Additive Manufacturing

Heat Treatment of Additive Manufactured Parts

Retort Furnaces
Chamber Furnaces
Forced Convection Furnaces
Annealing Furnaces
Protective Gas Boxes
Furnaces for Debinding
Sintering Furnaces
High-Temperature Furnaces
Ovens
Chamber Ovens

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 departments 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 partners in all important world markets ensure individual on-site customer service and consultation. There are certainly reference customers who are using similar furnaces or systems close to you.

Large Customer Test Center
What 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 additive manufacturing, 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 you individual needs without expensive modifications.
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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 are 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.

Apart from the choice of the right model and process parameters the previous processes before the heat treatment also have an influence on the overall result. One important criteria for a good surface quality is that the components are cleaned properly before the heat treatment.

This is particularly important for the processes that are carried out under vacuum or in furnaces that have a high requirement for a low residual oxygen content. Minor leaks or contamination can lead to insufficient results. For this reason, regular cleaning and maintenance of the furnace is important.

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.

<table>
<thead>
<tr>
<th>Metals</th>
<th>Ceramics, Glass, Composites, Sand</th>
<th>Plastics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debinding</td>
<td>Debinding</td>
<td>Curing</td>
</tr>
<tr>
<td>Sintering</td>
<td>Sintering</td>
<td>Tempering</td>
</tr>
<tr>
<td>Stress-relieving</td>
<td>Stress-relieving</td>
<td>Tempering</td>
</tr>
<tr>
<td>Solution annealing</td>
<td>Solution annealing</td>
<td>Drying</td>
</tr>
<tr>
<td>Hardening</td>
<td>Hardening</td>
<td>Drying</td>
</tr>
</tbody>
</table>

under Protective Gases, Reaction Gases or in Vacuum in Air in Air

<table>
<thead>
<tr>
<th>Chamber furnaces with protective gas boxes</th>
<th>Debinding in ashing furnace</th>
<th>Ovens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot-wall retort furnaces</td>
<td>Debinding in chamber furnaces with air circulation</td>
<td>Chamber dryers</td>
</tr>
<tr>
<td>Cold-wall retort furnaces</td>
<td>Sintering in chamber furnaces</td>
<td>Forced convection chamber furnaces</td>
</tr>
<tr>
<td></td>
<td>Debinding and Sintering in combi furnaces</td>
<td>See als concepts for drying, debinding, thermal cleaning and wax burnout in catalog Advanced Materials as well as catalog Thermal Process Technology I</td>
</tr>
<tr>
<td></td>
<td>Dewaxing Furnaces</td>
<td></td>
</tr>
</tbody>
</table>

See also concepts for drying, debinding, thermal cleaning and wax burnout in catalog Advanced Materials as well as catalog Thermal Process Technology I.
Binder-Free Systems

In binder-free additive manufacturing, in most cases, the components are produced with the powder-based laser melting process on a printing platform. In the meantime, other manufacturing processes have also become established on the market, which likewise require a corresponding heat treatment after the production 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 42 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 or steel components can also be heat treated in air.

<table>
<thead>
<tr>
<th>Platform sizes</th>
<th>Forced convection chamber furnaces, see page 42 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>

The models listed in the table above are just a few examples.
Inconel or Cobalt-Chromium Components

Materials such as Inconel and cobalt-chromium are generally heat treated at temperatures from 850 °C up to between 1,100 °C and 1,150 °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 1,100 °C.

Examples for Chamber furnaces see page 30 and 34

<table>
<thead>
<tr>
<th>Platform sizes</th>
<th>Chamber furnaces see page 30 and 34 up to 1,100 °C with protective gas box</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 x 100 mm</td>
<td>LH 30/12</td>
</tr>
<tr>
<td>250 x 250 mm</td>
<td>LH 120/12</td>
</tr>
<tr>
<td>400 x 400 mm</td>
<td>LH 216/12</td>
</tr>
<tr>
<td>420 x 520 mm</td>
<td>NW 440</td>
</tr>
<tr>
<td>400 x 800 mm</td>
<td>NW 660</td>
</tr>
</tbody>
</table>
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.

On pages 10 and 11 the different concepts are presented in a decision matrix and explained on the following pages.

<table>
<thead>
<tr>
<th>Printing dimensions up to (w x d x h)</th>
<th>Debinding furnaces(^1)</th>
<th>Sintering furnaces(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>see catalog Advanced Materials</td>
<td>see catalog Advanced Materials</td>
</tr>
<tr>
<td>100 x 100 x 100 mm</td>
<td>L 9/11 BO</td>
<td>LHT 4/16</td>
</tr>
<tr>
<td>200 x 200 x 150 mm</td>
<td>L 9/11 BO</td>
<td>HT 40/16</td>
</tr>
<tr>
<td>300 x 400 x 150 mm</td>
<td>L 40/11 BO</td>
<td>HT 64/17</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 (H\(_2\)), 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.

<table>
<thead>
<tr>
<th>Printing dimensions up to (w x d x h)</th>
<th>Hot-wall retort furnaces(^1)</th>
<th>Cold-wall retort furnaces(^2,3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>see page 14</td>
<td>see page 22</td>
</tr>
<tr>
<td>100 x 180 x 120 mm</td>
<td>NRA 17/..</td>
<td>VHT 8/..</td>
</tr>
<tr>
<td>180 x 320 x 170 mm</td>
<td>NRA 17/..</td>
<td>VHT 25/..</td>
</tr>
<tr>
<td>230 x 400 x 220 mm</td>
<td>NRA 50/..</td>
<td>VHT 40/..</td>
</tr>
<tr>
<td>300 x 450 x 300 mm</td>
<td>NRA 50/..</td>
<td>VHT 70/..</td>
</tr>
<tr>
<td>400 x 480 x 400 mm</td>
<td>NRA 150/..</td>
<td>VHT 100/..</td>
</tr>
</tbody>
</table>

\(^1\)Safety systems see page 16 and 19, max. oven chamber temperatures see page 14

\(^2\)Available with different heater materials and for different max. temperatures

\(^3\)With inner process chamber for the residual debinding
Which Furnace for Which Process?

