th>Model</th>
<th>Inner dimensions of process box in mm</th>
<th>Volume in l</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHT 8/..</td>
<td>w 120 d 210 h 150</td>
<td>3.5</td>
</tr>
<tr>
<td>VHT 25/..</td>
<td>w 200 d 350 h 200</td>
<td>14.0</td>
</tr>
<tr>
<td>VHT 40/..</td>
<td>w 250 d 430 h 250</td>
<td>25.0</td>
</tr>
<tr>
<td>VHT 70/..</td>
<td>w 325 d 475 h 325</td>
<td>50.0</td>
</tr>
<tr>
<td>VHT 100/..</td>
<td>w 425 d 500 h 425</td>
<td>90.0</td>
</tr>
<tr>
<td>VHT 250/..</td>
<td>w 575 d 700 h 575</td>
<td>230.0</td>
</tr>
<tr>
<td>VHT 500/..</td>
<td>w 725 d 850 h 725</td>
<td>445.0</td>
</tr>
</tbody>
</table>

Front made of textured stainless steel

Model | Inner dimensions in mm | Volume in l | Max. charge weight/kg | Outer dimensions in mm |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>VHT 8/..</td>
<td>w 170 d 240 h 200</td>
<td>8</td>
<td>5</td>
<td>1250 (800)</td>
</tr>
<tr>
<td>VHT 25/..</td>
<td>w 250 d 400 h 250</td>
<td>25</td>
<td>20</td>
<td>1500</td>
</tr>
<tr>
<td>VHT 40/..</td>
<td>w 300 d 450 h 300</td>
<td>40</td>
<td>30</td>
<td>1600</td>
</tr>
<tr>
<td>VHT 70/..</td>
<td>w 375 d 500 h 375</td>
<td>70</td>
<td>50</td>
<td>1800³</td>
</tr>
<tr>
<td>VHT 100/..</td>
<td>w 450 d 550 h 100</td>
<td>75</td>
<td>50</td>
<td>1900³</td>
</tr>
<tr>
<td>VHT 250/..</td>
<td>w 600 d 750 h 600</td>
<td>250</td>
<td>175</td>
<td>300³</td>
</tr>
<tr>
<td>VHT 500/..</td>
<td>w 750 d 900 h 750</td>
<td>500</td>
<td>350</td>
<td>320³</td>
</tr>
</tbody>
</table>

Graphite inner process chamber incl. charge holder

Molybdenum inner process chamber incl. six charge supports

<table>
<thead>
<tr>
<th>Model</th>
<th>Heating power in kW³</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHT 8/..</td>
<td>19/34²</td>
</tr>
<tr>
<td>VHT 25/..</td>
<td>45/65²</td>
</tr>
<tr>
<td>VHT 40/..</td>
<td>83/103/125²</td>
</tr>
<tr>
<td>VHT 70/..</td>
<td>105/125/150²</td>
</tr>
<tr>
<td>VHT 100/..</td>
<td>131/155/175²</td>
</tr>
<tr>
<td>VHT 250/..</td>
<td>180/210²</td>
</tr>
<tr>
<td>VHT 500/..</td>
<td>220/260/²</td>
</tr>
</tbody>
</table>

³Depending on furnace design connected load might be higher
²Dimensions may be smaller depending on the heater type
³Only with safety package for flammable gases

1With separated switching system unit
21800 °C/2200 °C
31200 °C/1600 °C
**H₂ Version for Operation with Hydrogen or other Reaction Gases**

In the H₂ version the retort furnaces can be operated under hydrogen or other reaction gases. For these applications, the systems are additionally equipped with the required safety technology. Only certified and industry proven safety sensors are used. The retort furnaces are controlled by a fail-safe PLC control system (S7-300F/safety controller).

- Certified safety concept
- Automation package (additional equipment see page 28)
- Redundant gas inlet valves for hydrogen
- Monitored pre-pressures of all process gases
- Bypass for safe purging of furnace chamber with inert gas
- Pressure-monitored emergency flooding with automated solenoid valve opening
- Electric or gas-heated exhaust gas torch for H₂ post-combustion
- Atmospheric operation: H₂ purging of retort starting from room temperature at controlled over pressure (50 mbar relative)

**Additional equipment**

- Partial pressure operation: H₂ flushing at underpressure in the retort starting from 750 °C furnace chamber temperature
- Inner process hood in the retort for debinding under hydrogen
- Process control and documentation via Nabertherm Control Center (NCC) for monitoring, documentation and control see page 88
The LBVHT model series with bottom loading specification are especially suitable for production processes which require either protective or reaction gas atmosphere or a vacuum. The basic performance specifications of these models are similar to the VHT models. Their size and design with electro-hydraulically driven table facilitate charging during production. The retort furnaces are available in various sizes and designs. Similar like the VHT models, these furnaces can be equipped with different heating concepts.

- Standard furnace sizes between 100 and 600 liters
- Designed as bottom loading retort furnace with electro-hydraulically driven table for easy and well-arranged charging
- Prepared to carry heavy charge weights
- Different heating concepts using
  - Graphite heating chamber up to Tmax 2400 °C
  - Molybdenum heating chamber up to Tmax 1600 °C
  - Tungsten heating chamber up to Tmax 2000 °C
- Frame structure filled with textured stainless steel sheets
- Standard design with gassing system for non-flammable protective or reaction gases
- Automatic gas supply system which also allows for operation with several process gases as additional equipment
- Gas supply systems for operating with hydrogen or other combustible reaction gases incl. safety package as additional equipment
- Switchgear and control box as well as gassing system integrated into the furnace housing
- Further product characteristics of the standard furnace as well as possible additional equipment can be found in the description of the VHT furnaces from Page 26

| Model       | Tmax °C | Model       | Tmax °C | Model       | Tmax °C | Inner dimensions in mm | Volume in l | Electrical connection *
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>LBVHT 100/16-MO</td>
<td>1600</td>
<td>LBVHT 160/20-W</td>
<td>2000</td>
<td>LBVHT 100/24-GR</td>
<td>2400</td>
<td>Ø 100 700 450</td>
<td>3-phase</td>
<td></td>
</tr>
<tr>
<td>LBVHT 250/16-MO</td>
<td>1600</td>
<td>LBVHT 250/20-W</td>
<td>2000</td>
<td>LBVHT 250/24-GR</td>
<td>2400</td>
<td>Ø 250 900 600</td>
<td>3-phase</td>
<td></td>
</tr>
<tr>
<td>LBVHT 600/16-MO</td>
<td>1600</td>
<td>LBVHT 600/20-W</td>
<td>2000</td>
<td>LBVHT 600/24-GR</td>
<td>2400</td>
<td>Ø 600 1200 800</td>
<td>3-phase</td>
<td></td>
</tr>
</tbody>
</table>

*Please see page 89 for more information about supply voltage
Cold-Wall Retort Furnaces up to 2400 °C or up to 3000 °C

Compared with the VHT models (page 26 ff), the retort furnaces of the SVHT product line offer improved performance data with regard to achievable vacuum and maximum temperature. Due to the design as pit-type furnace with tungsten heating, processes up to max. 2400 °C even in high vacuum can be implemented with retort furnaces of the SVHT..-W product line. Retort furnaces of the SVHT..-GR product line with graphite heating, also in pit-type design, can be operated in an inert gas atmosphere even up to max. 3000 °C.

- Standard sizes with a furnace chamber of 2 or 9 liters
- Designed as pit-type furnace, charged from above
- Frame construction with inserted sheets of textured stainless steel
- Dual shell water-cooled stainless steel container
- Manual operation of process gas and vacuum functions
- Manual gas supply for non-combustible process gas
- A step in front of the retort furnace for an ergonomic charging height
- Retort lid with gas-charged shock absorbers
- Controls and switchgear as well as gas supply integrated in furnace housing
- Defined application within the constraints of the operating instructions

Further standard product characteristics see description for standard design of VHT models page 26

Heating Options

SVHT ..-GR
- Applicable for processes:
  - Under protective or reaction gases or in the vacuum up to 2200 °C under consideration of relevant max. temperature limits
  - Under inert gas argon up to 3000 °C
- Max. vacuum up to 10^-4 mbar depending on the type of pump used
- Heating: graphite heating elements in cylindrical arrangement
- Insulation: graphite felt insulation
- Temperature measurement by means of an optical pyrometer

SVHT ..-W
- Applicable for processes under protective or reaction gases or in vacuum up to 2400 °C
- Max. vacuum up to 10^-5 mbar depending on the type of pump used
- Heating: cylindrical tungsten heating module
- Insulation: tungsten and molybdenum radiant plates
- Optical temperature measurement with pyrometer

Additional equipment such as automatic process gas control or design for the operation with flammable gases incl. safety system see VHT models page 26.
Retort Furnace Cooling Systems

Indirect cooling (hot-wall retort furnaces)
- Ambient air is blown onto the outer retorte surface to cool it down. The waste heat is removed via the exhaust air outlet of the furnace.
- The charge is cooled indirectly, which means that the atmosphere in the retort is not affected by the cooling.
- The charge cannot be quenched with the cooling system.

Direct cooling (cold-wall and hot-wall retort furnaces)
- Rapid gas cooling in the retort. For this purpose, the furnace atmosphere is circulated through a heat exchanger.
- The system pressure is not increased by the cooling; there is no gas quenching at high pressure.
- Not available for processes with flammable furnace atmospheres.

Cooling Behavior of Hot-Wall Retort Furnace with Charge (Example)

![Cooling Behavior of Hot-Wall Retort Furnace with Charge (Example)](image)

Cooling Behavior of Cold-Wall Retort Furnace with Charge (Example)

![Cooling Behavior of Cold-Wall Retort Furnace with Charge (Example)](image)
Tube Furnaces for Processes under Flammable or Non-Flammable Protective or Reaction Gases or under Vacuum

Compact laboratory tube furnace with manual gas supply system

High-temperature tube furnace for four different protective gases

With the wide range of available accessories, our professional tube furnaces can be designed optimally to suit various processes. By upgrading with different gas supply systems, processes can be carried out in a protective gas atmosphere, in vacuum, or under flammable protective or reaction gases. In addition to the convenient standard controllers, modern PLC controls can be used also.

- Tube furnaces (static) with Tmax 1100 °C to 1800 °C (max. 1400 °C in vacuum) for horizontal or vertical operation
- Rotary tube furnaces for batch or continuous processes with Tmax 1100 °C or 1300 °C
- Different working tube materials designed for various process requirements
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording process data with a USB flash drive

Additional equipment
- Different gas supply system packages for flammable or non-flammable protective or reaction gases
- Vacuum operation
- Multiple zone design to optimize temperature uniformity
- Charge control with temperature measurement in the working tube and in the furnace chamber outside the tube
- Display of temperature in the working tube with additional thermocouple
- Cooling systems for accelerated cooling of the working tube and the charge
- Individual solutions for process optimization available

Vertical tube furnace RHTV 50/150/17 with stand and gas supply system 2 as additional equipment

Thermocouple for charge control in the furnace RHTH 120/600/18

Sintering under hydrogen in a tube furnace of RHTH product line

Rotary Tube Furnace RSR 250/3500/15S
Customized Tube Furnaces

With their high level of flexibility and innovation, Nabertherm offers the optimal solution for customer-specific applications. Based on our standard models, we develop individual solutions also for integration in overriding process systems. The solutions shown on this page are just a few examples of what is feasible. From working under vacuum or protective gas via innovative control and automation technology for a wide selection of temperatures, sizes, lengths and other properties of tube furnace systems — we will find the appropriate solution for a suitable process optimization.

**Tube furnace RS 200/4500/08 with lift door for heat treatment of bars**

**RS 100/250/11S in split-type design for integration into a test stand**

**Tube furnace RHTV 120/480/16 LBS with working tube closed at one side, protective gas and vacuum option as well as with electric screw drive of the lift table**

**RS 250/2500/11S, five-zone controlled, for wire annealing in high-vacuum or under protective gases, incl. forced cooling and exhaust hood**

Please ask for our laboratory catalog to get further information about our extensive range of tube furnaces and other laboratory furnaces!
Wire and Strand Annealing Furnaces

These models are particularly suitable for continuous heat treatment at operation temperatures up to 1200 °C. The modular design allows adjustment to different length and width requirements. The heating elements are mounted on only one side of the furnace and can be changed individually during operation. Optimum temperature uniformity is achieved by means of a multiple zone control system tailored to the furnace dimensions.

- Tmax 1200 °C
- Modular design, variable length
- Small outer dimensions due to efficient microporous silica insulation
- Special heating elements that can be changed during operation
- Heating from the ceiling
- Optimum temperature uniformity by means of multiple zone control
- Defined application within the constraints of the operating instructions
- Controls description see page 88

Additional equipment

- Gas supply systems for the working tubes for non-flammable or flammable protective or reaction gases including hydrogen, with burn off torch and safety technology
- Process and charge documentation
- Double chamber furnace system with parallel chambers for simultaneous operation at different temperatures
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 88

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax in °C</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
<th>Outer dimensions in mm</th>
<th>Heating power in kW</th>
<th>Electrical connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>D 20/S</td>
<td>1200</td>
<td>400 x 1000 x 50</td>
<td>20</td>
<td>900 x 1200 x 1350</td>
<td>9</td>
<td>3-phase</td>
</tr>
<tr>
<td>D 30/S</td>
<td>1200</td>
<td>600 x 1000 x 50</td>
<td>30</td>
<td>1100 x 1200 x 1350</td>
<td>12</td>
<td>3-phase</td>
</tr>
<tr>
<td>D 50/S</td>
<td>1200</td>
<td>200 x 3600 x 50</td>
<td>50</td>
<td>700 x 4000 x 1150</td>
<td>15</td>
<td>3-phase</td>
</tr>
<tr>
<td>D 60/S</td>
<td>1200</td>
<td>200 x 5600 x 50</td>
<td>60</td>
<td>700 x 6000 x 1350</td>
<td>36</td>
<td>3-phase</td>
</tr>
<tr>
<td>D 70/S</td>
<td>1200</td>
<td>350 x 3600 x 50</td>
<td>70</td>
<td>850 x 4000 x 1100</td>
<td>36</td>
<td>3-phase</td>
</tr>
<tr>
<td>D 110/S</td>
<td>1200</td>
<td>480 x 4600 x 50</td>
<td>110</td>
<td>980 x 5000 x 1450</td>
<td>36</td>
<td>3-phase</td>
</tr>
<tr>
<td>D 130/S</td>
<td>1200</td>
<td>650 x 3600 x 50</td>
<td>130</td>
<td>1150 x 4000 x 1150</td>
<td>60</td>
<td>3-phase</td>
</tr>
<tr>
<td>D 180/S</td>
<td>1200</td>
<td>480 x 7600 x 50</td>
<td>180</td>
<td>580 x 8000 x 1350</td>
<td>80</td>
<td>3-phase</td>
</tr>
<tr>
<td>D 250/S</td>
<td>1200</td>
<td>950 x 5600 x 50</td>
<td>250</td>
<td>1400 x 6000 x 1350</td>
<td>80</td>
<td>3-phase</td>
</tr>
<tr>
<td>D 320/S</td>
<td>1200</td>
<td>850 x 7600 x 100</td>
<td>320</td>
<td>1400 x 8000 x 1350</td>
<td>160</td>
<td>3-phase</td>
</tr>
</tbody>
</table>

1Depending on furnace design connected load might be higher

*Please see page 89 for more information about supply voltage
Continuously operating furnaces are ideal for heat treatment of large numbers of small parts in a protective or reaction gas atmosphere, such as brazing, hardening, or annealing.

Controlled protective gas atmospheres are generated in the furnace by using a gas tight retort. If hydrogen or cracked gas is used for the process, the furnace is equipped with the corresponding safety technology.

Parameters such as maximum working temperature, exposure, and geometry of the charge all play a role in the choice of the conveying system. Established conveyor concepts include metal belts or rollers. Wire and strand annealing furnaces are used to anneal wires or strands; in this case, the charge is unwound in front of the furnace, drawn through the furnace and is then wound again behind the furnace.

To cool the components faster, a water-cooled dual shell is installed directly behind the heating zone; the length of this is determined by the required unloading temperature.
Salt-bath furnaces have an excellent temperature uniformity and ensure very good heat transfer to the work piece. Generally, heat treatment can be carried out with shorter dwell times than in chamber furnaces. Since the charge is heat treated with the exclusion of oxygen, scale and discoloration on the surface of the parts are kept to a minimum.

The salt-bath furnaces TS 20/15 - TSB 90/80 can be used for heat treatment of metals in neutral and active salt baths. They are used for processes such as nitriding according to Tenifer up to 600 °C, carburization to 950 °C or bright annealing to 1000 °C.