The next two double pages give an overview of which furnaces can be used in additive manufacturing for which process. This double page describes furnaces which can be used for processes in which no combustible substances escape.

<table>
<thead>
<tr>
<th>Atmosphere</th>
<th>Air</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maximum Temperature</strong></td>
<td>300 °C</td>
</tr>
<tr>
<td><strong>Requirement Oxygen Content</strong></td>
<td>21 %</td>
</tr>
<tr>
<td><strong>Vacuum</strong></td>
<td>-</td>
</tr>
<tr>
<td><strong>Flammable Process Gas</strong></td>
<td>-</td>
</tr>
<tr>
<td><strong>Furnace Heating</strong></td>
<td>Electric</td>
</tr>
</tbody>
</table>

Chamber oven KTR 2000 for curing after 3D-printing
Chamber furnace LH 60/12 with protective gas box for heat treatment in a protective gas atmosphere
Forced convection chamber furnace NA 250/45 for heat treatment in air
### Process Gas

<table>
<thead>
<tr>
<th>Temperature</th>
<th>1100 °C</th>
<th>1150 °C</th>
<th>2400 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>0,01 %</td>
<td>0,00 %</td>
<td>0,00 %</td>
</tr>
<tr>
<td>Vacuum</td>
<td>-</td>
<td>-</td>
<td>≤ 10⁻⁵ mbar</td>
</tr>
</tbody>
</table>

*With protective gas box*
- LH, page 30
- NW, page 34
- N, page 36
- NA*, page 42
- SAL*, page 48

### Vacuum

<table>
<thead>
<tr>
<th>Temperature</th>
<th>≤ 600 °C</th>
<th>≥ 600 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>0,00 %</td>
<td>0,00 %</td>
</tr>
<tr>
<td>Vacuum</td>
<td>≤ 10⁻⁵ mbar</td>
<td>≤ 10⁻⁵ mbar</td>
</tr>
</tbody>
</table>

*With protective gas box*
- NR(A), page 14
- SR(A), page 21
- LBR(A), page 20

### Electric

- VHT, page 22
- LBVHT, page 27

### Notes
- *Tmax 850 °C

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**SAL 250/65**

Cold-wall retort furnace VHT 100/12-MO for processes in high vacuum

Semi-automatic annealing plant with retort furnace NR 50/11 and water quenching bath on rails
Concepts for Drying, Debinding and Sintering of Parts with Binder Content

1) Air
2) Protective gas

Process

Drying Solvents

Atmosphere

Air

Maximum Temperature for Debinding

300 °C

450 °C

450 °C

600 °C

Organic Quantity

Low requirement for temperature uniformity

Increased requirement for temperature uniformity

Increased requirement for temperature uniformity

Low requirement for temperature uniformity

Requirement

Low requirement for temperature uniformity

Increased requirement for temperature uniformity

Increased requirement for temperature uniformity

Low requirement for temperature uniformity

Concept

LS

LS

DB10

BO

Acc. to EN 1539 Type A (NFPA 86 Class A). Monitored air exchange. Active venting of the exhaust gas via integrated exhaust gas fan. Uncontrolled furnace underpressure.

Debinding process with control difficulties of heating ramp (exothermic reaction).

Furnace Type

For Debinding

KTR, page 62

NA .. LS, page 42

NA .. 45 DB10, page 42

L .. BO, page 56

HT .. DB, page 58

For Debinding and/or Sintering

Furnace Heating

Electric

Gas

Post-Treatment of Exhaust Gases

Integrated thermal afterburning/catalytic afterburning

1) Air

2) Protective gas
<table>
<thead>
<tr>
<th>Debinding</th>
<th>Inert</th>
<th>Reaction gas</th>
<th>Catalytic</th>
</tr>
</thead>
<tbody>
<tr>
<td>650 °C</td>
<td>650 °C</td>
<td>600 °C</td>
<td>120 °C</td>
</tr>
<tr>
<td>Organic quantity low to high</td>
<td>Organic quantity low to high</td>
<td>Organic quantity low to high</td>
<td>Organic quantity low to high</td>
</tr>
<tr>
<td>Increased requirement for temperature uniformity</td>
<td>Low residual oxygen concentration</td>
<td>No residual oxygen concentration</td>
<td>High requirement for temperature uniformity</td>
</tr>
<tr>
<td>IDB</td>
<td>IDB</td>
<td>H₂</td>
<td>CDB</td>
</tr>
<tr>
<td>HT .. DB100, page 58</td>
<td>NA .. IDB, page 42 N .. HA IDB, page 42</td>
<td>NRA .. IDB, page 16 SRA .. IDB, page 21</td>
<td>NRA .. CDB, page 19</td>
</tr>
<tr>
<td>Separate catalytic afterburning system Separate thermal afterburning system</td>
<td>Thermal afterburning</td>
<td>Thermal afterburning</td>
<td>Flare</td>
</tr>
<tr>
<td>VHT .. IDB, page 22</td>
<td>VHT .. IDB, page 22</td>
<td>VHT .. H₂, page 22</td>
<td>VHT .. H₂, page 22</td>
</tr>
</tbody>
</table>

**Electric**

- Furnace in overpressure.
- Monitored air exchange.
- Pre heated fresh air.
- Separate catalytic afterburning system Separate thermal afterburning system.

**Inert**

- Thermal debinding in inert atmosphere. Monitored safe inert gas purging.

**Reaction gas**

- Thermal debinding or pyrolysis in an inert atmosphere Safe monitored inert gas purging.

**Catalytic**

- Catalytic debinding in nitrogen/nitric acid atmosphere. Monitored safe Nitrogen purging to displace the oxygen.
During debinding e.g. from technical ceramics, hydrocarbons are released, which might generate an ignitable mixture depending on their concentration in the furnace chamber. Nabertherm offers tailor-made passive and active safety packages depending on the process and the amount of binder, which enable safe operation of the furnace.

I. Debinding in Air

Debinding in an Electrically Heated Furnace
For debinding in air with electric heating Nabertherm offers various debinding packages tailored to the individual process requirements. All debinding packages have professional integrated safety technology. Passive or active safety concepts are available, depending on the specific requirements. The passive safety concepts differ upon the requirements for the quantity of organic materials, process reliability, and temperature distribution.

Passive Safety Concept
Nabertherm debinding furnaces are generally equipped with a passive safety concept to allow for a slow vaporization of flammable substances. The electrically heated furnaces work according to the dilution principle by introducing fresh air to reduce the degassing from the charge to a non-ignitable atmosphere in the furnace. The customer has to define the quantity of organic materials as well as the temperature curve, to make sure that the maximum permissible rate of vaporization is not exceeded. Thus, the customer is responsible for the function of the safety concept. The furnace DB safety package monitors all safety-relevant process parameters and initiates a respective emergency program in case of a malfunction. The passive safety concept has proven itself in practice based to its good price performance ratio. Depending on the process requirements, the following equipment packages are available.

DB10 Debinding Package for Air Circulation Furnaces (Convection Heating) up to 450 °C
The DB10 debinding package is the basic option for safe debinding in air circulation furnaces up to 450 °C. The furnace is equipped with an exhaust gas fan providing for a defined volume of air which is extracted from the furnace, thus allowing the volume of fresh air required for the debinding process to enter the furnace. The furnace is operated with negative pressure, which prevents an undefined emission of vaporization products.

Debinding Package for Laboratory Furnaces
The ashing furnaces have a passive safety system and integrated exhaust gas post combustion. An exhaust gas fan extracts flue gases from the furnace and simultaneously supplies fresh air to the furnace atmosphere with the result that sufficient oxygen is always available for the incineration process. The incoming air is guided behind the furnace heating and preheated to ensure good temperature uniformity. Exhaust gases are led from the furnace chamber to the integrated post combustion system, where they are postburned and catalytically cleaned. Directly after the incineration process (up to max. 600 °C) a subsequent process up to max. 1100 °C can take place.
II. Safety Concept EN 1539 (NFPA 86) to Dry Liquid Solvents in Ovens

The safety technology of furnaces and dryers used for processes in which solvents or other flammable substances are released and vaporized relatively quickly is regulated throughout Europe in EN 1539 (or NFPA 86 in the USA)

Typical applications are drying of mold varnish, surface coatings, and impregnating resins. Users include the chemical industry as well as many other areas, such as the automotive, electric, plastic processing and metalworking industries.

The safety concept relates to preventing the formation of explosive mixtures through continuous air exchange in the entire vapor space.

III. Debinding or Pyrolysis under Non-Flammable or Flammable Protective or Reaction Gases

IDB Safety Concept for Debinding in Protective Gas Boxes under Non-Flammable Protective Gases with Low Residual Oxygen
The IDB safety concept with an inert atmosphere in protective gas boxes is ideal for debinding processes under protective gas where a small amount of residual oxygen for the materials is permitted. The furnace technology in combination with a protective gas box made from heat-resistant stainless steel has a very good price performance ratio.

A monitored inert gas pre-flushing and conservation flushing during the process ensure that a residual oxygen concentration of 3 % is not exceeded in the protective gas box. The customer must check this limit value with regular measurements.

IDB Safety Concept in Retort Furnaces for Debinding under Non-Flammable Protective Gases or for Pyrolysis Processes
The retort furnaces in the NR(A) and SR(A) series are ideal for debinding under non-flammable protective gases or for pyrolysis processes. With the IDB option, the furnace chamber is flushed with protective gases. Exhaust gases are incinerated in an exhaust gas torch. The flushing and the torch function are monitored to ensure safe operation.

Safety Concept for Heat Treatment under Flammable Process Gases
If flammable process gases, such as hydrogen, are used, the retort furnace is also equipped and delivered with the required safety technology. Only components with the corresponding certification are used as safety-relevant sensors. The furnace is controlled by a failsafe PLC control system (S7300/safety control).

CDB Safety Package for Catalytic Debinding with Nitric Acid
The safety concept prevents explosive gas mixture forming when the furnace is operated with nitric acid. For this purpose, the gastight retort is automatically flushed with a controlled flow of nitrogen which displaces the atmospheric oxygen before nitric acid is introduced. During debinding, the monitored mixing ratio between the nitrogen and acid prevents an excess acid dosis and, or consequently, the formation of an explosive atmosphere.
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.

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 68
- 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 900 °C**
Design like models NRA ../06 with following differences:
- Outside heating with heating elements around the retort
- Retort made of 1.4828
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2

**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 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 900 °C- and 1100 °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 single-stage rotary vane pump
- 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 72

Additional equipment
- Upgrade for other non-flammable gases, H₂ version for flammable gases see page 16
- 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 and furnace type
- Indirect cooling see page 29
- Direct cooling see page 29
- 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 1150 °C
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 72
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
- Monitored gas pre-pressure of the process gas
- Bypass for safe flushing of furnace chamber with inert gas
- Thermal post combustion of exhaust gases

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).

- Process control under monitored overpressure
- Process control H1700 with PLC controls and graphic touch panel for data input
- Monitored gas pre-pressure of the process gas
- 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.