The crucible is inserted so that it is suspended in the salt-bath furnace and can be replaced easily if necessary. Two crucible types are available:

- Type P: low carbon steel and CrNi plated for carburizing, neutral salt and annealing baths up to 850 °C
- Type C: high alloy CrNi steel for neutral salt and annealing baths up to 1000 °C and for dip brazing of aluminum

Crucibles are wearing parts because they are exposed to thermal stress during the heating and cooling process and corrosive salt. The following parameters influence wear of the crucible:

- Working temperature
- Number of heating and cooling cycles
- Salt
- Charge material
- Charge quantity
- Contamination of the charge

The crucible must be checked regularly for wear and damage. We recommend to order a replacement crucible together with the furnace.
Salt-bath furnaces are available for heat treatment of steel and aluminum:

Features for heat treatment of steel:
- Tmax in salt: 750 °C or 1000 °C
- Safety technology according to EN 60519-2
- Melt-bath control: the temperature is measured in the salt as well as inside the furnace behind the crucible
- Removable collar plate made of steel
- Insulated swing-away lid
- Temperature uniformity up to +/- 2 °C according to DIN 17052-1 in the salt bath
- Over-temperature limiter in the furnace chamber to protect persons and the furnace
- Crucible can be easily replaced
- Defined application within the constraints of the operating instructions
- Controls description see page 88

Features for heat treatment of aluminum like steel, but
- Tmax in salt: 550 °C
- Over-temperature limiter in the furnace chamber and in the salt bath to protect persons and the furnace
- Optical and acoustic alarm to warn if the critical temperature is exceeded
- Eurotherm 6100e temperature recorder to document the temperature profile

Salt-bath furnaces can be delivered electrically heated or gas-fired

- Electrically heated (TS models):
  - Freely radiating, high quality heating elements on ceramic support tubes
  - Crucible heated from four sides
  - If a heating element is defective, the furnace can be heated with the remaining heating elements

- Gas-fired (TSB models):
  - Burner system with optimized flame management: high level of efficiency with overpressure operation to prevent false air entering
  - Burner technology according to DIN EN 7462, part 2
  - Lateral exhaust gas feed around the crucible

---

### Salt-bath Furnace Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Inner dimensions salt-bath crucible</th>
<th>Volume</th>
<th>Outer dimensions in mm</th>
<th>Heating power in kW</th>
<th>Electrical connection*</th>
<th>Weight in kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>TS 20/15</td>
<td>750</td>
<td>Ø 230 mm, h 500 mm</td>
<td>20 l</td>
<td>W 850, D 850, H 800</td>
<td>16</td>
<td>3-phase</td>
<td>650</td>
</tr>
<tr>
<td>TS 30/18</td>
<td>750</td>
<td>Ø 300 mm, h 500 mm</td>
<td>30 l</td>
<td>W 950, D 950, H 800</td>
<td>20</td>
<td>3-phase</td>
<td>700</td>
</tr>
<tr>
<td>TS 40/30</td>
<td>750</td>
<td>Ø 400 mm, h 600 mm</td>
<td>60 l</td>
<td>W 1050, D 1050, H 800</td>
<td>33</td>
<td>3-phase</td>
<td>750</td>
</tr>
<tr>
<td>TS 50/40</td>
<td>750</td>
<td>Ø 500 mm, h 800 mm</td>
<td>110 l</td>
<td>W 1150, D 1150, H 970</td>
<td>58</td>
<td>3-phase</td>
<td>1000</td>
</tr>
<tr>
<td>TS 60/63</td>
<td>750</td>
<td>Ø 610 mm, h 800 mm</td>
<td>220 l</td>
<td>W 1250, D 1250, H 970</td>
<td>70</td>
<td>3-phase</td>
<td>1200</td>
</tr>
<tr>
<td>TS 70/72</td>
<td>750</td>
<td>Ø 700 mm, h 1000 mm</td>
<td>370 l</td>
<td>W 1350, D 1350, H 1370</td>
<td>80</td>
<td>3-phase</td>
<td>1500</td>
</tr>
<tr>
<td>TS 90/80</td>
<td>750</td>
<td>Ø 900 mm, h 1000 mm</td>
<td>500 l</td>
<td>W 1600, D 1600, H 1400</td>
<td>100</td>
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<td>1700</td>
</tr>
<tr>
<td>TS, TSB 20/20</td>
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<td>Ø 230 mm, h 500 mm</td>
<td>20 l</td>
<td>W 850, D 850, H 800</td>
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<tr>
<td>TS, TSB 30/30</td>
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<td>30 l</td>
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</tr>
<tr>
<td>TS, TSB 40/40</td>
<td>1000</td>
<td>Ø 400 mm, h 600 mm</td>
<td>60 l</td>
<td>W 1050, D 1050, H 800</td>
<td>44</td>
<td>3-phase</td>
<td>750</td>
</tr>
<tr>
<td>TS, TSB 50/50</td>
<td>1000</td>
<td>Ø 500 mm, h 800 mm</td>
<td>110 l</td>
<td>W 1150, D 1150, H 970</td>
<td>66</td>
<td>3-phase</td>
<td>1000</td>
</tr>
<tr>
<td>TS, TSB 60/63</td>
<td>1000</td>
<td>Ø 610 mm, h 800 mm</td>
<td>220 l</td>
<td>W 1250, D 1250, H 970</td>
<td>80</td>
<td>3-phase</td>
<td>1200</td>
</tr>
<tr>
<td>TS, TSB 70/72</td>
<td>1000</td>
<td>Ø 700 mm, h 1000 mm</td>
<td>370 l</td>
<td>W 1350, D 1350, H 1370</td>
<td>100</td>
<td>3-phase</td>
<td>1500</td>
</tr>
<tr>
<td>TS, TSB 90/80</td>
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<td>Ø 900 mm, h 1000 mm</td>
<td>500 l</td>
<td>W 1600, D 1600, H 1400</td>
<td>120</td>
<td>3-phase</td>
<td>1700</td>
</tr>
</tbody>
</table>

1 Depending on furnace design connected load might be higher
2 Salt bath temperature
3 Tmax for heat treatment of aluminum 550 °C

---

*Please see page 89 for more information about supply voltage*
Salt-Bath Furnaces for Heat Treatment of Steel or Light Metals
Electrically Heated or Gas-Fired

Accessories
- Exhaust gas collection at crucible rim
  - For the direct extraction of vapors and exhaust gases
  - Flange on the back to connect the customer’s exhaust gas system
  - Only in combination with a lid that is manually placed on top
- Pneumatic lid opening
  - Pneumatic lateral movement of the swivel lid
  - Manual lowering and raising of the lid with a lever
  - Foot pedal control
  - Not available in combination with exhaust gas collection at crucible rim
- Charging basket for bulk materials
  - Possible lid closing over the salt bath with inserted charging basket
  - For manual charging of small martempering and salt baths
  - Charging with a crane or charging aid for large martempering and salt baths
- Process control and documentation via Nabertherm Control Center NCC for monitoring, documentation, and control

Process Examples with Petrofer and Durferrit Salts

<table>
<thead>
<tr>
<th>TS models up to 750 °C</th>
<th>Nitriding</th>
<th>Annealing and blackening</th>
<th>Hardening, Tempering, Annealing, Quenching</th>
<th>Preheating, annealing of gold, silver or brass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen 420, Nitrogen 460, Nitrogen 500</td>
<td>SFS 240</td>
<td>GS 185, GS 230, GS 250, GS 345, GS 405, GS 406, GS 430, GS 520</td>
<td>GS 540, GS 640, GS 846</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>TS models up to 1000 °C</th>
<th>Carbonitriding, carburizing</th>
<th>Annealing, hardening, preheating</th>
<th>Carburizing</th>
<th>Preheating of high-speed steel, annealing</th>
<th>Preheating, annealing of gold, silver or brass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbogen VC, Carbogen DK</td>
<td>HS 535, HS 645, HS 650, GS 940, GS 940</td>
<td>Carbogen Universal, Carbomax +GS-25, Carborapid +GS-25, Carbogen 800/800 ST, Carbogen 1000/1000 ST, CECONTROL 50H, CECONTROL 80B, CECONTROL 110B, CECONSTANT 80, CECONSTANT 100</td>
<td>GS 540, GS 680, GS 670, GS 750, HS 550, HS 635, HS 760</td>
<td>GS 550, GS 645</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TS models for aluminum</th>
<th>Artificial ageing, solution annealing</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS 135, AS 200, AS 225, AVS 220, AVS 250</td>
<td></td>
</tr>
</tbody>
</table>

Salt-bath furnace TS 40/30 with exhaust gas collection at crucible rim and manual lid

Charging basket for salt-bath furnaces
Martempering Furnaces using Neutral Salts
Electrically Heated

QS 20 - QS 400 martempering furnaces are filled with neutral salt and offer remarkably rapid and intensive heat transmission to the workpiece while ensuring optimum temperature uniformity. Since the batch is heat treated with the exclusion of oxygen, scale and discoloration on the surface of the parts are reduced to a minimum. For working temperatures at between 180 °C and 500 °C these martempering furnaces are useful for quenching or cooling with minimal workpiece distortion, retempering, austempering for optimal toughness, recrystallization annealing after electrical discharge machining (EDM) and for bluing.

The quenching or cooling process is applied in order to achieve an even temperature uniformity throughout the workpiece’s entire cross-section before the formation of martensite and to avoid distortion and formation of cracks in complex mechanical components during the subsequent hardening process.

Tempering in a martempering bath is the same as the tempering process in forced convection furnace and is used to reduce a previously hardened workpiece to a desired hardness, to increase toughness and reduce stress within the workpiece.

Austempering is a good choice to achieve a high level of toughness and dimensional accuracy in oil hardened low-alloy steels. Workpieces subject to austempering have high tensile strength and good elasticity.

- Tmax 550 °C
- Very good temperature uniformity
- Martemper bath temperature control
- Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Heating with immersion heating elements
- Rectangular crucible, integrated in the housing
- Charging basket
- Crucible made of 1.4828
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 88

Additional equipment
- Charging aid with hand crank and cable winch, mounted on side of furnace
- Process control and documentation via VCD software package for monitoring, documentation and control

Process Examples with Petrofer and Durferrit Salts

QS-baths (steel/Nitinol)

<table>
<thead>
<tr>
<th>Process Examples with Petrofer and Durferrit Salts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardening, isothermic treatment of steels up to 950 °C, stress relieving, annealing, bluing, banitization</td>
</tr>
<tr>
<td>Homogenization annealing, recrystallization annealing; warm-bath curing, tempering, banitizing, bluing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
<th>Outer dimensions in mm (W x D x H)</th>
<th>Heating power in kW</th>
<th>Electrical connection</th>
<th>Weight in kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>QS 20</td>
<td>550</td>
<td>300 x 210 x 460</td>
<td>20</td>
<td>610 x 580 x 920</td>
<td>2.6</td>
<td>1-phase</td>
<td>110</td>
</tr>
<tr>
<td>QS 30</td>
<td>550</td>
<td>300 x 210 x 580</td>
<td>30</td>
<td>610 x 580 x 920</td>
<td>3.2</td>
<td>1-phase</td>
<td>140</td>
</tr>
<tr>
<td>QS 70</td>
<td>550</td>
<td>400 x 320 x 680</td>
<td>70</td>
<td>750 x 680 x 980</td>
<td>7.5</td>
<td>3-phase</td>
<td>240</td>
</tr>
<tr>
<td>GS 200</td>
<td>550</td>
<td>540 x 520 x 880</td>
<td>400</td>
<td>900 x 900 x 1200</td>
<td>18.0</td>
<td>3-phase</td>
<td>660</td>
</tr>
<tr>
<td>GS 400</td>
<td>550</td>
<td>730 x 720 x 980</td>
<td>400</td>
<td>1100 x 1100 x 1500</td>
<td>24.0</td>
<td>3-phase</td>
<td>1150</td>
</tr>
</tbody>
</table>

* Depending on furnace design connected load might be higher
* Please see page 89 for more information about supply voltage

Additional equipment
- Charging aid with hand crank and cable winch, mounted on side of furnace
- Process control and documentation via VCD software package for monitoring, documentation and control

Martempering Furnace QS 20 with charging basket
Martempering hardening in practice
Heating element in the crucible
Martempering furnace QS 30 with charging aid

41
These universal chamber furnaces with radiation heating have been specifically designed to withstand heavy-duty use in the tool shop. They are particularly useful for processes such as tool making or for hardening jobs, e.g. annealing, hardening and forging. With help of various accessories, these furnaces can be customized to your application requirements.

- Compact, robust design
- Deep furnace chamber with three-sides heating: from both side walls and bottom
- Heating elements on support tubes ensure free heat radiation and a long service life
- Bottom heating protected by heat conducting SiC tiles
- Stainless steel upper door jamb protects furnace structure when furnace is opened hot
- Base frame included in the delivery, N 7/H - N 17/HR designed as table-top model
- Exhaust opening in the side of the furnace, or on rear wall of chamber furnace in the N 31/H models and higher
- Temperature uniformity up to +/- 10 °C according to DIN 17052-1
- Low energy consumption due to multi-layer insulation
- Gas spring dampers provide for easy door opening and closing
- Heat resistant zinc paint for protection of door and door frame (for model N 81 and larger)
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 88

For additional features see separate catalog „Thermal Process Technology I“

---

### Chamber Furnaces

**Electrically Heated**

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax (°C)</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
<th>Outer dimensions in mm</th>
<th>Heating power in kW</th>
<th>Electrical connection</th>
<th>Weight in kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>N 7/H</td>
<td>1200</td>
<td>250 250 140</td>
<td>9 800 650 600</td>
<td>3.0 1-phase 60</td>
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</tr>
<tr>
<td>N 11/H</td>
<td>1200</td>
<td>250 350 140</td>
<td>11 1100 1340</td>
<td>3.5 1-phase 70</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>N 17/HR</td>
<td>1200</td>
<td>250 500 140</td>
<td>17 1750 1540</td>
<td>5.5 3-phase 70</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>N 31/H</td>
<td>1200</td>
<td>350 350 250</td>
<td>30 1040 1100</td>
<td>6.4 3-phase 90</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N 41/H</td>
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<td>350 500 250</td>
<td>40 1250 1340</td>
<td>15.0 3-phase 210</td>
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<td></td>
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</tr>
<tr>
<td>N 61/H</td>
<td>1200</td>
<td>350 750 250</td>
<td>60 1500 1340</td>
<td>20.0 3-phase 260</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>N 87/H</td>
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<td>1000 250 250</td>
<td>87 1750 1540</td>
<td>25.0 3-phase 400</td>
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<td></td>
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<tr>
<td>N 81</td>
<td>1200</td>
<td>500 750 250</td>
<td>80 1900 1790</td>
<td>20.0 3-phase 820</td>
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<td></td>
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<tr>
<td>N 161</td>
<td>1200</td>
<td>550 750 400</td>
<td>160 1930 1980</td>
<td>30.0 3-phase 910</td>
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<td></td>
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<tr>
<td>N 321</td>
<td>1200</td>
<td>750 1100 400</td>
<td>320 2270 2040</td>
<td>47.0 3-phase 1300</td>
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<tr>
<td>N 641</td>
<td>1200</td>
<td>1000 1300 500</td>
<td>640 2670 2240</td>
<td>70.0 3-phase 2100</td>
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<td></td>
<td></td>
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<td>500 750 250</td>
<td>80 1960 1840</td>
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<td></td>
<td></td>
</tr>
<tr>
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<td>160 1990 2030</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>N 321/13</td>
<td>1300</td>
<td>750 1100 400</td>
<td>320 2330 2090</td>
<td>60.0 3-phase 1500</td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>N 641/13</td>
<td>1300</td>
<td>1000 1300 500</td>
<td>640 2730 2290</td>
<td>80.0 3-phase 2500</td>
<td></td>
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</tr>
</tbody>
</table>

1Table-top model
2Heating only between two phases
3Depending on furnace design connected load might be higher

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1 For additional features see separate catalog „Thermal Process Technology I“

---

*Please see page 89 for more information about supply voltage*
Charging Plates for Models N 7/H - N 641/13

We recommend these accessories for applications up to 1100 °C to protect the furnace floor, especially if a charging cart is used.

- Tmax 1100 °C
- Three raised edges
- Heat-resistant alloy 314 (AISI)/(DIN material no. 1.4841)
- Larger plates and custom dimensions available upon request

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Furnace</th>
<th>W (mm)</th>
<th>D (mm)</th>
<th>H (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>628000138</td>
<td>N 7/H</td>
<td>240</td>
<td>290</td>
<td>25</td>
</tr>
<tr>
<td>628000139</td>
<td>N 11/H, N 11/HR</td>
<td>240</td>
<td>390</td>
<td>25</td>
</tr>
<tr>
<td>628000141</td>
<td>N 17/HR</td>
<td>240</td>
<td>540</td>
<td>30</td>
</tr>
<tr>
<td>628000400</td>
<td>N 31/H</td>
<td>340</td>
<td>390</td>
<td>30</td>
</tr>
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<td>628000133</td>
<td>N 41/H</td>
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<td>540</td>
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<td>628000142</td>
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</tr>
<tr>
<td>628001925</td>
<td>N 87/H</td>
<td>340</td>
<td>1040</td>
<td>30</td>
</tr>
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<td>628000133</td>
<td>N 81, N 81/13</td>
<td>480</td>
<td>790</td>
<td>30</td>
</tr>
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<td>628000144</td>
<td>N 161, N 161/13</td>
<td>530</td>
<td>790</td>
<td>30</td>
</tr>
<tr>
<td>628000145</td>
<td>N 321, N 321/13</td>
<td>720</td>
<td>1140</td>
<td>30</td>
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<tr>
<td>628000146</td>
<td>N 641, N 641/13</td>
<td>950</td>
<td>1530</td>
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</tbody>
</table>

Annealing Boxes for Models N 7/H - N 161/13

Working with Annealing Boxes

Annealing boxes are made of heat-resistant alloy 314 (AISI)/(DIN material no. 1.4841) and also feature a lid for top charging. A ceramic fiber gasket is inserted in the circular seal profile on the upper edge of the box to seal it. To prevent oxidation during the process, neutral annealing coal is placed in the box. These bind the oxygen in the box. The oxygen inside the box is bound by the coal. After the heat treatment, the box is removed from the oven, the lid is opened using tongs and the workpiece removed. Our annealing boxes are also well suited for brazing.

The boxes can also be used with the appropriate granulate for carburizing (also referred to as case hardening or cementing) and for powder nitriding or powder boriding. The workpieces are placed in the box with carburizing granulate or nitriding powder or boriding powder and a suitable activator.

- Tmax 1100 °C
- Annealing box with lid and seal profile
- Lid sealing with ceramic fiber
- Also usable for carburizing and powder nitriding
- Heat-resistant alloy 314 (AISI)/(DIN material no. 1.4841)

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Furnace</th>
<th>Inner dimensions in mm</th>
<th>Outer dimensions in mm</th>
<th>Charging method of the box</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>w (mm)</td>
<td>d (mm)</td>
<td>h (mm)</td>
<td>W (mm)</td>
</tr>
<tr>
<td>631000962</td>
<td>180</td>
<td>190</td>
<td>90</td>
<td>216</td>
</tr>
<tr>
<td>631000967</td>
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<td>631000973</td>
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<td>90</td>
<td>216</td>
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<td>631000977</td>
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<td>316</td>
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<tr>
<td>631000982</td>
<td>280</td>
<td>380</td>
<td>200</td>
<td>316</td>
</tr>
<tr>
<td>631000986</td>
<td>280</td>
<td>500</td>
<td>200</td>
<td>316</td>
</tr>
<tr>
<td>631001088</td>
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<td>494</td>
<td>185</td>
<td>462</td>
</tr>
<tr>
<td>631000312</td>
<td>450</td>
<td>550</td>
<td>250</td>
<td>515</td>
</tr>
</tbody>
</table>

Article no. 601655055, 1 set of fiber insulation cord, 5 strips of 610 mm each

Work space = box inner dimensions: - 30 mm to all sides
Larger boxes and custom dimensions available upon request
Protective Gas Boxes for Models N 7/H - N 641/13

The annealing boxes for heat treatment under protective gas are equipped with a protective gas inlet and outlet. A box with protective gas is advisable for larger workpieces requiring defined heat treating. We would be pleased to carry out Trials at our technical center can be carried out on request. Up to furnace model N 61/H with downward door opening the gas ductway is laid through the upper section of the door collar, for larger furnaces with upward door opening the supply line is laid through the lower furnace collar.

The box is pressurized with non flammable protective and reactive gases such as argon, nitrogen or forming gas via the protective gas tube. There are manual and automatic systems available for protective gas. See pages 74 - 75. for more information about protective gases which can be used as well as manual and automatic protective gas systems.

After charging the box it is closed and preflushed outside the furnace. Afterwards the box is placed in the preheated furnace. The quantity of gas can be reduced to the process flush quantity. After the heat treatment the box is pulled out of the furnace, the charge taken from the box and placed in the quenching medium. We recommend using binding wire on the parts so that they can easily be grasped by tongs.

A flexible type K thermocouple is installed in the box for measuring the temperature; we recommend connecting it to a digital display device or to a temperature recorder.

The box can also be cooled down on a cooling platform while closed. Be sure that the protective gas flowrate is increased for this application.

- Tmax 1100 °C
- For non-combustible protective and reactive gases argon, nitrogen and forming gas (observe national regulations)
- Protective gas box with fiber sealing and lid, gas supply via a tube into the bottom of the box
- Protective gas connection via quick coupling with hose connector (inner diameter 9 mm)
- Piping for gas inlet and outlet through the furnace collar
- Heat-resistant alloy 314 (AISI)/(DIN material no. 1.4841)
- Charge thermocouple type K for temperature display or charge control

Additional equipment
- Starting from N 31/H a charging cart is recommended see page 78
- Digital temperature display see page 69
- Gas supply systems see page 74
- Charging forks see page 47
- Draw Hook see page 77

<table>
<thead>
<tr>
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<th>Outer dimensions in mm</th>
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Article no. 601655055, 1 set of fiber insulation cord, 5 strips of 610 mm each

Work space = box inner dimensions: - 30 mm to all sides

Larger boxes and custom dimensions available upon request
Protective Gas Boxes with Evacuation Lid for Models N 7/H - N 614/13

For heat treatment of bulk goods and hollow parts under a protective gas atmosphere we recommend the usage of protective gas boxes with an additional evacuation lid.

These boxes are equipped with a lid for top charging, protective gas inlet and outlet as well as an evacuation lid with rubber sealing gasket. Gas ductwork and handling while hot is the same as the protective gas boxes described on page 45. In addition, these boxes also feature a connection for a vacuum pump with a shut-off valve.

After charging the box in a cold state it is evacuated and afterwards flushed with protective gas. By repeating this process once or several times the results are considerably improved. After the box was flushed with protective gas the last time, the evacuation lid is removed and the box is placed into the preheated furnace. Protective gas is used for heat treatment. Thus, traces of oxygen in the box can be reduced by a considerable amount which improves the quality of the components accordingly.

After the heat treatment the box is taken out of the furnace and can be cooled in air or be opened to remove the charge.

The box can also be force-cooled on a cooling platform while closed. Be sure that the protective gas flowrate is increased for this application.

- Tmax 1100 °C
- For non-combustible protective and reactive gases argon, nitrogen and forming gas (observe national regulations)
- Protective gas box with fiber sealing and lid with locks, recess for evacuation lid, gas inlet via a pipe into the bottom of the box
- Evacuation lid with rubber sealing (Elastomer) and manometer
- Protective gas connection via three-way ball valve and quick coupling with hose connector (inner diameter 9 mm)
- Piping for gas inlet and outlet through the furnace collar
- Heat-resistant alloy 314 (AISI)/(DIN material no. 1.4841)
- Charge thermocouple type K for temperature display or charge control

Additional equipment
- Starting from N 31/H a charging cart is recommended see page 78
- Digital temperature display see page 69
- Vacuum pump see page 75
- Gas supply systems see page 74
- Charging forks see page 47
- Draw Hook siehe Seite 77

<table>
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<tr>
<th>Article no.</th>
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<th>Inner dimensions in mm</th>
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- Without piping and evacuation lid

Article no. 601655055, 1 set of fiber insulation cord, 5 strips of 610 mm each

Larger boxes and custom dimensions available upon request.
Charging Forks

Charging forks to charge and remove protective gas boxes up to model N 17/H

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Protective Gas Boxes with Hinged Lids for Fast Quenching for Models N 7/H - N 31/H

For heat treatment of small amounts of bulk material or small parts under protective gases with subsequent fast quenching in oil or water, we recommend to use protective gas boxes with a hinged lid. Boxes with an angled hinged lid on the front are equipped with a protective gas line on the rear wall. The supply line is run through the upper furnace collar.

After preflushing the box with non-flammable protective and reactive gases such as argon, nitrogen or forming gas 95/5, the box is placed with hinged lid first into the furnace. Due to a slight overpressure within the box the protective gas is vented off through the hinged lid.

After the heat treatment the box is taken out of the furnace and the charge is poured into quenching bath directly out of the box. By placing the box at an angle the hinged lid opens by itself. The contact with ambient air is reduced to a minimum.

- Tmax 110 °C
- For non-combustible protective and reactive gases argon, nitrogen and forming gas (observe national regulations)
- Protective gas box with flap lid and gas supply from the rear wall
- Protective gas connection via quick coupling with hose connector (inner diameter 9 mm)
- Piping for gas inlet and outlet through the furnace collar
- Lid remains closed through its own weight
- Holder with hand handle
- Heat-resistant alloy 314 (AISI)/(DIN material no. 1.4841)
- Charge thermocouple type K for temperature display or charge control

Additional equipment
- Starting from N 31/H a charging cart is recommended see page 78
- Digital temperature display see page 69
- Gas supply systems see page 74

<table>
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<tr>
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Work space = box inner dimensions: - 30 mm to all sides
Larger boxes and custom dimensions available upon request

$^1$ Without piping
Gas Feed Boxes with Hinged Lid for Models N 7/H - N 87/H which Remain in the Furnace

Working with Protective Gas Boxes with Hinged Lid in continuous Operation

In the case of successive protective gas heat treatment of individual parts, a gassing box is recommended, which remains in the furnace. For charging, the box is equipped with a flap lid to the front. The lid closes without a sealing profile against the oblique position of the box opening. Larger gas losses in comparison with removable boxes can be expected. For the protective gas supply the pipe goes through a bore on the rear wall of the furnace.

For charging, the box is opened in the furnace using a draw hook and the workpieces are placed into the box. The box is continuously flushed with non-flammable protective and reactive gases such as argon, nitrogen or forming gas 95/5. Due to a slight overpressure within the box the protective gas is vented off through the hinged lid.

After the heat treatment the box is opened using a draw hook and the workpieces are removed.

- Tmax 1100 °C
- For non-combustible protective and reactive gases argon, nitrogen and forming gas (observe national regulations)
- Protective gas box with flap lid and gas supply from the rear wall
- Protective gas connection via quick coupling with hose connector (inner diameter 9 mm)
- Piping for gas inlet and outlet through the rear wall
- Front flap lid which opens downwards
- Heat-resistant alloy 314 (AISI)/(DIN material no. 1.4841)
- Charge thermocouple type K for temperature display or charge control
- The furnace will not be equipped with a charging plate (protective gas box is permanently installed)

Additional equipment

- Digital temperature display see page 69
- Gas supply systems see page 74

<table>
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<tr>
<th>Article no.</th>
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Work space = box inner dimensions: - 30 mm to all sides
Larger boxes and custom dimensions available upon request

1 Without piping
Protective Gas Annealing Bag and Holder
for Models N 7/H - N 87/H

When workpieces made of air-hardened steel must be heat treated under protective gas and quenched afterwards, the protective gas annealing bag with holder is an optimal solution. This system consists of a holder with charge carrier and protective gas tube as well as a bag made of stainless steel heat treating foil.

The charge is placed on the charge carrier and covered with the protective gas annealing bag. The bag is preflushed with non-flammable protective and reactive gases such as argon, nitrogen or forming gas 95/5 and placed together with the holder in the furnace. After the charge has been heated, the protective gas annealing bag and holder are removed from the furnace and cooled with the help of the forced cooling system or in still air. At the same time the workpiece remains in the bag in the protective gas atmosphere. This prevents oxidation from occurring. Due to thin-walled foil very rapid cooling times can be achieved.

The protective gas annealing bag is also suitable for quenching workpieces in oil or water. The protective gas annealing bag with holder is taken out of the hot furnace after the heating time. The bag is pulled off the holder above the quenching bath using a heat protection glove. After this the workpiece can slide directly into the quenching bath. The short exposure to ambient air while being pulled out normally has only minimum effect on the surface oxidation of workpieces.

The bags can be used multiple times. Our experience shows that at temperatures < 950 °C the stainless steel heat treating bag lasts for approx. 10 - 15 processes. At temperatures between 950 °C and 1050 °C, use for approx. 5 - 10 processes can be assumed.

- Tmax 1100 °C
- For non-combustible protective and reactive gases argon, nitrogen and forming gas (observe national regulations)
- Holder with protective gas annealing bag
- Supplied with three protective gas annealing bags
- Protective gas supply with quick lock and hose connector (inner diameter 9 mm)
- Protective protective gas through notch in upper furnace collar
- Holder with hand handle
- Heat-resistant alloy 314 (AISI)/(DIN material no. 1.4841)
- Charge thermocouple type K for temperature display or charge control

Additional equipment
- Starting from N 31/H a charging cart is recommended see page 78
- Digital temperature display see page 69
- Gas supply systems see page 74

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Stainless Steel Heat Treating Foil to avoid Surface Reactions

Single parts requiring protection against decarburizing can be wrapped in a stainless steel heat treating foil off the roll or packed in prepared envelopes or bags. The rolls are available in various lengths and widths, the envelopes and bags are supplied in various dimensions.

Foil off the roll can be cut to size using gold plates scissors and the workpiece can be wrapped to requirements. See page 76 - 77 for more details about accessory supplies required, such as tongs and special gloves. The protected workpiece can now be loaded into the heated furnace. Due to the foil’s thinness, it takes on the furnace temperature immediately and binds oxygen trapped in the foil packaging. There is then no oxygen present to oxidize the workpiece itself. The workpiece stays clean.

After the appropriate dwell time in the furnace, the wrapped workpiece is immersed in the quenching medium. After quenching the foil is removed and the part is then tempered.

Care should be taken to ensure that the foil is not too close to the workpiece as otherwise the foil may become damaged. If the workpiece should have several openings or gaps, and a large amount of oxygen can be wrapped up, these gaps can be filled in with foil pieces. This increases the foil surface area.

The foil has very sharp edges. Use gloves and tools.

Annealing and Heat Treating Foils

- Tmax 1200 °C
- Stainless steel heat treating foil for single use
- Ultra-thin stainless steel heat treating foil for bright annealing of workpieces in all shapes and sizes
- Foil is cut to the correct size
- Workpieces are packed into the foil as closely as possible
- Airtight lock by means of folds of a fold lock or suitable tools (see below)
- Rapid heating of the foil binds the oxygen in the packed piece, preventing virtually all oxidation and decarburizing
- Quenching takes place with a foil, so the workpiece remains protected
- Rapid quenching

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Accessory Equipment for Processing Bags, Envelopes and Foils

We recommend using special protective gloves and tools for closing bags, envelopes and foils because the foil has very sharp edges and can be damaged if handled using conventional tools.

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<td>Roll tongs for annealing envelopes and bag</td>
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<tr>
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<td>Hynit L finger protection gloves for foil use</td>
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Annealing Envelopes

- Annealing envelopes useful up to Tmax 1200 °C
- For hardening small parts
- Airtight lock by means of folds of a fold lock or suitable tools see page 50
- Rapid heating of the foil binds the oxygen in the annealing envelope preventing virtually all oxidation and decarburizing
- Rapid quenching in air, oil or water, ensuring high dimensional accuracy
- Workpieces are placed as tightly as possible in the annealing envelope
- Envelopes made of ultra-thin stainless steel heat treating foil, welded on three sides, for single use

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Other dimensions available upon request

Annealing Bags

- Annealing bag suitable for powder nitriding, boriding and high speed steel hardening up to approx. 1050 °C - 1150 °C for cold work purposes
- Made of stainless steel heat treating foil for single use
- For hardening of blocks, stamps, cutting plates, etc.
- Rapid heating binds the oxygen in the annealing bag so that high-alloy and medium-alloy steel grades can be hardened
- Rapid quenching in air, oil or water, ensuring high dimensional accuracy
- Workpieces are placed as tightly as possible into the annealing bag
- Airtight lock by means of folds of a fold lock or suitable tools see page 50

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<tbody>
<tr>
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<td>D</td>
<td>H</td>
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<tr>
<td>491046535</td>
<td>250</td>
<td>350</td>
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</tbody>
</table>

Other dimensions available upon request
Carburizing Granulate

- Workpieces are placed into an annealing box with carburizing granulate and the lid is closed and sealed.
- At approx. 900 °C the steel reacts with the carbon and forms an approx. 0.2 - 2 mm thick layer.
- The thickness of the layer depends on the length of the process, approx. 0.1 mm/hr, a process time of approx. 6 - 8 hrs achieves good average results.
- Powder for alloyed and non-alloyed steels as well as granulate for multiple use with approx. 20 % new granulate added.
- Supplied in 25 kg sacks.