- 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
- Monitored pre-pressures of all process gases
- Bypass for safe flushing of furnace chamber with inert gas
- Torch for thermal post combustion of exhaust gases
- Emergency flood container for purging the furnace in case of failure

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Work space dimensions in mm</th>
<th>Useful volume in l</th>
<th>Electrical connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRA 17/..</td>
<td>650 or 900</td>
<td>1100</td>
<td>255</td>
<td>255</td>
</tr>
<tr>
<td>NRA 25/..</td>
<td>650 or 900</td>
<td>1100</td>
<td>400</td>
<td>400</td>
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<tr>
<td>NRA 50/..</td>
<td>650 or 900</td>
<td>1100</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>NRA 75/..</td>
<td>650 or 900</td>
<td>1100</td>
<td>700</td>
<td>700</td>
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<td>NRA 150/..</td>
<td>650 or 900</td>
<td>1100</td>
<td>1250</td>
<td>1250</td>
</tr>
<tr>
<td>NRA 200/..</td>
<td>650 or 900</td>
<td>1100</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>NRA 300/..</td>
<td>650 or 900</td>
<td>1100</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>NRA 400/..</td>
<td>650 or 900</td>
<td>1100</td>
<td>900</td>
<td>900</td>
</tr>
<tr>
<td>NRA 500/..</td>
<td>650 or 900</td>
<td>1100</td>
<td>720</td>
<td>720</td>
</tr>
<tr>
<td>NRA 700/..</td>
<td>650 or 900</td>
<td>1100</td>
<td>650</td>
<td>650</td>
</tr>
<tr>
<td>NRA 1000/..</td>
<td>650 or 900</td>
<td>1100</td>
<td>670</td>
<td>670</td>
</tr>
</tbody>
</table>

*Please see page 73 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 72

<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 kW²</th>
<th>Electrical connection*</th>
<th>Weight in kg</th>
<th>Acidic quantity (HNO₃) in ml/h</th>
<th>Nitrogen (N₂) in l/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRA 40/02 CDB</td>
<td>200</td>
<td>300 450 300 40</td>
<td>1400 1600 2400</td>
<td>2</td>
<td>3-phase¹</td>
<td>800</td>
<td>max. 70 ml/h</td>
<td>1000 l/h</td>
<td></td>
</tr>
<tr>
<td>NRA 150/02 CDB</td>
<td>200 1500</td>
<td>450 700 450 150</td>
<td>1650 1960 2850</td>
<td>20</td>
<td>3-phase¹</td>
<td>1650</td>
<td>max. 180 ml/h</td>
<td>max. 4000 l/h</td>
<td></td>
</tr>
</tbody>
</table>

¹Heating only between two phases
²Depending on furnace design connected load might be higher
³External dimensions vary when furnace is equipped with additional equipment. Dimensions on request.

³Please see page 73 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, 900 °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 71
- 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
**Pit-Type Retort Furnaces up to 1100 °C**

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 650 °C**
  - Heating inside the retort
  - Gas-circulation with powerful fan in the furnace lid
  - Temperature uniformity up to +/- 5 °C inside the work space see page 68
  - Single-zone control
  - Retort made of 1.4571
  - Insulation made of high-grade mineral wool

- **Models SRA .../09 with Tmax 900 °C**
  Design like models SR.../06 with following differences:
  - All-around heating from outside of the retort
  - Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
  - 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 71
- 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**

<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</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 1700 1800</td>
<td>3-phase</td>
<td>600</td>
</tr>
<tr>
<td>SR(A) 25/..</td>
<td>250</td>
<td>500</td>
<td>25</td>
<td>1300 1900 1800</td>
<td>3-phase</td>
<td>800</td>
</tr>
<tr>
<td>SR(A) 50/..</td>
<td>400</td>
<td>450</td>
<td>50</td>
<td>1400 2000 1800</td>
<td>3-phase</td>
<td>1300</td>
</tr>
<tr>
<td>SR(A) 100/.. 650</td>
<td>400</td>
<td>800</td>
<td>100</td>
<td>1400 2000 2100</td>
<td>3-phase</td>
<td>1500</td>
</tr>
<tr>
<td>SR(A) 200/.. 900</td>
<td>600</td>
<td>700</td>
<td>200</td>
<td>1600 2200 2200</td>
<td>3-phase</td>
<td>2100</td>
</tr>
<tr>
<td>SR(A) 300/.. or 600</td>
<td>600</td>
<td>1000</td>
<td>300</td>
<td>1600 2200 2500</td>
<td>3-phase</td>
<td>2400</td>
</tr>
<tr>
<td>SR(A) 500/.. 1100</td>
<td>800</td>
<td>1000</td>
<td>500</td>
<td>1800 2400 2700</td>
<td>3-phase</td>
<td>2800</td>
</tr>
<tr>
<td>SR(A) 600/..</td>
<td>800</td>
<td>1200</td>
<td>600</td>
<td>1800 2400 2900</td>
<td>3-phase</td>
<td>3000</td>
</tr>
<tr>
<td>SR(A) 800/..</td>
<td>1000</td>
<td>1000</td>
<td>800</td>
<td>2000 2600 2800</td>
<td>3-phase</td>
<td>3300</td>
</tr>
<tr>
<td>SR(A) 1000/..</td>
<td>1000</td>
<td>1300</td>
<td>1000</td>
<td>2000 2600 3100</td>
<td>3-phase</td>
<td>3500</td>
</tr>
<tr>
<td>SR(A) 1500/..</td>
<td>1200</td>
<td>1300</td>
<td>1500</td>
<td>2200 2800 3300</td>
<td>3-phase</td>
<td>3500</td>
</tr>
</tbody>
</table>

*Please see page 73 for more information about supply voltage

*External dimensions vary when furnace is equipped with additional equipment. Dimensions on request.*
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
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
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

Retort furnace VHT 8/16-MO with automation package

Retort furnace VHT 100/16-MO with automation package
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 (\(N_2\), 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 pathes after debinding results in a clean process gas atmosphere during sintering.