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Description</th>
<th>Container</th>
</tr>
</thead>
<tbody>
<tr>
<td>491070250</td>
<td>KG 6 - granulate for alloyed steels and multiple re-use</td>
<td></td>
</tr>
<tr>
<td>491070275</td>
<td>KG 30 - granulate for non-alloyed steels and multiple re-use</td>
<td></td>
</tr>
</tbody>
</table>

Nitriding Powder and Activator

- Workpieces are placed into an annealing box together with the nitriding powder and activator and the lid is closed and sealed.
- Powder nitriding causes a thin cover layer to form against friction wear and fatigue resistance is substantially increased.
- At approx. 550 °C an extremely thick cover layer forms (up to 1000 HV) which covers the hardened steel or the carburized edge layer. The activator improves process conditions.
- The process duration at 550 °C is at least 10 hrs.
- For all steels and cast iron, such as hot work steel matrices, injection molding dies, wear parts and machine components.
- Anti-nitriding paste to protect areas which should not be processed.

<table>
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<tr>
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<th>Description</th>
<th>Container</th>
</tr>
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<td>491010150</td>
<td>Activator</td>
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<td>491010100</td>
<td>Activator</td>
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</tr>
<tr>
<td>491003000</td>
<td>Anti-nitriding paste</td>
<td>2 kg</td>
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</tbody>
</table>
Process Examples

Permanently installed protective gas box which is loaded from the front.

Heat treatment under protective gas atmosphere in a protective gas box incl. charge thermocouple.

Protective gas box used in a large bogie hearth furnace with air circulation.

Protective gas box with flap which opens together with the furnace door.

Hardening in annealing tray with alloy bag.

Bulk material bright annealing in an annealing box with evacuation facility.
Chamber Furnaces with Brick Insulation or Fiber Insulation

The chamber furnaces LH 15/12 - LF 120/14 have been trusted for many years as professional chamber furnaces. These furnaces are available with either a robust insulation of light refractory bricks (LH models) or with a combination insulation of refractory bricks in the corners and low heat storage, quickly cooling fiber material (LF models). With a wide variety of optional equipment, these chamber furnaces can be optimally adapted to your processes.

- Tmax 1200 °C, 1300 °C, or 1400 °C
- Dual shell housing with rear ventilation, provides for low shell temperatures
- High furnace chamber with five-sided heating for very good temperature uniformity
- Heating elements on support tubes ensure free heat radiation and a long service life
- Controller mounted on furnace door and removable for comfortable operation
- Protection of bottom heating and flat stacking surface provided by embedded SiC plate in the floor
- LH models: multi-layered, fiber-free insulation of light refractory bricks and special backup insulation
- LF models: high-quality non-classified fiber insulation with corner bricks for shorter heating and cooling times
- Door with brick-on-brick seal, hand fitted
- Short heating times due to high installed power
- Self-supporting arch for high stability and greatest possible protection against dust
- Quick lock on door
- Motor driven exhaust air flap
- Freely adjustable air slide intake in furnace floor
- Base included
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 88

Additional equipment
- Parallel swinging door, pivots away from operator, for opening when hot
- Lift door with electro-mechanic linear drive
- Separate wall-mounting or floor standing cabinet for switchgear
- Cooling fan for shorter cycle times
- Protective gas connection to purge with non-flammable protective or reaction gases
- Manual or automatic gas supply system
- Scale to measure weight reduction during annealing
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 88

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
<th>Outer dimensions in mm</th>
<th>Heating power in kW</th>
<th>Electrical connection</th>
<th>Weight in kg</th>
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<td>1200</td>
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<tr>
<td>LH 60/12</td>
<td>1200</td>
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<td>LH 120/12</td>
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<td>890 x 1180 x 1470</td>
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<td>30</td>
<td>710 x 930 x 1290</td>
<td>8.0</td>
<td>3-phase</td>
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<tr>
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<td>60</td>
<td>790 x 1080 x 1370</td>
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<tr>
<td>LH 120/13</td>
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<tr>
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<td>LF 30/13</td>
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<td>15.0</td>
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<td>LF 30/14</td>
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<tr>
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<td>890 x 1180 x 1470</td>
<td>18.0</td>
<td>3-phase</td>
<td>370</td>
</tr>
</tbody>
</table>

*Heating only between two phases
*Depending on furnace design connected load might be higher

*Please see page 89 for more information about supply voltage
Due to the cubic interior of the LH chamber furnaces and the corresponding protective gas boxes, these furnaces are ideally suited for higher batches. Gassing boxes for the LH models have a standard charge thermocouple, which can be used, for example, for charge control. The protective gas inlet and outlet is routed through the furnace collar in the case of a furnace with a swivel door on the left and through the lower furnace collar in the lift-door configuration.

These boxes have a lid for charging from above, protective gas inlet and outlet.

- Tmax 1100 °C
- For non-combustible protective and reactive gases argon, nitrogen and forming gas (observe national regulations)
- Protective gas box with fiber seal and cover with locks, inert gas introduction via a pipe into the bottom of the box
- Protective gas connection via quick coupling with hose connector (inner diameter 9 mm)
- Piping for gas inlet and outlet through the furnace collar
- Heat-resistant alloy 314 (AISI)/(DIN material no. 1.4841)
- Charge thermocouple type K for temperature display or charge control

### Protective Gas Boxes for Models LH 15/.. - LH 216/..

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Furnace</th>
<th>Inner dimensions in mm</th>
<th>Outer dimensions in mm</th>
<th>Charging method of the box</th>
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<td>LH 30/..</td>
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<td>235 252 236</td>
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<td>315 332 316</td>
<td>draw hook</td>
</tr>
<tr>
<td>631001279</td>
<td>LH 120/..</td>
<td>350 350 350</td>
<td>415 411 441</td>
<td>charging stacker</td>
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<tr>
<td>631001280</td>
<td>LH 216/..</td>
<td>450 450 400</td>
<td>514 535 554</td>
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</table>

Article no. 601655055, 1 set of fiber insulation cord, 5 strips of 610 mm each

Work space = box inner dimensions: - 30 mm to all sides

Larger boxes and custom dimensions available upon request

### Protective Gas Boxes with Charging from the Front

Design as the described protective gas boxes, but with charging from the front. These protective gas boxes remain in the oven and are equipped with a lid that can be opened to the front. After the lid has been opened, the batch can be removed directly.

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Furnace</th>
<th>Inner dimensions in mm</th>
<th>Outer dimensions in mm</th>
<th>Charging method of the box</th>
</tr>
</thead>
<tbody>
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<td>631001310</td>
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<td>LH 60/..</td>
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<td>320 298 344</td>
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<td>LH 120/..</td>
<td>350 350 350</td>
<td>420 398 444</td>
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</tbody>
</table>

Article no. 601655055, 1 set of fiber insulation cord, 5 strips of 610 mm each

Work space = box inner dimensions: - 30 mm to all sides

Larger boxes and custom dimensions available upon request
Protective Gas Boxes with Evacuation Lid for Models LH 15/.. - LH 216/..

Design as the described protective gas boxes, but with an additional evacuation lid. In order to reduce the residual oxygen in the box, protective gas boxes with evacuation lids can be used. These boxes have a lid for top loading, a protective gas inlet and outlet, and an evacuation cover with rubber gasket. The gas piping and the handling in the warm state corresponds to the gassing boxes on page 56. In addition, a connection for a vacuum pump via three-way ball valve is provided.

In combination with a vacuum pump, the oxygen is evacuated from the box in cold state and afterwards flushed with protective gas. Repeating the process once or several times will significantly improve the results. After this process, the evacuation cover is removed and the actual heat treatment process is started under protective gas. After the heat treatment, the box is pulled out of the furnace and can be cooled in air or opened for batch removal.

- Protective gas box with fiber sealing and lid with locks, recess for evacuation lid, gas inlet via a pipe into the bottom of the box
- Evacuation lid with rubber sealing (Elastomer) and manometer
- Protective gas connection via three-way ball valve and quick coupling with hose connector (inner diameter 9 mm)

Additional equipment
- Starting from LH 30/.. a charging cart is recommended see page 78
- Digital temperature display see page 69
- Vacuum pump see page 75
- Gas supply systems see page 74
- Extended gas piping for the use of smaller boxes in larger furnace models
- Draw hook see page 77
- Charging stacker see page 79

Charging plates are recommended to protect the furnace floor. The charging plates are particularly suitable for heat treatment with protective gas boxes in order to minimize wear during charging.

- Tmax 1100 °C
- Threeside upstand
- Heat-resistant alloy 314 (AISI)/(DIN material no. 1.4841)
- With spacer o the rear heating elements

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Furnace</th>
<th>Inner dimensions in mm</th>
<th>Outer dimensions in mm(^1)</th>
<th>Charging method of the box</th>
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</thead>
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<td>d (mm)</td>
<td>h (mm)</td>
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<td>100</td>
<td>100</td>
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<td>631001282</td>
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<td>631001285</td>
<td>LH 216/..</td>
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Article no. 601655055, 1 set of fiber insulation cord, 5 strips of 610 mm each
Work space = box inner dimensions: - 30 mm to all sides
Larger boxes and custom dimensions available upon request

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Furnace</th>
<th>W (mm)</th>
<th>D (mm)</th>
<th>H (mm)</th>
</tr>
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<tbody>
<tr>
<td>628002013</td>
<td>LH 15/..</td>
<td>190</td>
<td>230</td>
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<td>628002014</td>
<td>LH 30/..</td>
<td>260</td>
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Chamber Furnaces with Drawer Bottom or as a Bogie

The NW chamber furnaces enable simple charging for cold-cold processes. The heat treatment can take place under air or under non-flammable protective gases with a protective gas box or protective gas hood. With a drawer mechanism (NW 150 - NW 300/H) the furnace table can be easily pulled out of the chamber furnace. The larger models NW 440 - NW 1000/H are designed as shuttle furnace with completely free traversing bogie. Free access in front of the furnace allows for a simplified and clear charging.

- Tmax 1300 °C, 1100 °C with protective gas box (additional equipment)
- Dual shell housing, galvanized steel sheets
- Double-walled door with front made of textured stainless steel
- Controller mounted on furnace door and removable for comfortable operation (up to model NW 440)
- Heating from five sides with special arrangement of heating elements for optimum temperature uniformity

- Heating elements of support tubes provide for free radiation of the heat
- Multi-layer insulation with light-weight refractory bricks and high-quality, energy-saving backing insulation

- Vaulted ceiling
- Furnace table can be pulled-out as drawer (NW 150 - NW 300)
- From chamber furnace NW 440 bogie on four castors (two with brakes) which can be pulled out completely.
- Accession assistance and removable drawbar for bogie
- SiC-floor plate protects floor elements and provides a level setting surface
- Door sealing ground by hand (brick on brick); NW 150 - NW 300
- Semi-automatic air inlet flap closes the air inlet at a temperature which can be set in the controller for NW 150 - NW 300
- Exhaust air outlet in the ceiling, motor driven exhaust air flap for chamber furnaces NW 440 - NW 1000
- Comfortable charging height with base of 800 mm (chamber furnaces NW 440 - NW 1000 = 500 mm)
- Defined application within the constraints of the operating instructions
- NTLog for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 88

Additional equipment
- Protective gas boxes and hoods
- Manual or automatic gas supply system
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 88

### Table of Dimensions and Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
<th>Outer dimensions in mm</th>
<th>Connected load kW</th>
<th>Electrical connection*</th>
<th>Weight in kg</th>
</tr>
</thead>
<tbody>
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<td>1300</td>
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<td>790 x 1150 x 1600</td>
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<td>NW 200</td>
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</table>

*Please see page 89 for more information about supply voltage.
Protective Gas Boxes and Protective Gas Hoods for Chamber Furnaces NW 150 - NW 1000

Protective Gas Boxes
These protective gas boxes have a cover with a sealing profile as well as a protective gas inlet and outlet. They are pulled out of the furnace in cold condition and charged from above.

- Tmax 1100 °C
- For non-combustible protective and reactive gases argon, nitrogen and forming gas (observe national regulations)
- Protective gas box with fiber seal and cover with locks, inert gas introduction via a pipe into the bottom of the box
- Protective gas connection via quick coupling with hose connector (inner diameter 9 mm)
- Piping for gas inlet and outlet through the furnace collar
- Forklift receptive
- Heat-resistant alloy 314 (AISI)/(DIN material no. 1.4841)
- Charge thermocouple type K for temperature display or charge control

Protective Gas Hoods
Protective gas hoods consist of a a and a bottom with a sealing profile as well as protective gas inlet and outlet. After charging the bottom in front of the oven in cold condition, the hood is put on and the drawer or the car is pushed back into the oven.

Design as protective gas boxes, but
- Gassing hood with eye for raising the hood by crane
- Hood bottom with sealing
- Piping for gas inlet and outlet at the hood through the furnace collar

Additional equipment for protective gas boxes and hoods
- Digital temperature display see page 69
- Gas supply systems see page 74

Furnace Article no. Inner dimensions in mm
NW 150 631001229 w 330 d 420 h 400
NW 200 631001330 w 400 d 420 h 500
NW 300 631001331 w 450 d 550 h 550
NW 440 631001332 w 500 d 600 h 750
NW 660 631001333 w 500 d 750 h 750
NW 1000 on request

Article no. Protective gas hood Inner dimensions in mm Charging the furnace
631001334 w 300 d 360 h 400 Drawer
631001335 w 370 d 360 h 450 Drawer
631001336 w 420 d 530 h 500 Drawer
631001337 w 470 d 580 h 550 On a bogie
631001338 w 470 d 750 h 550 On a bogie

Article no. 601655055, 1 set of fiber insulation cord, 5 strips of 610 mm each
Work space = box inner dimensions: - 30 mm to all sides
Larger boxes and custom dimensions available upon request
Forced Convection Chamber Furnaces < 675 Liters
Electrically Heated

The very good temperature uniformity of these chamber furnace with air circulation provides for ideal process conditions for annealing, curing, solution annealing, artificial ageing, preheating, or soft annealing and brazing. The forced convection chamber furnaces are equipped with a suitable annealing box for soft annealing of copper or tempering of titanium, and also for annealing of steel under non-flammable protective or reaction gases. The modular forced convection chamber furnace design allows for adaptation to specific process requirements with appropriate accessories.

- Tmax 450 °C, 650 °C, or 850 °C
- Stainless steel air-baffles in the furnace for optimum air circulation
- Swing door hinged on the right side
- Base frame included in the delivery, NA 15/65 designed as table-top model
- Horizontal air circulation
- Temperature uniformity up to +/- 4 °C according to DIN 17052-1 (model NA 15/65 up to +/- 5 °C)
- Optimum air distribution enabled by high flow speeds
- One frame sheet and rails for two additional trays included in the scope of delivery (NA 15/65 without frame sheet)
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 88

Additional equipment (not for model NA 15/65)
- Optimization of the temperature uniformity up to +/- 3 °C according to DIN 17052-1
- Air inlet and exhaust air flaps when used for drying
- Controlled cooling with fan
- Manual lift door (up to model N(A) 120/.. (HA))
- Pneumatic lift door
- Air circulation with speed control, recommendable for processes with light or sensitive charge
- Additional frame sheet
- Roller conveyor in furnace chamber for heavy charges
Forced convection chamber furnace
NA 500/65

- Annealing boxes
- Feed and charging aids
- Safety technology according to EN 1539 (NFPA 86) (models NA .. LS) for charges containing solvents
- Inlets, measuring frames and thermocouples for TUS measurements charge or comparative measurements
- Charge control
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 88

### Model Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax</th>
<th>Inner dimensions in mm</th>
<th>Volume</th>
<th>Outer dimensions in mm</th>
<th>Heating power in kW</th>
<th>Electrical connection*</th>
<th>Weight in kg</th>
<th>Heat-up time to Tmax in minutes</th>
<th>Cool-down time from Tmax to 150 °C in minutes</th>
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</tbody>
</table>

*Table-top model see page 60
*Heating only between two phases
*Depending on furnace design connected load might be higher

*Please see page 89 for more information about supply voltage
*Additional equipment
*Empty furnace
For the heat treatment, workpieces are placed in the box, the lid is locked using the sealing locks and flushed with protective gas outside the furnace for some time and then placed in the furnace. Depending on the weight, a charging cart (page 30) is recommended.