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

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 29

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 (\(N_2\), 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 72
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 $10^{-3}$ 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 exhaust gas washers
- Heated exhaust gas outlet to avoid condensation deposits in the exhaust gas line

<table>
<thead>
<tr>
<th>Tmax</th>
<th>VHT ...-GR</th>
<th>VHT ...-MO</th>
<th>VHT .../18-W</th>
<th>VHT .../18-KE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max</td>
<td>1800 °C, 2200 °C or 2400 °C</td>
<td>1200 °C or 1600 °C</td>
<td>1800 °C</td>
<td>1800 °C</td>
</tr>
<tr>
<td>Inert gas</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Air/Oxygen</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Rough vacuum and fine vacuum ($&gt;10^{-5}$ mbar)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>High vacuum ($&lt;10^{-10}$ mbar)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Material of heater</td>
<td>Graphite</td>
<td>Molybdenum</td>
<td>Tungsten</td>
<td>MoSi₂</td>
</tr>
<tr>
<td>Material of insulation</td>
<td>Graphite felt</td>
<td>Molybdenum</td>
<td>Tungsten/Molybdenum</td>
<td>Ceramic fiber</td>
</tr>
</tbody>
</table>

1 Tmax reduces to 1400 °C
2 Depending on the temperature
3 Only with safety package for flammable gases
4 Up to 1800 °C

<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 2/..</td>
<td>80 x 125 x 150</td>
<td>1.5</td>
</tr>
<tr>
<td>VHT 8/..</td>
<td>120 x 210 x 150</td>
<td>3.5</td>
</tr>
<tr>
<td>VHT 25/..</td>
<td>200 x 350 x 200</td>
<td>14.0</td>
</tr>
<tr>
<td>VHT 40/..</td>
<td>250 x 430 x 250</td>
<td>25.0</td>
</tr>
<tr>
<td>VHT 70/..</td>
<td>325 x 475 x 325</td>
<td>50.0</td>
</tr>
<tr>
<td>VHT 100/..</td>
<td>425 x 500 x 425</td>
<td>90.0</td>
</tr>
<tr>
<td>VHT 250/..</td>
<td>575 x 700 x 575</td>
<td>230.0</td>
</tr>
<tr>
<td>VHT 500/..</td>
<td>725 x 850 x 725</td>
<td>445.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
<th>Max. charge capacity/kg</th>
<th>Outer dimensions in mm</th>
<th>Heating power in kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHT 2/..</td>
<td>110 x 125 x 150</td>
<td>2</td>
<td>2</td>
<td>1250 (800)</td>
<td>1000</td>
</tr>
</tbody>
</table>

1 With separated switching system unit
2 Depending on furnace design connected load might be higher
3 Dimensions may be smaller depending on the heater type
4 External dimensions vary when furnace is equipped with additional equipment. Dimensions on request.
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 24)
- 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 72
The LBVHT model series with bottom loading specification are especially suitable for production processes which require either protective or reaction gase 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 22

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Model</th>
<th>Tmax °C</th>
<th>Tmax °C</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
<th>Electrical connection*</th>
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<td>LBVHT 100/16-MO</td>
<td>1600</td>
<td>LBVHT 100/20-W</td>
<td>2000</td>
<td>2400</td>
<td>Ø 45</td>
<td>h 70</td>
<td>100</td>
</tr>
<tr>
<td>LBVHT 250/16-MO</td>
<td>1600</td>
<td>LBVHT 250/20-W</td>
<td>2000</td>
<td>2400</td>
<td>Ø 60</td>
<td>h 90</td>
<td>250</td>
</tr>
<tr>
<td>LBVHT 600/16-MO</td>
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<td>2000</td>
<td>2400</td>
<td>Ø 80</td>
<td>h 120</td>
<td>600</td>
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</tbody>
</table>

*Please see page 73 for more information about supply voltage
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: NRA 50/09 with charge of 40 kg)

<table>
<thead>
<tr>
<th>Setpoint</th>
<th>Without cooling</th>
<th>Indirect cooling</th>
<th>Rapid gas cooling</th>
<th>Indirect cooling and rapid gas cooling</th>
</tr>
</thead>
</table>

Schematic presentation of rapid gas cooling
1 Gas heat exchanger
2 Radial fan
3 Shut-off valves

Fan cooling, hot-wall retort furnace NRA 400/03

Rapid gas cooling, cold-wall retort furnace VHT 8/16-MO
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 for the laboratory. 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 insulation of light refractory bricks and special backup insulation
- LF models: high-quality fiber insulation with corner bricks for shorter heating and cooling times. Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2.
- 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 inlet integrated 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 72

Gas supply system for non-flammable protective or reactive gas with shutoff valve and flow meter with regulator valve, optionally with magnetic valve

LF furnace design provides for shorter heating and cooling times

LH 60/12 with manual lift door and protective gas box for non-flammable protective or reactive gases
Chamber furnace LF 60/14 with fresh air fan to accelerate the cooling times

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 72

<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>Connected load kW</th>
<th>Electrical connection</th>
<th>Weight in kg</th>
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</thead>
<tbody>
<tr>
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<td>1200</td>
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<td>15</td>
<td>680 860 1230</td>
<td>5.0</td>
<td>3-phase</td>
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<tr>
<td>LH 30/12</td>
<td>1200</td>
<td>320 320 320</td>
<td>30</td>
<td>710 930 1290</td>
<td>7.0</td>
<td>3-phase</td>
<td>200</td>
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<tr>
<td>LH 60/12</td>
<td>1200</td>
<td>400 400 400</td>
<td>60</td>
<td>790 1080 1370</td>
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<tr>
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<td>216</td>
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<tr>
<td>LH 30/13</td>
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<tr>
<td>LH 60/13</td>
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<td>LH 120/13</td>
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<tr>
<td>LF 60/14</td>
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<td>120</td>
<td>890 1180 1470</td>
<td>18.0</td>
<td>3-phase</td>
<td>370</td>
</tr>
</tbody>
</table>

*Heating only between two phases
*Please see page 73 for more information about supply voltage

Parallel swinging door for opening when hot
Protective Gas Boxes for Models LH 15/.. - LH 216/..

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

Additional equipment
- Starting from LH 30/.. a charging cart is recommended see page 54
- Digital temperature display see page 51
- Gas supply systems see page 52
- Extended gas piping for the use of smaller boxes in larger furnace models
- Draw hook
- Charging stacker see page 55

<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>
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<td>d</td>
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<td>631001313</td>
<td>LH 120/..</td>
<td>350</td>
<td>350</td>
<td>350</td>
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</tbody>
</table>

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>LH 120/..</td>
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<td>350</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

1 Without piping
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 32. 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 54
- Digital temperature display see page 51
- Vacuum pump see page 53
- Gas supply systems see page 52
- Extended gas piping for the use of smaller boxes in larger furnace models
- Draw hook
- Charging stacker see page 55

### Protective Gas Boxes with Evacuation Lid

<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>W D H</td>
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<td>506 535 540</td>
<td>charging stacker</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 |

### Charging Plates for Models LH 15/.. - LH 216/..

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>Outer dimensions in mm</th>
</tr>
</thead>
<tbody>
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<td>628002016</td>
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<td>628002017</td>
<td>LH 216/..</td>
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</table>
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

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
<th>Outer dimensions1 in mm</th>
<th>Connected load kW</th>
<th>Electrical connection*</th>
<th>Weight in kg</th>
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</thead>
<tbody>
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<td>1300</td>
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<td>150</td>
<td>790 1150 1600</td>
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<tr>
<td>NW 200</td>
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<td>200</td>
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</tbody>
</table>

*Please see page 73 for more information about supply voltage

1External dimensions vary when furnace is equipped with additional equipment. Dimensions on request.

Chamber furnace NW 440 with free traversing bogie

Chamber furnace NW 300 with pulled-out furnace table
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 51
- Gas supply systems see page 52

Furnace | Article no. | Inner dimensions in mm | Protective gas box | Protective gas hood |
<table>
<thead>
<tr>
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</table>
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 see page 68
- 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 72

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

---

### Chamber Furnaces
**Electrically Heated**

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
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<th>Volume in l</th>
<th>Outer dimensions in mm</th>
<th>Heating power in kW</th>
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</table>

1Table-top model
2Heating only between two phases
3Depending on furnace design connected load might be higher
4External dimensions vary when furnace is equipped with additional equipment. Dimensions on 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 52 - 53. 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 54
- Digital temperature display see page 51
- Gas supply systems see page 52
- Charging forks see page 39
- Draw Hook

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Furnace</th>
<th>Inner dimensions in mm</th>
<th>Outer dimensions in mm</th>
<th>Preflush rate</th>
<th>Process flush rate</th>
<th>Charging method</th>
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<td>5 - 8</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 Evacuation Lid for Models N 7/H - N 614/13

For heat treatment of bulk goods and hollow parts under 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 37. 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 threeway 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 54
- Digital temperature display see page 51
- Vacuum pump see page 53
- Gas supply systems see page 52
- Charging forks see page 39
- Draw Hook

<table>
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<tr>
<th>Article no.</th>
<th>Furnace</th>
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<th>Outer dimensions in mm·</th>
<th>Pflush rate</th>
<th>Process flush rate</th>
<th>Charging method of the box</th>
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<td>10 - 20</td>
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</table>

Article no. 601605055, 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
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>
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<tr>
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Charging Forks

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Charging forks to charge and remove protective gas boxes up to model N 17/H
# 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 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
- Charging cart see page 54

### Table: Tool Shop Hardening Systems MHS 31, MHS 41 and MHS 61

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<thead>
<tr>
<th>Model</th>
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<td>w</td>
<td>d</td>
</tr>
<tr>
<td>N 61/H</td>
<td>1280</td>
<td>350</td>
<td>750</td>
<td>250</td>
<td>900</td>
<td>1040</td>
<td>1500</td>
</tr>
<tr>
<td>NA 60/65</td>
<td>650</td>
<td>350</td>
<td>500</td>
<td>350</td>
<td>900</td>
<td>910</td>
<td>1390</td>
</tr>
<tr>
<td>Quenching bath Q 50</td>
<td>-</td>
<td>200</td>
<td>170</td>
<td>-</td>
<td>700</td>
<td>350</td>
<td>350</td>
</tr>
<tr>
<td>Heating element</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Accessories</td>
<td></td>
<td>w</td>
<td>d</td>
<td>h</td>
<td>l</td>
<td>w</td>
<td>d</td>
</tr>
<tr>
<td>Charging cart CW1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>880 - 920</td>
<td>350</td>
<td>1100</td>
</tr>
<tr>
<td>Charging cart CWK1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>880 - 920</td>
<td>350</td>
<td>1100</td>
</tr>
<tr>
<td>Side platform</td>
<td>-</td>
<td>600</td>
<td>600</td>
<td>-</td>
<td>900</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>Protective gas box N 31/H</td>
<td>1100</td>
<td>280</td>
<td>230</td>
<td>200</td>
<td>-</td>
<td>316</td>
<td>304</td>
</tr>
<tr>
<td>Protective gas box N 41/H</td>
<td>1100</td>
<td>280</td>
<td>380</td>
<td>200</td>
<td>-</td>
<td>316</td>
<td>454</td>
</tr>
</tbody>
</table>