**Basic Version**
- For non-combustible protective and reactive gases argon, nitrogen and forming gas (observe national regulations)
- Protective gas box with fiber seal and cover with locks, inert gas introduction via a pipe into the bottom of the box
- Piping for gas inlet and outlet through the furnace collar
- Models N 250/..HA, NA 250/.., N 500/..HA und NA 500/.. will be delivered without bottom frame sheet
- Heat-resistant alloy: 309 (AISI)/(DIN material no. 1.4828)
- Charge thermocouple type K for temperature display or charge control

**Additional equipment**
- Digital temperature display see page 69
- Gas supply systems see page 74
- Extended gas piping for the use of smaller boxes in larger furnace models
- Draw hook see page 77
- Charging cart see page 78

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### Article no. (Furnace with hinged door) (Furnace with lift door) | Furnace | Inner dimensions in mm | Outer dimensions in mm | Charging method of the box
---|---|---|---|---
631000410 | 631000763 | NA 30/.., N 30/..HA | w d h | W D H
220 | 320 | 160 | 282 | 376 | 242 | draw hook
631000411 | 631000764 | NA 60/.., N 60/..HA | 270 | 420 | 260 | 336 | 460 | 340 | draw hook
631000412 | 631000765 | NA 120/.., N 120/..HA | 350 | 520 | 340 | 436 | 560 | 430 | draw hook
631000413 | 631000766 | NA 250/.., N 250/..HA | 480 | 630 | 460 | 546 | 680 | 600 | charging stacker
631000414 | 631000767 | NA 500/.., N 500/..HA | 630 | 780 | 610 | 696 | 836 | 760 | charging stacker

Article no. 601655055, 1 set of fiber insulation cord, 5 strips of 610 mm each

Larger boxes and custom dimensions available upon request.
Design as the boxes described above, but with additional evacuation lid and connection. Before the box is placed in the furnace, in a cold state an evacuation and protective gas atmosphere are alternately generated to force out the oxygen and achieve a pure atmosphere.

- Protective gas box with fiber sealing and lid with locks, recess for evacuation lid, gas inlet via a pipe into the bottom of the box
- Evacuation lid with rubber sealing (Elastomer) and manometer
- Protective gas connection via three-way ball valve and quick coupling with hose connector (inner diameter 9 mm)
- Piping for gas inlet and outlet through the furnace collar

Additional equipment
- Digital temperature display see page 69
- Vacuum pump see page 75
- Gas supply systems see page 74
- Extended gas piping for the use of smaller boxes in larger furnace models
- Draw hook see page 77
- Charging cart see page 78

---

### Protective Gas Boxes with Evacuation Lid for Models NA 30/45 - N 500/85HA

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Furnace with hinged door</th>
<th>Furnace with lift door</th>
<th>Inner dimensions in mm</th>
<th>Outer dimensions in mm&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Charging method of the box</th>
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</table>

- 631000559, 1 set of fiber insulation cord, 5 strips of 610 mm each
- Work space = box inner dimensions: ± 30 mm to all sides
- Larger boxes and custom dimensions available upon request

<sup>1</sup> Without piping and evacuation lid
Protective Gas Boxes According to AMS 2750 E, Instrumentation Type D for Forced Convection Furnaces

These boxes are based on the standard protective gas boxes for furnaces with hinged door. To fulfill AMS 2750 E, instrumentation, type D requirements the boxes are equipped with necessary measuring ports.

- Temperature uniformity class 2: +/- 5 °C in useful space
- Additional port for customers flexible SAT thermocouple with max. 1,5 mm diameter
- Thermocouple, overtemperature protection, metal clad thermocouple, type N with plug

### Protective Gas Boxes According to AMS 2750 E, Instrumentation Type D

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Furnace</th>
<th>Inner dimensions in mm</th>
<th>Outer dimensions in mm</th>
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<td>631000763</td>
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<td>631000764</td>
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</table>

Article no. 601655055, 1 set of fiber insulation cord, 5 strips of 610 mm each

1 Without piping

Work space = box inner dimensions: - 30 mm to all sides
Larger boxes and custom dimensions available upon request

---

### Protective Gas Boxes with Evacuation Lid According to AMS 2750 E, Instrumentation Type D

These boxes are based on the standard protective gas boxes with evacuation lid for furnaces with hinged door. Before the box is placed in the furnace, in a cold state an evacuation and protective gas atmosphere are alternately generated to force out the oxygen and achieve a pure atmosphere.

- Temperature uniformity class 2: +/- 5 °C in useful space
- Additional port for customers flexible SAT thermocouple with max. 1,5 mm diameter
- Thermocouple, overtemperature protection, metal clad thermocouple, type N with plug

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Furnace</th>
<th>Inner dimensions in mm</th>
<th>Outer dimensions in mm</th>
</tr>
</thead>
<tbody>
<tr>
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Article no. 601655055, 1 set of fiber insulation cord, 5 strips of 610 mm each

1 Without piping

Work space = box inner dimensions: - 30 mm to all sides
Larger boxes and custom dimensions available upon request

---

### Protective Gas Boxes for Automotive (CQI-9) and Aeronautic (AMS7NADCAP) Norms

- Lid for TUS measurements
- Protective gas box
- Over-temperature protection
- Controlling thermocouple (Furnace)
- Charging thermocouple/controlling thermocouple (box)
- SAT thermocouple
- TUS recorder
- Controller

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Larger boxes and custom dimensions available upon request

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Protective Gas Boxes for Automotive (CQI-9) and Aeronautic (AMS7NADCAP) Norms
Sealed Forced Convection Chamber Furnaces NA-I and NA-SI

Sealed forced convection chamber furnaces are suitable if a heat treatment process up to 650 °C requires a protective gas atmosphere that does not have to be completely oxygen free.

The difference between the two variants is that the I-model only has a sealed outer housing while the SI-model has a welded inner box, which further reduces the residual oxygen concentration.

NA-I design
Like forced convection chamber furnaces < 675 l (page 60) with the following changes
- Tmax 450 °C and 650 °C
- Silicone door seal
- Furnace housing sealed with silicone
- Protective gas connection in the back wall
- Defined application within the constraints of the operating instructions
- Residual oxygen concentration < 1 % depending on the volume and type of protective gas
- For non-flammable protective and reaction gases such as argon, nitrogen, and forming gas (national regulations must be considered)

NA-SI design
Additional features
- Tmax 650 °C
- Welded inner housing
- 2-sided heating and air circulation
- Door sealed with seal gas
- Sealed connection to circulation motor
- Gas inlet via circulator shaft
- Defined application within the constraints of the operating instructions
- Residual oxygen concentration to 0.1 % depending on the volume and type of protective gas
- For non-flammable protective and reaction gases such as argon, nitrogen, and forming gas (national regulations must be considered)

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<th>Tmax °C</th>
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¹Table-top model
²Heating only between two phases
*Please see page 89 for more information about supply voltage
³Depending on furnace design connected load might be higher
Forced Convection Pit-Type Furnaces
Electrically Heated

Forced convection pit-type furnaces offer the advantage of easy charging, for heat treatment of heavy parts or loads in charge baskets. With maximum application temperatures available from 450 °C to 850 °C, these compact pit-type furnaces are particularly useful for processes such as tempering, solution annealing, artificial ageing, and soft annealing.

- Tmax 450 °C, 650 °C, 850 °C
- Air circulation fans in the furnace bottom, high circulation rate
- Vertical air circulation with square air heating chamber
- Temperature uniformity up to +/- 4 °C according to DIN 17052-1
- Interior walls from stainless steel
- Switchgear with solid-state relays
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 88

Additional equipment
- Charging hoist with swivel arm and charge basket
- Optimization of the temperature uniformity up to +/- 2 °C according to DIN 17052-1
- Integrated fan for rapid cool down or separate cooling station for annealing box cooling outside of the furnace
- Annealing box with protective gas inlet and outlet for production in a defined atmosphere
- Manual or automatic gas supply systems for non-flammable protective or reaction gases
- Process control and documentation via VCD software package for monitoring, documentation and control see page 88

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
<th>Max. charging weight in kg</th>
<th>Outer dimensions in mm</th>
<th>Heating power in kW*</th>
<th>Electrical connection* in kg</th>
<th>Weight in kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAL 30/45</td>
<td>450</td>
<td>300 250 400</td>
<td>30</td>
<td>120 750 850 1250</td>
<td>3.0</td>
<td>1-phase 130</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAL 60/45</td>
<td>450</td>
<td>350 500 600</td>
<td>60</td>
<td>120 800 950 1350</td>
<td>6.0</td>
<td>3-phase 225</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAL 120/45</td>
<td>450</td>
<td>450 600 750</td>
<td>120</td>
<td>120 900 1050 1450</td>
<td>9.0</td>
<td>3-phase 280</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAL 250/45</td>
<td>450</td>
<td>500 750 900</td>
<td>250</td>
<td>400 1050 1200 1600</td>
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<td></td>
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<tr>
<td>SAL 500/45</td>
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<td>600 900 1100</td>
<td>500</td>
<td>400 1200 1350 1750</td>
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<td>3-phase 980</td>
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<td></td>
</tr>
<tr>
<td>SAL 30/65</td>
<td>650</td>
<td>300 250 400</td>
<td>30</td>
<td>120 750 850 1250</td>
<td>5.5</td>
<td>3-phase 130</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAL 60/65</td>
<td>650</td>
<td>350 500 600</td>
<td>60</td>
<td>120 800 950 1350</td>
<td>9.0</td>
<td>3-phase 225</td>
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</tr>
<tr>
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<td>120</td>
<td>120 900 1050 1450</td>
<td>13.0</td>
<td>3-phase 280</td>
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<td></td>
</tr>
<tr>
<td>SAL 250/65</td>
<td>650</td>
<td>500 750 900</td>
<td>250</td>
<td>400 1050 1200 1600</td>
<td>20.0</td>
<td>3-phase 750</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAL 500/65</td>
<td>650</td>
<td>600 900 1100</td>
<td>500</td>
<td>400 1200 1350 1750</td>
<td>30.0</td>
<td>3-phase 980</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAL 30/85</td>
<td>850</td>
<td>300 250 400</td>
<td>30</td>
<td>80 600 740 1000</td>
<td>5.5</td>
<td>3-phase 130</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAL 60/85</td>
<td>850</td>
<td>350 500 600</td>
<td>60</td>
<td>80 800 950 1350</td>
<td>9.0</td>
<td>3-phase 225</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAL 120/85</td>
<td>850</td>
<td>450 600 750</td>
<td>120</td>
<td>80 900 1050 1450</td>
<td>13.0</td>
<td>3-phase 280</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAL 250/85</td>
<td>850</td>
<td>500 750 900</td>
<td>250</td>
<td>250 1050 1200 1600</td>
<td>20.0</td>
<td>3-phase 750</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAL 500/85</td>
<td>850</td>
<td>600 900 1100</td>
<td>500</td>
<td>250 1200 1350 1750</td>
<td>30.0</td>
<td>3-phase 980</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 Heating only between two phases
2 Depending on furnace design connected load might be higher

*Please see page 89 for more information about supply voltage
Protective Gas Boxes for Models SAL 30/45 - SAL 500/85

For tempering and bright annealing, workpieces are laid in the box, the lid is pressed firmly shut using the sealing locks and flushed with protective gas outside the box for some time and then placed in the furnace. Due to weight reasons we recommend to use a charging aid for charging.

- For non-combustible protective and reactive gases argon, nitrogen and forming gas (observe national regulations)
- Protective gas box with fiber seal and cover with locks, inert gas introduction via a pipe into the bottom of the box
- Protective gas connection via quick coupling with hose connector (inner diameter 9 mm)
- Piping for gas inlet and outlet through the furnace collar
- Heat-resistant alloy: 450 °C - 304 (AISI)/(DIN material no. 1.4301), 650 °C - 321 (AISI)/(DIN material no. 1.4541) or 850 °C - 309 (AISI)/(DIN material no. 1.4828)
- Charging aid lifting eyes
- Charge thermocouple type K for temperature display or charge control

Additional equipment
- Digital temperature display see page 69
- Gas supply systems see page 74

### Charged Aid for Models SAL 30/45 - SAL 500/85

A charging aid, fastened to the furnace consisting of a swivel arm and winch is recommended for charging series SAL 30/45A - SAL 250/85 forced convection pit-type furnaces with protective gas boxes or baskets. This allows easy and safe furnace charging.

- Swivel arm, mounted on side of furnace
- For ease of charging and removal of Nabertherm charging baskets and protective gas boxes
- Winch with hand crank
- Max. charging weight 140 kg

<table>
<thead>
<tr>
<th>Furnace</th>
<th>Total height in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAL 30/45 - SAL 120/45</td>
<td>2400</td>
</tr>
<tr>
<td>SAL 250/45</td>
<td>2600</td>
</tr>
<tr>
<td>SAL 500/45</td>
<td>3010</td>
</tr>
</tbody>
</table>

### Protective Gas Boxes for Models SAL 30/45 - SAL 500/85

For tempering and bright annealing, workpieces are laid in the box, the lid is pressed firmly shut using the sealing locks and flushed with protective gas outside the box for some time and then placed in the furnace. Due to weight reasons we recommend to use a charging aid for charging.

<table>
<thead>
<tr>
<th>Article no. with charge thermocouple</th>
<th>Furnace</th>
<th>Inner dimensions in mm</th>
<th>Outer dimensions in mm</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>631000500</td>
<td>SAL 30/45</td>
<td>215 165 277</td>
<td>281 231 354</td>
<td></td>
</tr>
<tr>
<td>631000501</td>
<td>SAL 60/45</td>
<td>265 265 377</td>
<td>331 331 454</td>
<td></td>
</tr>
<tr>
<td>631000502</td>
<td>SAL 120/45</td>
<td>365 365 477</td>
<td>431 431 554</td>
<td></td>
</tr>
<tr>
<td>631000503</td>
<td>SAL 250/45</td>
<td>515 515 627</td>
<td>581 561 704</td>
<td></td>
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<tr>
<td>631000504</td>
<td>SAL 500/45</td>
<td>665 665 727</td>
<td>731 731 804</td>
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</tr>
<tr>
<td>631000505</td>
<td>SAL 30/65</td>
<td>215 165 277</td>
<td>281 231 354</td>
<td></td>
</tr>
<tr>
<td>631000506</td>
<td>SAL 60/65</td>
<td>265 265 377</td>
<td>331 331 454</td>
<td></td>
</tr>
<tr>
<td>631000507</td>
<td>SAL 120/65</td>
<td>365 365 477</td>
<td>431 431 554</td>
<td></td>
</tr>
<tr>
<td>631000508</td>
<td>SAL 250/65</td>
<td>515 515 627</td>
<td>581 561 704</td>
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</tr>
<tr>
<td>631000509</td>
<td>SAL 500/65</td>
<td>665 665 727</td>
<td>731 731 804</td>
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</tr>
<tr>
<td>631000510</td>
<td>SAL 30/85</td>
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<td>281 231 354</td>
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<tr>
<td>631000511</td>
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<td>265 265 377</td>
<td>331 331 454</td>
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<td>365 365 477</td>
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</tr>
<tr>
<td>631000513</td>
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<td>515 515 627</td>
<td>581 561 704</td>
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<tr>
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<td>SAL 500/85</td>
<td>665 665 727</td>
<td>731 731 804</td>
<td></td>
</tr>
</tbody>
</table>

Article no. 601655055, 1 sales unit of fiber insulation cord, 5 strips of 610 mm each

1 Without piping
Charging Baskets for Models SAL 30/45 - SAL 500/85

The workpieces are placed in basket for tempering. We recommend the use of a charging aid for charging.

- Heat-resistant charging basket for small parts and bulk materials, incl. handle or crane lifting eyes
- Filling from side via 2 drawers (3 levels)
- Hole size 12 mm
- Heat-resistant alloy: 450 °C - 304 (AISI)/(DIN material no. 1.4301), 650 °C - 321 (AISI)/(DIN material no. 1.4541) or 850 °C - 309 (AISI)/(DIN material no. 1.4828)

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Furnace</th>
<th>Inner dimensions in mm</th>
</tr>
</thead>
<tbody>
<tr>
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<td>w</td>
</tr>
<tr>
<td>631000477</td>
<td>SAL 30/45</td>
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</tr>
<tr>
<td>631000478</td>
<td>SAL 60/45</td>
<td>260</td>
</tr>
<tr>
<td>631000479</td>
<td>SAL 120/45</td>
<td>360</td>
</tr>
<tr>
<td>631000480</td>
<td>SAL 250/45</td>
<td>510</td>
</tr>
<tr>
<td>631000481</td>
<td>SAL 500/45</td>
<td>570</td>
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<tr>
<td>631000482</td>
<td>SAL 30/65</td>
<td>210</td>
</tr>
<tr>
<td>631000483</td>
<td>SAL 60/65</td>
<td>260</td>
</tr>
<tr>
<td>631000484</td>
<td>SAL 120/65</td>
<td>360</td>
</tr>
<tr>
<td>631000485</td>
<td>SAL 250/65</td>
<td>510</td>
</tr>
<tr>
<td>631000486</td>
<td>SAL 500/65</td>
<td>570</td>
</tr>
</tbody>
</table>

The workpieces are placed on different levels for tempering. We recommend the use of a charging aid for charging.