¹Heating only between two phases
²Depending on furnace design connected load might be higher
³Please see page 73 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 52
- Draw hook
- Safety equipment consisting of rim exhaust with flame trap and oil steam separator

Additional equipment
- Suction hood
- Water bath

### Furnace 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>Heating power in kW</th>
<th>Electrical connection</th>
<th>Weight in kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>N 41/H¹</td>
<td>1280</td>
<td>350 500 250</td>
<td>40</td>
<td>1040 1250 1340</td>
<td>15.0</td>
<td>3-phase</td>
<td>260</td>
</tr>
</tbody>
</table>

¹Furnace description see page 36
²Depending on furnace design connected load might be higher

### Protective Gas Hardening System SHS 41

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Protective gas hardening system</th>
<th>W</th>
<th>D</th>
<th>H</th>
<th>Oil quench bath size in liters</th>
<th>max. load Weight</th>
<th>max. quench yield/h</th>
<th>Preflush rate</th>
<th>Process flush rate</th>
<th>Heating power oil bath/kW</th>
<th>Electrical connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>6310061104</td>
<td>SHS 41 Gas hood (spare part)</td>
<td>260</td>
<td>360</td>
<td>180</td>
<td>400</td>
<td>25 kg</td>
<td>20 kg</td>
<td>20 - 25</td>
<td>10 - 15</td>
<td>6.0</td>
<td>3-phase</td>
</tr>
</tbody>
</table>

*Please see page 73 for more information about supply voltage
Chamber furnaces with air circulation are characterized particularly by their very good temperature uniformity. As a result, they are well suited for processes such as calcination and drying e.g. ceramic materials. The design as a debinding furnace for safe debinding in air or in an inert atmosphere is possible. When used for debinding in air the exhaust gases are diluted by fresh air to reliably prevent an inflammatory atmosphere in the furnace chamber. For debinding processes that have to take place under inert gas, the IDB passive safety concept with a residual oxygen content of max. 3 % is recommended.

- 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) see page 68
- 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 (NA 30/45 - N 675/85 HA)
- Controls description see page 72

Additional equipment (not for model NA 15/65)
- Optimization of the temperature uniformity up to +/- 3 °C according to DIN 17052-1 see page 68
- 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
<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>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>°C w d h in l</td>
<td>W D H</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NA 30/45(LS)</td>
<td>450 290 420 260 30</td>
<td>1040 1290 1385</td>
<td>3.0 / 9.0</td>
<td>1(3)-phase</td>
<td>285</td>
<td>120</td>
<td>120</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>NA 60/45(LS)</td>
<td>450 350 500 350 60</td>
<td>1100 1370 1475</td>
<td>6.0 / 12.0</td>
<td>3-phase</td>
<td>350</td>
<td>120</td>
<td>240</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>NA 120/45(LS)</td>
<td>450 600 450 120 1250 1550 1550</td>
<td>9.0 / 18.0</td>
<td>3-phase</td>
<td>460</td>
<td>60</td>
<td>240</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NA 250/45(LS)</td>
<td>450 600 750 600 250 1350 1650 1725</td>
<td>12.0 / 24.0</td>
<td>3-phase</td>
<td>590</td>
<td>60</td>
<td>120</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NA 500/45(LS)</td>
<td>450 750 1000 750 500 1550 1900 1820</td>
<td>18.0 / 24.0</td>
<td>3-phase</td>
<td>750</td>
<td>60</td>
<td>240</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NA 675/45(LS)</td>
<td>450 750 1200 750 675 1550 2100 1820</td>
<td>24.0 / 30.0</td>
<td>3-phase</td>
<td>900</td>
<td>90</td>
<td>270</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NA 15/65</td>
<td>650 295 340 170 15</td>
<td>470 790 460</td>
<td>2.8</td>
<td>1-phase</td>
<td>60</td>
<td>40</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>NA 30/65</td>
<td>650 290 420 260 30</td>
<td>870 1290 1385</td>
<td>6.0</td>
<td>3-phase</td>
<td>285</td>
<td>120</td>
<td>270</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>NA 60/65</td>
<td>650 350 500 350 60</td>
<td>910 1390 1475</td>
<td>9.0</td>
<td>3-phase</td>
<td>350</td>
<td>120</td>
<td>270</td>
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<tr>
<td>NA 120/65</td>
<td>650 450 600 450 120 990 1470 1550</td>
<td>12.0</td>
<td>3-phase</td>
<td>460</td>
<td>60</td>
<td>300</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
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<td>650 600 750 600 250 1170 1650 1680</td>
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<td>3-phase</td>
<td>590</td>
<td>90</td>
<td>270</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NA 500/65</td>
<td>650 750 1000 750 500 1290 1890 1825</td>
<td>27.0</td>
<td>3-phase</td>
<td>750</td>
<td>60</td>
<td>240</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NA 675/65</td>
<td>650 750 1200 750 675 1290 2100 1825</td>
<td>27.0</td>
<td>3-phase</td>
<td>900</td>
<td>90</td>
<td>270</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N 30/85 HA</td>
<td>850 290 420 260 30</td>
<td>607 + 255 1175 1315</td>
<td>5.5</td>
<td>3-phase</td>
<td>195</td>
<td>180</td>
<td>900</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td>N 60/85 HA</td>
<td>850 350 500 350 60</td>
<td>667 + 255 1250 1400</td>
<td>9.0</td>
<td>3-phase</td>
<td>240</td>
<td>150</td>
<td>900</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>N 120/85 HA</td>
<td>850 450 600 450 120 767 + 255 1350 1500</td>
<td>13.0</td>
<td>3-phase</td>
<td>310</td>
<td>150</td>
<td>900</td>
<td>120</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N 250/85 HA</td>
<td>850 600 750 600 250 1002 + 255 1636 1860</td>
<td>20.0</td>
<td>3-phase</td>
<td>610</td>
<td>180</td>
<td>900</td>
<td>180</td>
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<td></td>
</tr>
<tr>
<td>N 500/85 HA</td>
<td>850 750 1000 750 500 1152 + 255 1886 2010</td>
<td>30.0</td>
<td>3-phase</td>
<td>1030</td>
<td>180</td>
<td>900</td>
<td>210</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N 675/85 HA</td>
<td>850 750 1200 750 675 1152 + 255 2100 2010</td>
<td>30.0</td>
<td>3-phase</td>
<td>1350</td>
<td>210</td>
<td>900</td>
<td>210</td>
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<td></td>
</tr>
</tbody>
</table>