- Heat-resistant charging basket, incl. handle/crane lifting eyes
- Charged from side via 2 drawers (3 levels)
- Hole size 12 mm
- Heat-resistant alloy: 450 °C - 304 (AISI)/(DIN material no. 1.4301), 650 °C - 321 (AISI)/(DIN material no. 1.4541) or 850 °C - 309 (AISI)/(DIN material no. 1.4828)

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Furnace</th>
<th>Inner dimensions in mm</th>
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<tbody>
<tr>
<td></td>
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<td>631006124</td>
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<tr>
<td>631006036</td>
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<td>280</td>
</tr>
<tr>
<td>631006037</td>
<td>SAL 120/45</td>
<td>344</td>
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<tr>
<td>631006038</td>
<td>SAL 250/45</td>
<td>490</td>
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<td>631006039</td>
<td>SAL 500/45</td>
<td>660</td>
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<td>631006040</td>
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<td>631006041</td>
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<td>490</td>
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<tr>
<td>631006049</td>
<td>SAL 500/85</td>
<td>660</td>
</tr>
</tbody>
</table>

The workpieces are placed on different levels for tempering. We recommend the use of a charging aid for charging.

- Heat-resistant charging basket for small parts and bulk materials, incl. handle/crane lifting eyes
- Charged in different floors
- Hole size 12 mm
- Heat-resistant alloy: 450 °C - 304 (AISI)/(DIN material no. 1.4301), 650 °C - 321 (AISI)/(DIN material no. 1.4541) or 850 °C - 309 (AISI)/(DIN material no. 1.4828)

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Furnace</th>
<th>No. of baskets</th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>w</td>
</tr>
<tr>
<td>631006106</td>
<td>SAL 250/85</td>
<td>7</td>
<td>10 kg</td>
<td>530</td>
</tr>
</tbody>
</table>
Temperature Measurement in Gas Supply Systems

The use of a thermometer with thermocouple is recommended for determining the exact heat treatment temperature in protective gas boxes or gas feed annealing bags with holders. The thermocouple is permanently mounted on the respective protective gas boxes or gas feed annealing bag holder. A simple manual thermometer with LCD display or a temperature indicator with LED display can be supplied, mounted in a separate metal housing. Both are equipped with a two-pole plug unit for connecting to the thermocouple. The temperature can be determined in this way and, if necessary, readjusted on the controller.

Upon request, the furnace can be operated by charge control with a thermocouple attached to the workpiece.

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Description</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>402000057</td>
<td>Temperature indicator with digital display, 230 V 1/N connection, in metal housing</td>
<td>Connecting cable between heat treatment with charge thermocouple and Article no. 402000057, 5 m</td>
</tr>
<tr>
<td>542100028</td>
<td>Temperature indicator with digital display, battery-operated, manual device</td>
<td>Connecting cable between heat treatment with charge thermocouple and Article no. 542100028, 3 m</td>
</tr>
<tr>
<td>V000808</td>
<td>Connecting cable between heat treatment with charge thermocouple and Article no. 402000057, 5 m</td>
<td>Connecting cable between heat treatment with charge thermocouple and Article no. 542100028, 3 m</td>
</tr>
</tbody>
</table>

TUS Measuring Frame for Protective Gas Box

To carry out the temperature uniformity measurement (TUS) the protective gas box will be equipped with a second lid. The TUS measuring frame is fixed to the lid and it is equipped with measuring port for thermocouples.

- Tmax 1100 °C
- Useful for all relevant TUS norms
- Under the assumption that the furnace is equipped with a measuring port for thermocouples
- Heat-resistant alloy 314 (AISI)/(DIN material no. 1.4828)
- Thermocouples not included
The work platform of the system is designed to carry an N 7/H - N 17/H series hardening furnace and NA 15/65 annealing furnace. Suitable protective gas boxes can be used. A movable oil/water bath for quenching and subsequent cleaning is positioned below the furnaces. This compact system is a practical solution is space is an issue.

After heat treatment in the hardening furnace, the parts are removed from the furnace or the gas feed box and quenched in an oil quench bath or water bath. The charging basket can be used to move the part within the bath so that it cools more evenly. After quenching in oil the workpiece should be cleaned in the water bath, dried and immediately tempered in a forced convection furnace in order to optimally fix the mechanical components with regard to their strength behavior for the required conditions, minimize distortion and prevent potential flaws.

Additional equipment
- Protective gas boxes see page 45 - 48
- Protective gas annealing bag and holder see page 49
- Gas supply systems see page 74
- Charging forks see page 47

---

### Tool Shop Hardening System KHS 17

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
<th>Outer dimensions in mm</th>
<th>Heating power in kW²</th>
<th>Electrical connection*</th>
<th>Weight in kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>N 7/H</td>
<td>1280</td>
<td>250 250 120</td>
<td>7 720 640 510</td>
<td>3.0 1-phase</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N 11/H</td>
<td>1280</td>
<td>250 350 140</td>
<td>11 720 740 510</td>
<td>3.6 1-phase</td>
<td>70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N 11/HR</td>
<td>1280</td>
<td>250 350 140</td>
<td>17 720 890 510</td>
<td>5.5 3-phase¹</td>
<td>70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N 17/HR</td>
<td>1280</td>
<td>250 500 140</td>
<td>15 470 845 460</td>
<td>6.4 3-phase¹</td>
<td>90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N 15/65HA</td>
<td>650</td>
<td>295 340 170</td>
<td>475 1155 215</td>
<td>2.4 1-phase</td>
<td>55</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹Heating only between two phases
²Depending on furnace design connected load might be higher

*Please see page 89 for more information about supply voltage

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### Additional Equipment
- Protective gas boxes see page 45 - 48
- Protective gas annealing bag and holder see page 49
- Gas supply systems see page 74
- Charging forks see page 47

---

### Article list

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Article</th>
<th>Outer dimensions in mm</th>
<th>Charging floor grid dimensions</th>
</tr>
</thead>
<tbody>
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<td></td>
<td></td>
<td>W D H</td>
<td>Width in mm</td>
</tr>
<tr>
<td>401000104</td>
<td>Work table with quenching and cleaning bath</td>
<td>735  850 1155</td>
<td>-</td>
</tr>
<tr>
<td>401000102</td>
<td>Charging basket for quenching and cleaning bath</td>
<td>- - -</td>
<td>215</td>
</tr>
</tbody>
</table>
Tool Shop Hardening System MHS 17

The MHS 17 hardening system has a modular design and consists of a work platform for the heat treating furnaces, an oil bath for quenching and water bath for cleaning parts. As an option both baths can be delivered incl. heating. The baths are mounted to the left and right of the work platform and have charging baskets in order to induce even cooling of the parts in the bath. All parts may be ordered separately meaning the hardening system can be retrofitted or equipment added individually depending on the materials processed.

The MHS 17 can have an air quenching system added to it for air-hardened steels. This platform has a powerful cooling fan to force cool the parts requiring hardening and also the gas feed annealing bag and holder. A refractory brick base is for placing hot boxes and workpieces on them. The quenching baths can also be fastened onto the forced cooling system.

An additional storage platform can be integrated within the system for holding accessory equipment and/or optional charging accessories.

Additional equipment see page 70.

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
<th>Outer dimensions in mm</th>
<th>Heating power in kW</th>
<th>Electrical connection*</th>
<th>Weight in kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>for MHS 17</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N 7/H</td>
<td>1280</td>
<td>250 250 120</td>
<td>7</td>
<td>720 640 510</td>
<td>3.0</td>
<td>1-phase</td>
<td></td>
</tr>
<tr>
<td>N 11/H</td>
<td>1280</td>
<td>250 350 140</td>
<td>11</td>
<td>720 740 510</td>
<td>3.6</td>
<td>1-phase</td>
<td>70</td>
</tr>
<tr>
<td>N 11/HR</td>
<td>1280</td>
<td>250 350 140</td>
<td>11</td>
<td>720 740 510</td>
<td>5.5</td>
<td>3-phase¹</td>
<td>70</td>
</tr>
<tr>
<td>N 17/HR</td>
<td>1280</td>
<td>250 500 140</td>
<td>17</td>
<td>720 890 510</td>
<td>6.4</td>
<td>3-phase¹</td>
<td>90</td>
</tr>
<tr>
<td>N 15/65HA</td>
<td>650</td>
<td>295 340 170</td>
<td>15</td>
<td>470 845 460</td>
<td>2.4</td>
<td>1-phase</td>
<td>55</td>
</tr>
</tbody>
</table>

¹Heating only between two phases
²Depending on furnace design connected load might be higher

*Please see page 89 for more information about supply voltage

Additional equipment see page 70.

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Article</th>
<th>Outer dimensions in mm</th>
<th>Volume in l</th>
<th>Charging floor grid dimensions</th>
<th>Connected load kW</th>
<th>Supply voltage</th>
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<tbody>
<tr>
<td>631006421</td>
<td>Work platform</td>
<td>1000 850 760</td>
<td>-</td>
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<tr>
<td>631006407</td>
<td>Oil bath</td>
<td>280 510 510</td>
<td>50</td>
<td>400 200</td>
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<tr>
<td>631006408</td>
<td>Water bath</td>
<td>280 510 510</td>
<td>50</td>
<td>400 200</td>
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<td>230 V</td>
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<tr>
<td>631001011</td>
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<tr>
<td>631001012</td>
<td>Heating element (water bath)</td>
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<tr>
<td>631000429</td>
<td>Forced cooling system (cooling platform)</td>
<td>560 610 760</td>
<td>400 200</td>
<td>0.2</td>
<td>230 V</td>
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<tr>
<td>631000442</td>
<td>Side platform</td>
<td>560 610 760</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
### Tool Shop Hardening Systems MHS 31, MHS 41 and MHS 61

These toolshop hardening systems are suitable for hardening larger components in air or under a protective gas atmosphere. They can be assembled from a chamber furnace, a forced convection furnace, a gas box with a gas supply via a solenoid valve, a charging plate to protect the furnace floor, and a quenching bath with heating element. During the heat treatment under protective gas, the process starts with the flushing of the batch in the protective gas box by means of protective gas. Subsequently, annealing is carried out in the chamber furnace at a lower process flushing rate. The chamber furnace is opened after the annealing process and the batch is removed from the protective gas box to be quenched in the preheated quench bath. The final annealing process takes place in the forced convection furnace. For easier charging, we recommend the use of optional charging aids such as pull hooks and charging trolleys.

The toolshop hardening systems are an assembly of furnaces and accessories from our standard range. All components can also be ordered separately.

### Additional equipment
- Draw hook see page 77
- Charging cart see page 78

### Table

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax</th>
<th>Inner dimensions in mm</th>
<th>Charging height</th>
<th>Outer dimensions in mm</th>
<th>Heating power in kW¹</th>
<th>Electrical connection*</th>
<th>Weight in kg</th>
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</thead>
<tbody>
<tr>
<td>MHS 31 N 31/H</td>
<td>1280</td>
<td>350 350 250</td>
<td>900 1040 1100 1340</td>
<td>15 3-phase 210</td>
<td>5 3-phase¹ 285</td>
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<tr>
<td>NA 30/65</td>
<td>650</td>
<td>290 420 260</td>
<td>900 1290 1385</td>
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<td>- 200 170</td>
<td>700 350 350 700</td>
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<td>-</td>
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<td>Heating element</td>
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<tr>
<td>MHS 41 N 41/H</td>
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<td>350 500 250</td>
<td>900 1040 1250 1340</td>
<td>15 3-phase 260</td>
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<tr>
<td>NA 60/65</td>
<td>650</td>
<td>350 500 350</td>
<td>900 1390 1475</td>
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<td></td>
</tr>
<tr>
<td>Quenching bath Q 50</td>
<td>- 200 170</td>
<td>700 350 350 700</td>
<td>- - -</td>
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<td>Heating element</td>
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<td>- - -</td>
<td>- -</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>MHS 61 N 61/H</td>
<td>1280</td>
<td>350 750 250</td>
<td>900 1040 1500 1350</td>
<td>20 3-phase 400</td>
<td>9 3-phase 350</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NA 60/65</td>
<td>650</td>
<td>350 500 350</td>
<td>900 1390 1475</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Quenching bath Q 50</td>
<td>- 200 170</td>
<td>700 350 350 700</td>
<td>- - -</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Heating element</td>
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<tr>
<td>Accessories</td>
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<td>880 - 920</td>
<td>330 1100 880 - 920</td>
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<tr>
<td>Charging cart CW1</td>
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<td>-</td>
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<td>-</td>
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<tr>
<td>Charging cart CWK1</td>
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<td>- - -</td>
<td>- -</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Side platform</td>
<td>- 600 600 900</td>
<td>- 900 600 600 900</td>
<td>- - -</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Protective gas box N 31/H</td>
<td>1100 280 230 200</td>
<td>- 316 304 226</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Protective gas box N 41/H</td>
<td>1100 280 380 200</td>
<td>- 316 454 226</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

¹ Heating only between two phases
² Depending on furnace design connected load might be higher

*Please see page 89 for more information about supply voltage
Protective Gas Hardening System SHS 41

This compact, semi-automatic system is suitable for hardening in a protective gas atmosphere followed by quenching of the workpiece in oil. In this way, even larger parts can be annealed under a protective gas and quenched. It consists of a chamber furnace N 41/H hardening furnace with a pneumatic door opening and charging plates as well as an oil quench bath on rollers with an integrated pneumatic lowering unit, a floor grid with gas hood, a holding unit for the gas hood as well as a rim exhaust with flame trap.

The workpiece is placed on the floor grid and covered with the gas hood. After preflushing with protective gas, the gas hood is pushed with the floor grid into the chamber furnace. After the heat treatment is completed, the workload is pulled out of the furnace onto the lowering unit. The hood remains above the quenching bath while the charging floor grid is lowered pneumatically. In order to obtain best quenching results, the pneumatic lowering unit is moved up and down in the oil quench bath. After completion, the workload is moved into unloading position.

This low cost system can be used for hardening processes which otherwise could only be handled in complex furnace systems.

- Chamber furnace N 41/H
- Pneumatic pedal switch operated door opening
- Charging plate
- Oil quench bath on rollers
- Pneumatic lowering unit
- Heating of oil quench bath
- Oil temperature display
- Charging floor grid and gas hood
- Holding unit for gas hood
- Manual protective gas unit see page 74
- Draw hook see page 77
- Safety equipment consisting of rim exhaust with flame trap and oil steam separator

Additional equipment
- Suction hood
- Water bath

Furnace Table

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Protective gas hardening system</th>
<th>Outer dimensions in mm</th>
<th>Heating power in kW</th>
<th>Electrical connection*</th>
<th>Weight in kg</th>
</tr>
</thead>
</table>

*Please see page 89 for more information about supply voltage
Gas Supply Systems

Protective Gases
Protective gases are used to force oxygen out of the gas feed boxes mentioned above. Make sure to use protective gases behaving neutrally toward the heat treated part. The protective gases should be inert, meaning no chemical bonding should occur with the workpiece or the furnace and no reactions should be endured.

In many cases, nitrogen is used as protective gas (lighter than air). Our experience shows that nitrogen does not always lead to sufficient results. A longer preflush time must also be used.

Better results are achieved by adding a mixture of nitrogen and adding some hydrogen. Hydrogen acts as a reducing constituent and reacts with the oxygen. This gas mixture is known as forming gas and available in stores. Experience has shown that adding 5 % hydrogen to the nitrogen leads to good results. According to the EU material safety data sheet this mixture is considered as not flammable. National regulations, however, must be observed. This gas can be obtained in premixed form. No measures must be taken in advance to prevent explosions.

If the workpiece has an affinity to hydrogen, argon used as protective gas can lead to good results.

Argon is a gas which is heavier than air. This makes it relatively easy to fill the protective gas containers. Forming gas with added hydrogen (depending on the country law up to a ration of 98/2) is lighter, but it has the advantage of burning at higher temperatures and therefore binds with the oxygen. Even in a cold state, the leaking hydrogen transports the oxygen very easily out of the container.

For gas mixtures with hydrogen or other combustible gases, the valid safety regulations must always be observed. If the mixture is declared as combustible, the furnace, provided it is a gas tight version, can be fitted with a corresponding safety system.

Always make sure that the room is properly ventilated when working with protective gases. Country-specific safety regulations must also be followed.

### Manual Gas Feed Fitting for Bottles
- Pressure reducing valve with assembled flow meter and attached pressure gauge indicating the bottle pressure
- The assembled variable area flow meter ensures good readability of the amount used
- Connection: screw connection for bottle
- Exit: hose connection (inner diameter 9 mm)
- 200 bar intake pressure, 4 bar outlet pressure
- Incl. 4 m connecting hose to the furnace

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Type of gas</th>
<th>Flow rate l/min</th>
</tr>
</thead>
<tbody>
<tr>
<td>631000309</td>
<td>Ar</td>
<td>0 - 30</td>
</tr>
<tr>
<td>631000310</td>
<td>N₂</td>
<td>0 - 30</td>
</tr>
<tr>
<td>631000311</td>
<td>Non-flammable forming gas</td>
<td>0 - 30</td>
</tr>
</tbody>
</table>

Alternative connection threads on request
Automatic Gas Supply System for two different Flushing Quantities, e.g. high Volume Pre-flushing and low Volume for ongoing Operation

Consisting of:
- Switching system with 3-step switch for gas inlet Off/Manual/Automatic via "Extra" function of respective controller, timer for switching from large gas quantity to small gas quantity. Gas feed stops at when program quits.
- Automatic gas feed panel with pressure reducer, two adjustable flow meters and two solenoid valves, preinstalled conduit and wiring attached to furnace from the side on an assembly plate.
- Connection: hose connection (inner diameter 9 mm)
- Exit: hose connection (inner diameter 9 mm)
- Max. 10 bar intake pressure, max. 300 mbar outlet pressure
- Incl. connecting hose between furnace and protective gas box or gas connection
- Available only in combination with furnace or switchgear

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Type of gas</th>
<th>Flow rate l/min</th>
</tr>
</thead>
<tbody>
<tr>
<td>631000379</td>
<td>Ar</td>
<td>0 - 30</td>
</tr>
<tr>
<td>631000380</td>
<td>N₂</td>
<td>0 - 30</td>
</tr>
<tr>
<td>631000381</td>
<td>Non-flammable forming gas</td>
<td>0 - 30</td>
</tr>
</tbody>
</table>

Alternative connection threads on request

Automatic Gas Supply System for two different Flushing Quantities, e.g. high Volume Pre-flushing and low Volume for ongoing Operation

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Type of gas</th>
<th>Flow rate l/min</th>
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</thead>
<tbody>
<tr>
<td>631000316</td>
<td>Ar</td>
<td>4 - 80</td>
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<tr>
<td>631000200</td>
<td>N₂</td>
<td>4 - 80</td>
</tr>
<tr>
<td>631000315</td>
<td>Non-flammable forming gas</td>
<td>4 - 80</td>
</tr>
</tbody>
</table>

Vacuum Pump

Oil sealed rotary vane vacuum pump for universal use within the low vacuum range. Highly compact and low noise construction. Manometer included in delivery.

- Sliding vane rotary pump with sucking capacity of max. 16 m³/h
- 0.5 mbar absolute
- Connection hose made of stainless steel 2000 mm
- Connector KF16
- Manometer (-1/0.6 bar)

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Outer dimensions in mm</th>
<th>Connections on suction side</th>
<th>Connected load</th>
<th>Supply voltage*</th>
<th>Nominal suction power m³/h</th>
<th>Suction capacity m³/h-l</th>
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<tbody>
<tr>
<td>601403057</td>
<td>280 315 200</td>
<td>3/4&quot; 1/2&quot; inner thread</td>
<td>0.55 kW</td>
<td>230 V</td>
<td>16</td>
<td>15</td>
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</tbody>
</table>

*Article no. for other possible supply voltages on request
Gloves

Frontal Protection Coat

- Frontal heat protection
- Open back
- Velcro fastener on the back
- Material Preox-Aramid-Aluminium
- For radiated heat up to 1000 °C, max. 95 sec.
- C3-classification according to EN 11612-C
- Length 1300 mm

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Description</th>
<th>Short-time contact temperature in °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>699000325</td>
<td>Frontal Protection Coat, Size 54 (D), 1300 mm</td>
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</tbody>
</table>

Heat-Resistant Face Mask

- Light design with adjustable hat size
- Plastic window, folds up

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>491041105</td>
<td>Heat-resistant face mask</td>
</tr>
</tbody>
</table>
**Draw Hook**

- For charging protective gas annealing bags with holder, annealing and protective gas boxes
- Large handle, also easy to handle with glove

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Length in mm</th>
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<tbody>
<tr>
<td>631006663</td>
<td>500</td>
</tr>
<tr>
<td>63100693</td>
<td>750</td>
</tr>
<tr>
<td>63100594</td>
<td>1000</td>
</tr>
</tbody>
</table>

**Binding Wire**

- For binding workpieces to allow easy removal from boxes
- Annealed twice and safe from breakage during charging

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Wire Ø in mm</th>
<th>Container</th>
</tr>
</thead>
<tbody>
<tr>
<td>491036090</td>
<td>0.90</td>
<td>25 kg ring</td>
</tr>
<tr>
<td>491036125</td>
<td>1.20</td>
<td>25 kg ring</td>
</tr>
<tr>
<td>491036150</td>
<td>1.60</td>
<td>25 kg ring</td>
</tr>
<tr>
<td>491036200</td>
<td>2.00</td>
<td>25 kg ring</td>
</tr>
<tr>
<td>491036300</td>
<td>3.00</td>
<td>25 kg ring</td>
</tr>
</tbody>
</table>

**Hardening Tongs**

- Various shapes and sizes for different applications and workpiece geometries
- Handle length 600 mm, assuring sufficient distance from hot furnace chamber and for deep immersion length into quench bath

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>491003001</td>
<td>Tongs with flat jaw suitable for hand forming</td>
</tr>
<tr>
<td>491003002</td>
<td>Tongs with vertical mouth for lifting off floor</td>
</tr>
<tr>
<td>491003003</td>
<td>Tongs with bent mouth, universal use</td>
</tr>
<tr>
<td>491003004</td>
<td>Tongs with double-curve jaw, universal use</td>
</tr>
<tr>
<td>491003005</td>
<td>Half round tongs, for round rod materials</td>
</tr>
<tr>
<td>491003008</td>
<td>Knee tongs for larger rings with thick wall</td>
</tr>
<tr>
<td>491003006</td>
<td>Handy universal tongs for small parts (handle length 500 mm)</td>
</tr>
</tbody>
</table>

**Draw Hook**

- For charging protective gas annealing bags with holder, annealing and protective gas boxes
- Large handle, also easy to handle with glove

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<td>25 kg ring</td>
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<tr>
<td>491036150</td>
<td>1.60</td>
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</tr>
<tr>
<td>491036200</td>
<td>2.00</td>
<td>25 kg ring</td>
</tr>
<tr>
<td>491036300</td>
<td>3.00</td>
<td>25 kg ring</td>
</tr>
</tbody>
</table>

**Hardening Tongs**

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- Handle length 600 mm, assuring sufficient distance from hot furnace chamber and for deep immersion length into quench bath

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<td>Knee tongs for larger rings with thick wall</td>
</tr>
<tr>
<td>491003006</td>
<td>Handy universal tongs for small parts (handle length 500 mm)</td>
</tr>
</tbody>
</table>
Cooling Platforms for Models N 17/HR, N 61/H, N 161

Storage platforms are used for forced cooling of mechanical components or annealing boxes outside of the furnace. The platform can also be used for charging the box in front of the furnace.

- Fan with 25 m³/min ambient air

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Designation</th>
<th>Furnace</th>
<th>Connected load kW</th>
<th>Supply voltage*</th>
</tr>
</thead>
<tbody>
<tr>
<td>631000529</td>
<td>up to N 17/HR</td>
<td>550 610 760</td>
<td>0.2</td>
<td>230 V</td>
</tr>
<tr>
<td>631000529</td>
<td>up to N 61/H</td>
<td>335 1100 880 - 920</td>
<td>0.2</td>
<td>230 V</td>
</tr>
<tr>
<td>631000294</td>
<td>up to N 161</td>
<td>700 800 900</td>
<td>0.9</td>
<td>230 V</td>
</tr>
</tbody>
</table>

*Article no. for other possible supply voltages on request

Charging Devices with and without Cooling Fan for Models N 31/H - N 641/13, N 30/45 HA - N 500/85 HA, LH (LF) 15/... - LH (LF) 216/...

Charging Cart CW(K) 1, CW(K) 15 and CW(K) 16

- 4 casters, freely movable
- Equipped with a rack at working height for temporary storage
- Fixing lock for annealing bags (CWK)
- CWK version with cooling fan (0.2 kW, 230 V)

Charging Cart CW 2 - CW 4 and CWK 2 - CWK 4

- 2 casters, 2 fixed rollers for heavy loads
- Equipped with a grid at working height for temporary storage
- Furnace locking via pedal lever
- CWK version with cooling fan (0.9 kW, 230 V)

**Please see page 89 for more information about supply voltage**

*Without holding grip

---

Charging Cart CWK 1

 Cooling Platforms for Models N 17/HR, N 61/H, N 161

Storage platforms are used for forced cooling of mechanical components or annealing boxes outside of the furnace. The platform can also be used for charging the box in front of the furnace.

- Fan with 25 m³/min ambient air

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Designation</th>
<th>Furnace</th>
<th>Connected load kW</th>
<th>Supply voltage*</th>
</tr>
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<tbody>
<tr>
<td>631000529</td>
<td>up to N 17/HR</td>
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<td>up to N 161</td>
<td>700 800 900</td>
<td>0.9</td>
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</tr>
</tbody>
</table>

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Charging Devices with and without Cooling Fan for Models N 31/H - N 641/13, N 30/45 HA - N 500/85 HA, LH (LF) 15/... - LH (LF) 216/...

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- 4 casters, freely movable
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- Fixing lock for annealing bags (CWK)
- CWK version with cooling fan (0.2 kW, 230 V)

Charging Cart CW 2 - CW 4 and CWK 2 - CWK 4

- 2 casters, 2 fixed rollers for heavy loads
- Equipped with a grid at working height for temporary storage
- Furnace locking via pedal lever
- CWK version with cooling fan (0.9 kW, 230 V)

**Please see page 89 for more information about supply voltage**

*Without holding grip
Charging Cart WS 81 and WS 12

For charging of protective gas and annealing boxes.
- 2 casters, 2 fixed rollers for heavy loads
- Parallel guided lift, approx. 20 mm
- Max. charging weight 80 kg
- Guiding track, mounted at the furnace base frame
- Guiding track and charging cart can be also ordered separately

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Designation</th>
<th>Furnace</th>
</tr>
</thead>
<tbody>
<tr>
<td>631000473</td>
<td>WS 81</td>
<td>N 81..</td>
</tr>
<tr>
<td>631000695</td>
<td>WS 12</td>
<td>N 120/..HA</td>
</tr>
</tbody>
</table>

Art.-No. for NA 120/.. on request

Charging Stacker WS 25 - WS 321

- Lifting device with hand winch
- Compact construction with push bar and manual lifting device for easy and safe lifting
- 2 casters, 2 fixed rollers
- Adjustable loading fork width
- Max. charging weight 500 kg
- Guiding track, mounted at the furnace base frame
- Guiding track and forklift can be also ordered separately

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Designation</th>
<th>Furnace</th>
</tr>
</thead>
<tbody>
<tr>
<td>631000425</td>
<td>WS 161</td>
<td>N 161..</td>
</tr>
<tr>
<td>631000370</td>
<td>WS 321</td>
<td>N 321..</td>
</tr>
<tr>
<td>631000299</td>
<td>WS 25</td>
<td>N 250/..HA</td>
</tr>
<tr>
<td>631000532</td>
<td>WS 50</td>
<td>N 500/..HA</td>
</tr>
</tbody>
</table>

Art.-No. for NA 250/.. and NA 500/.. on request

WS 641 Charging Stacker

Design as charging stacker WS 25 - WS 321, but
- Lifting device with manual hydraulic
- Max. charging weight 700 kg

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Designation</th>
<th>Furnace</th>
</tr>
</thead>
<tbody>
<tr>
<td>631000426</td>
<td>WS 641</td>
<td>N 641..</td>
</tr>
</tbody>
</table>

Charging stacker WS 641 with chamber furnace N 641 and guiding track at the base frame
Baths for quenching in oil or water as well as for cleaning and degreasing are available as single or double baths and are made of stainless steel. Oil quench bath assure highly even cooling of workpieces and are equipped with a lid to immediately extinguish ignited oil. For optimal results, pre-tempering water baths for cleaning workpieces should have an appropriate degreasing additive mixed in to the water bath. An optional heating allows for a bath temperature of approx. 70 °C. All baths come with a charge carrier, supply and drain line.

### Quenching and Cleaning Baths

**Quenching bath Q 200 for quenching in oil or water**

**Quenching bath Q 400 D with manual charging aid**

**Oil cooler as additional equipment**

---

**The oil and water quench baths are combined within a single housing and separated by a sheet metal wall in the Q 200 D, Q 400 D and Q 600 D combination baths. The oil quench bath is slightly preheated by the heated water bath. A splash pan is installed in front of the combination bath. Charging aids are available as additional equipment. The Q 200 D combination bath comes with a charge carrier, for models Q 400 D and Q 600 D must be ordered extra. For greater quenchant performance, the baths can be equipped with oil coolers.**

---

### Article no. Bath Outer dimensions in mm Volume Quenchant performance in kg/h max. load weight in kg

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Bath</th>
<th>Outer dimensions in mm</th>
<th>Volume in l</th>
<th>Quenchant performance in kg/h</th>
<th>max. load weight in kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>101300050</td>
<td>Q 50</td>
<td>350 350 700</td>
<td>50</td>
<td>5 - 10</td>
<td>20</td>
</tr>
<tr>
<td>101300040</td>
<td>Q 200</td>
<td>550 550 900</td>
<td>200</td>
<td>25 - 30</td>
<td>20</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Heating element (optional)</th>
<th>Connected load kW</th>
<th>Supply voltage*</th>
</tr>
</thead>
<tbody>
<tr>
<td>631001014</td>
<td>Q 50</td>
<td>3</td>
<td>230 V</td>
</tr>
<tr>
<td>631001012</td>
<td>Q 200</td>
<td>6</td>
<td>400 V</td>
</tr>
</tbody>
</table>

*Article no. for other possible supply voltages on request

**Quenching bath Q 200 D with manual charging aid**

**Quenching bath Q 400 D with manual charging aid**

**Oil cooler as additional equipment**

---

**Oil cooler**

<table>
<thead>
<tr>
<th>Oil cooler</th>
<th>max. quenchant performance in kg/h</th>
<th>Connected load kW</th>
<th>Electrical connection¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q 200 D</td>
<td>approx. 100</td>
<td>0.55</td>
<td>3-phase</td>
</tr>
<tr>
<td>Q 400 D</td>
<td>approx. 200</td>
<td>2.20</td>
<td>3-phase</td>
</tr>
<tr>
<td>Q 600 D</td>
<td>approx. 300</td>
<td>2.20</td>
<td>3-phase</td>
</tr>
</tbody>
</table>

¹Please see page 89 for more information about supply voltage

---

**Heating element**

<table>
<thead>
<tr>
<th>Heating element</th>
<th>Connected load kW</th>
<th>Supply voltage*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q 200 D</td>
<td>6</td>
<td>400 V</td>
</tr>
<tr>
<td>Q 400 D</td>
<td>9</td>
<td>400 V</td>
</tr>
<tr>
<td>Q 600 D</td>
<td>15</td>
<td>400 V</td>
</tr>
</tbody>
</table>

*Other supply voltages possible on request
Quench Tanks

Subject to process, charge size and weight a customized quench bath will be designed and delivered. Standard sizes are also available. Water, oil or polymer are available as quenching medium.

Available quenching mediums:
- Water
- Oil
- Polymer

Design Specifications
- Powerful circulation of the quenching medium
- Controlled heating systems
- Lowering devices for the charge
- Fill-level control
- Automatic refill system in case of water as quenching medium
- Connection port for customer’s cooling system
- Cooling system of the quenching medium via heat exchanger
- Oil separator for quench tanks with water
- Protective gas supply on the surface of oil quench tanks as fire protection
- Integration of bath temperature in the process control and documentation

Oil quenching bath OAB 67000 with heat exchanger and a volume of 67.000 liters oil

Combined oil quenching and cleaning bath with immersable tables, protection cover, oil separator and exhaust system

Oil separator for quench tanks with water

Powerful circulation of quenching medium
Hardening Oil

- Suitable for most tooling steels
- Thermo-chemically stable and low misting
- Unlimited service life under normal use
- For mild quenching in critical martensite range
- Durixol W 25 w, can be cleaned using water

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Description</th>
<th>Container</th>
</tr>
</thead>
<tbody>
<tr>
<td>491000140</td>
<td>Durixol W 25</td>
<td>50 l barrel</td>
</tr>
<tr>
<td>491000161</td>
<td>Durixol W 25</td>
<td>200 l barrel</td>
</tr>
<tr>
<td>491000240</td>
<td>Durixol W 25 w</td>
<td>50 l barrel</td>
</tr>
</tbody>
</table>

Quench Water Additive

- For even and rapid water hardening
- For water temperatures to 70°C, thus reducing risk of cracks and deformation

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Description</th>
<th>Container</th>
</tr>
</thead>
<tbody>
<tr>
<td>491050200</td>
<td>Hydrodur GF</td>
<td>50 kg sack</td>
</tr>
</tbody>
</table>

Detergent

- Cleaning additives increase the water time of the water and reduce costs
- Minimizes oil traces on workpieces and fumes during tempering

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Description</th>
<th>Container</th>
</tr>
</thead>
<tbody>
<tr>
<td>493000016</td>
<td>Feroclean N-SF</td>
<td>10 kg canister</td>
</tr>
<tr>
<td>493000014</td>
<td>Feroclean N-SF</td>
<td>30 kg canister</td>
</tr>
<tr>
<td>493000017</td>
<td>Feroclean N-SF</td>
<td>50 kg barrel</td>
</tr>
</tbody>
</table>

Insulating Materials

- Formable ceramic-based paste to seal annealing boxes
- Also suitable for covering workpiece parts not requiring hardening

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Description</th>
<th>Container</th>
</tr>
</thead>
<tbody>
<tr>
<td>491000120</td>
<td>Lemit heat-resistant putty</td>
<td>19 kg</td>
</tr>
</tbody>
</table>
Tailor-Made Furnace Plants

Various furnace families can be upgraded with protective gas boxes for processes under non-flammable protection or reaction gases.

Forced convection bogie hearth furnace W 5290/85 AS with annealing box for heat treatment of coils under protective gas

Top hat furnace plant with three exchangeable tables and protective gas boxes for heat treatment with non-flammable protective or reaction gases

Air circulation chamber furnace N 250/65 HA IDB with protective gas box for inert debinding under protective gases incl thermal post combustion (TNV). Please also see catalog Advanced Materials.
Temperature Uniformity and System Accuracy

Temperature uniformity is defined as the maximum temperature deviation in the work space of the furnace. There is a general difference between the furnace chamber and the work space. The furnace chamber is the total volume available in the furnace. The work space is smaller than the furnace chamber and describes the volume which can be used for charging.

**Specification of Temperature Uniformity in +/- K in the Standard Furnace**

In the standard design the temperature uniformity is specified in +/- K at a defined set-temperature with the work space of the empty furnace during the dwell time. In order to make a temperature uniformity survey the furnace should be calibrated accordingly. As standard our furnaces are not calibrated upon delivery.

**Calibration of the Temperature Uniformity in +/- K**

If an absolute temperature uniformity at a reference temperature or at a defined reference temperature range is required, the furnace must be calibrated appropriately. If, for example, a temperature uniformity of +/- 5 K at a set temperature of 750 °C is required, it means that measured temperatures may range from a minimum of 745 °C to a maximum of 755 °C in the work space.

**System Accuracy**

Tolerances may occur not only in the work space, they also exist with respect to the thermocouple and in the controls. If an absolute temperature uniformity in +/- K at a defined set temperature or within a defined reference working temperature range is required, the following measures have to be taken:

- Measurement of total temperature deviation of the measurement line from the controls to the thermocouple
- Measurement of temperature uniformity within the work space at the reference temperature or within the reference temperature range
- If necessary, an offset is set at the controls to adjust the displayed temperature at the controller to the real temperature in the furnace
- Documentation of the measurement results in a protocol

**Temperature Uniformity in the Work Space incl. Protocol**

In standard furnaces a temperature uniformity is guaranteed as +/- K without measurement of temperature uniformity. However, as additional feature, a temperature uniformity measurement at a reference temperature in the work space compliant with DIN 17052-1 can be ordered. Depending on the furnace model, a holding frame which is equivalent in size to the charge space is inserted into the furnace. This frame holds thermocouples at defined measurement positions (11 thermocouples with square cross-section, 9 thermocouple with circular cross-section). The temperature uniformity measurements are performed at a reference temperature specified by the customer at a pre-defined dwell time. If necessary, different reference temperatures or a defined reference working temperature range can also be calibrated.
Standards such as the AMS 2750 E (Aerospace Material Specifications) are applicable for the industrial processing of high-quality materials. They define industry-specific requirements for heat treatment. Today, the AMS 2750 E and derivative standards such as AMS 2770 for the heat treatment of aluminum are the guidelines for the aerospace industry. After the introduction of the CQI-9, the automotive industry has also committed to submit heat treatment processes to stricter rules. These standards describe in detail the requirements applicable to thermal processing plants.

- Temperature uniformity in the work space (TUS)
- Instrumentation (definition of measurement and control systems)
- Calibration of the measurement system (IT) from the controller via the measurement line to the thermocouple.
- Inspections of system accuracy (SAT)
- Documentation of the inspection cycles

Norm compliance is necessary to ensure that the required quality standard of the manufactured components can also be reproduced in series. For this reason, extensive and repeated inspections as well as controls of the instrumentation, including the relevant documentation, are required.

**Furnace Class and Instrumentation Requirements of the AMS 2750 E**

Depending on the quality requirements of heat treatment job the customer specifies instrumentation type and the temperature uniformity class. The instrumentation type describes the necessary combination of the applied control, recording media as well as thermocouples. The temperature uniformity of the furnace and the class of the selected instrumentation are defined based on the required furnace class. The higher the requirements are set for the furnace class the more precise the instrumentation must be.

### Instrumentation

<table>
<thead>
<tr>
<th>Type</th>
<th>Furnace class</th>
<th>Temperature uniformity</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Each control zone has a thermocouple connected to the controller x x x x x 1 +/- 3 +/- 5

Recording of the temperature measured by the control thermocouple x x x x 2 +/- 6 +/- 10

Sensors for recording the coldest and hottest spots x x 3 +/- 8 +/- 15

Each control zone has a charge thermocouple with recording system x x 4 +/- 10 +/- 20

Each control zone has an over-temperature protection unit x x x x x 5 +/- 14 +/- 25

6 +/- 24 +/- 50

### Regular Inspections

The furnace or the heat treatment plant must be designed so that the requirements of the AMS 2750 E can be met and be reproduced. The standard also requires the inspection intervals for the instrumentation (SAT = System Accuracy Test) and the temperature uniformity of the furnace (TUS = Temperature Uniformity Survey). The SAT/TUS tests must be performed by the customer with measuring devices and sensors which operate independently of the furnace instrumentation.

### Nabertherm Services

The suitable furnace model for the corresponding heat treatment can be designed based on the process, the charge, the required furnace class and the type of instrumentation. Depending on the required specs, alternative solutions can be offered.

- Furnace designs, which meet standards, following customer specifications regarding furnace class and instrumentation, incl. gauge connections for repeated customer inspections at regular intervals. No consideration of requirements with respect to documentation
- Data recording devices (e.g., temperature recorder) for TUS and/or SAT measurements see page 90
- Data recording, visualization, time management via the Nabertherm Control Center (NCC), based on Siemens WinCC software see page 88
- Commissioning at site, incl. the first TUS and SAT inspection
- Connection of existing furnace plant to meet norm requirements
- Documentation of the complete process chain in line with the corresponding norm
Implementation of AMS 2750 E

Basically, two different systems are available for control and documentation, a proven Nabertherm system solution or instrumentation using Eurotherm controllers/temperature recorders. The Nabertherm AMS package is a convenient solution that includes the Nabertherm Control Center for control, visualization, and documentation of the processes and test requirements based on PLC control.

Instrumentation with Nabertherm Control Center (NCC) for Control, Visualization, and Documentation based on a Siemens PLC Controls

The attractive feature of the instrumentation with Nabertherm Control Center in combination with PLC controls of the furnace is the convenient data input and visualization. The software programming is structured in a way that both the user and the auditor can navigate it without difficulty.

In daily use, the following product characteristics stand out:

- Very easy to navigate and straightforward presentation of all the data in plain text on the PC
- Automatic saving of the charge documentation at the end of the program
- Administration of the calibration cycles in the NCC
- Results of the measurement distance calibration are entered in the NCC
- Schedule management of the required testing cycles including a reminder function. The testing cycles for TUS (Temperature Uniformity Survey) and SAT (System Accuracy Test) are entered in days and monitored by the system and the operator or tester is informed in time about upcoming tests. The values of the tests are entered directly into NCC and saved as PDF files on the PC. There are no additional tasks involved in documenting the tests.
- Option of transferring the measurement data to a customer’s server

Example of a design with Type A Nabertherm Control Center
The Nabertherm Control Center can be extended to enable a complete documentation of the heat treatment process apart from just the furnace data. For example, when heat-treating aluminum, in addition to the furnace, the temperatures in the quenching basin or a separate cooling medium can also be documented.

**Example of a design containing Type D Eurotherm instrumentation**

**Alternative Instrumentation with Temperature Controllers and Recorders from Eurotherm**

As an alternative to instrumentation with the Nabertherm Control Center (NCC) and PLC controls, instrumentation with controllers and temperature recorders is also available. The temperature recorder has a log function that must be configured manually. The data can be saved to a USB stick and be evaluated, formatted, and printed on a separate PC. Besides the temperature recorder, which is integrated into the standard instrumentation, a separate recorder for the TUS measurements is needed (see page 88).

**Furnace Chamber Control**

Only the furnace chamber temperature is measured and controlled. Regulation is carried out slowly to avoid out-of-range values. As the charge temperature is not measured and controlled, it may vary a few degrees from the chamber temperature.

**Charge Control**

If the charge control is switched on, both the charge temperature and furnace chamber temperature are measured. By setting different parameters the heat-up and cooling processes can be individually adapted. This results in a more precise temperature control at the charge.
Nabertherm has many years of experience in the design and construction of both standard and custom control alternatives. All controls are remarkable for their ease of use and even in the basic version have a wide variety of functions.

Standard Controllers
Our extensive line of standard controllers satisfies most customer requirements. Based on the specific furnace model, the controller regulates the furnace temperature reliably and is equipped with an integrated USB-interface for documentation of process data (NTLog/NTGraph).

The standard controllers are developed and fabricated within the Nabertherm group. When developing controllers, our focus is on ease of use. The user can choose between 17 languages. From a technical standpoint, these devices are custom-fit for each furnace model or the associated application. From the simple controller with an adjustable temperature to the control unit with freely configurable control parameters, stored programs and PID microprocessor control with self-diagnosis system, we have a solution to meet your requirements.

HiProSystems Control and Documentation
This professional process control with PLC controls for single and multi-zone furnaces is based on Siemens hardware and can be adapted and upgraded extensively. HiProSystems control is used when more than two process-dependent functions, such as exhaust air flaps, cooling fans, automatic movements, etc., have to be handled during a cycle, when furnaces with more than one zone have to be controlled, when special documentation of each batch is required and when remote service is required. It is flexible and is easily tailored to your process or documentation needs.

Alternative User Interfaces for HiProSystems
Process control H500/H700
This basic panel accommodates most basic needs and is very easy to use. Firing cycle data and the extra functions activated are clearly displayed in a table. Messages appear as text. Data can be stored on a USB stick using the „NTLog Comfort“ option (not available for all H700).

Process control H1700
Customized versions can be realized in addition to the scope of services of the H500/H700

Process control H3700
Display of functions on a large 12“ display. Display of basic data as online trend or as a graphical system overview. Scope as H1700

Control, Visualisation and Documentation with Nabertherm Control Center NCC
Upgrading the HiProSystems-Control individually into a PC-based NCC provides for additional interfaces, operating documentation, and service benefits in particular for controlling furnace groups including charge beyond the furnace itself (quenching tank, cooling station etc.):

- Recommended for heat treatment processes with extensive requirements in respect to documentation e.g. for metals, technical ceramics or in the medicine field
- Software extension can be used also in accordance with the AMS 2750 E (NADCAP)
- Documentation according to the requirements of Food and Drug Administration (FDA), Part 11, EGV 1642/03 possible
- Charge data can be read in via barcodes
- Interface for connection to overriding systems
- Connection to mobile phone or stationary network for malfunction message transmission via SMS
- Control from various locations over the network
- Measurement range calibration up to 18 temperatures per measuring point for use at different temperatures. For norm-relevant applications a multilevel calibration is possible.
Mains Voltages for Nabertherm Furnaces

1-phase: all furnaces are available for mains voltages from 110 V - 240 V at 50 or 60 Hz.

3-phase: all furnaces are available for mains voltages from 200 V - 240 V or 380 V - 480 V, at 50 or 60 Hz.

The connecting rates in the catalog refer to the standard furnace with 400 V (3/N/PE) respectively 230 V (1/N/PE).
**Data storing of Nabertherm controllers with NTLog Basic**

NTLog Basic allows for recording of process data of the connected Nabertherm controller (B400, B410, C440, C450, P470, P480) on a USB stick.

The process documentation with NTLog Basic requires no additional thermocouples or sensors. Only data recorded which are available in the controller.

The data stored on the USB stick (up to 80,000 data records, format CSV) can afterwards be evaluated on the PC either via NTGraph or a spreadsheet software used by the customer (e.g. MS Excel).

For protection against accidental data manipulation the generated data records contain checksums.

**Data storing of HiProSystems with NTLog Comfort**

The extension module NTLog Comfort offers the same functionality of NTLog Basic module. Process data from a HiProSystems control are read out and stored in real time on a USB stick (not available for all H700 systems). The extension module NTLog Comfort can also be connected using an Ethernet connection to a computer in the same local network so that data can be written directly onto this computer.

**Software NTEdit for Entering Programs on the PC**

Entering programs is simplified considerably by using the software NTEdit (Freeware). The program can be entered on the PC and then be imported into the controller with a USB stick. The display is tabular or graphical. The program import in NTEdit is also possible. With NTEdit Nabertherm provides a user-friendly free tool. A prerequisite for the use is the client installation of MS-Excel for Windows (2007/2010/2013). NTEdit is available in German and English.

**Visualization with NTGraph**

The process data from NTLog can be visualized either using the customer’s own spreadsheet program (e.g. MS-Excel) or NTGraph (Freeware). With NTGraph Nabertherm provides an additional user-friendly tool free of charge for the visualization of the data generated by NTLog. Prerequisite for its use is the installation of the program MS-Excel for Windows (version 2003/2010/2013). After data import presentation as diagram, table or report can be chosen. The design (color, scaling, reference labels) can be adapted by using prepared sets.

NTGraph is available in seven languages (DE/EN/FR/SP/IT/CH/RO). In addition, selected texts can be generated in other languages.
VCD-Software for Visualization, Control and Documentation

Documentation and reproducibility are more and more important for quality assurance. The powerful VCD software represents an optimal solution for single multi furnace systems as well as charg documentation on the basis of Nabertherm controllers.

The VCD software is used to record process data from the controllers B400/B410, C440/C450 and P470/P480. Up to 400 different heat treatment programs can be stored. The controllers are started and stopped via the software. The process is documented and archived accordingly. The data display can be carried-out in a diagram or as data table. Even a transfer of process data to MS Excel (.csv format *) or the generation of reports in PDF format is possible.

Features
- Available for controllers B400/B410/C440/C450/P470/P480
- Suitable for operating systems Microsoft Windows 7 or 8/8.1 or 10 (32/64 Bit)
- Simple installation
- Setting, Archiving and print of programs and graphics
- Operation of controllers via PC
- Archiving of process curves from up to 16 furnaces (also multi-zone controlled)
- Redundant saving of archives on a server drive
- Higher security level due to binary data storage
- Free input of charge date with comfortable search function
- Possibility to evaluate data, files can be converted to Excel
- Generation of a PDF-report
- 17 languages selectable

Extension package 1 for display of an additional temperature measuring point, independant of the furnace controls
- Connection of an independant thermocouple, type S, N or K with temperature display on controller C6D, e. g. for documentation of charge temperature
- Conversion and transmission of measured values to the VCD software
- For data evaluation, please see VCD-software features
- Display of measured temperature directly on the extension package

Extension package 2 for the connection of up to three, six or nine measuring point, independant of the furnace controls
- Connection of three thermocouples, type K, S, N or B to the included connecting box
- Possible extension of up to two or three connecting boxes with up to nine measuring points
- Conversion and transmission of measured values to the VCD software
- Data evaluation, see VCD features
The whole World of Nabertherm: www.nabertherm.com

Please visit our website www.nabertherm.com and find out all you want to know about us - and especially about our products.

Besides news and our current calendar of trade fairs, there is also the opportunity to get in touch directly with your local sales office or nearest dealer worldwide.

Professional Solutions for:
- Arts & Crafts
- Glass
- Advanced Materials
- Laboratory
- Dental
- Thermal Process Technology for Metals, Plastics and Surface Finishing
- Foundry

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