1Table-top model see page 42
2Heating only between two phases
3Depending on furnace design connected load might be higher
4Please see page 73 for more information about supply voltage
5Additional equipment
6Empty furnace
7External dimensions vary when furnace is equipped with additional equipment. Dimensions on request.
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
- Protective gas connection via quick coupling with hose connector (inner diameter 9 mm)
- 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 51
- Gas supply systems see page 52
- Extended gas piping for the use of smaller boxes in larger furnace models
- Draw hook
- Charging cart see page 54

### Protective Gas Boxes for Models
**NA 30/45 - N 500/85HA**

<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>(Furnace with hinged door)</td>
<td>(Furnace with lift door)</td>
<td>w</td>
<td>d</td>
<td>h</td>
</tr>
<tr>
<td>631000410</td>
<td>631000763</td>
<td>NA 30/..</td>
<td>N 30/..HA</td>
<td>220</td>
</tr>
<tr>
<td>631000411</td>
<td>631000764</td>
<td>NA 60/..</td>
<td>N 60/..HA</td>
<td>270</td>
</tr>
<tr>
<td>631000412</td>
<td>631000765</td>
<td>NA 120/..</td>
<td>N 120/..HA</td>
<td>350</td>
</tr>
<tr>
<td>631000413</td>
<td>631000766</td>
<td>NA 250/..</td>
<td>N 250/..HA</td>
<td>480</td>
</tr>
<tr>
<td>631000414</td>
<td>631000767</td>
<td>NA 500/..</td>
<td>N 500/..HA</td>
<td>630</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

**Forced convection chamber**
- Furnace N 250/85 HA with protective gas box

![Protective gas box with insertions](Image)

![Protective gas box with extended piping for usage in a large furnace model](Image)
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 51
- Vacuum pump see page 53
- Gas supply systems see page 52
- Extended gas piping for the use of smaller boxes in larger furnace models
- Draw hook
- Charging cart see page 54

### Protective Gas Boxes with Evacuation Lid for Models

<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[^1]</th>
<th>Charging method of the box</th>
</tr>
</thead>
<tbody>
<tr>
<td>631000559</td>
<td>631000806</td>
<td>NA 30/... N 30/...HA</td>
<td>w 170 d 300 h 130</td>
<td>W 258 D 388 H 222</td>
<td>draw hook</td>
</tr>
<tr>
<td>631000560</td>
<td>631000807</td>
<td>NA 60/... N 60/...HA</td>
<td>w 230 d 380 h 220</td>
<td>W 318 D 468 H 297</td>
<td>draw hook</td>
</tr>
<tr>
<td>631000561</td>
<td>631000808</td>
<td>NA 120/... N 120/...HA</td>
<td>w 330 d 480 h 320</td>
<td>W 418 D 568 H 412</td>
<td>draw hook</td>
</tr>
<tr>
<td>631000562</td>
<td>631000809</td>
<td>NA 250/... N 250/...HA</td>
<td>w 430 d 580 h 370</td>
<td>W 518 D 668 H 532</td>
<td>charging stacker</td>
</tr>
<tr>
<td>631000563</td>
<td>631000810</td>
<td>NA 500/... N 500/...HA</td>
<td>w 560 d 810 h 530</td>
<td>W 648 D 898 H 692</td>
<td>charging stacker</td>
</tr>
</tbody>
</table>

[^1]: Without piping and evacuation lid

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 Automotive (CQI-9) and Aeronautic (AMS7NADCAP) Norms

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

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Furnace</th>
<th>Inner dimensions in mm</th>
<th>Outer dimensions in mm¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>631000410</td>
<td>631000763</td>
<td>NA 30/... N 30/...HA</td>
<td>220 320 160 282 376 242</td>
</tr>
<tr>
<td>631000411</td>
<td>631000764</td>
<td>NA 60/... N 60/...HA</td>
<td>270 420 260 336 460 340</td>
</tr>
<tr>
<td>631000412</td>
<td>631000765</td>
<td>NA 120/... N 120/...HA</td>
<td>350 520 340 436 560 430</td>
</tr>
<tr>
<td>631000413</td>
<td>631000766</td>
<td>NA 250/... N 250/...HA</td>
<td>480 630 460 546 680 600</td>
</tr>
<tr>
<td>631000414</td>
<td>631000767</td>
<td>NA 500/... N 500/...HA</td>
<td>630 780 610 696 836 760</td>
</tr>
</tbody>
</table>

¹ Without piping

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 mm¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>631001049</td>
<td>631001054</td>
<td>NA 30/... N 30/...HA</td>
<td>220 300 130 258 388 222</td>
</tr>
<tr>
<td>631001050</td>
<td>631001055</td>
<td>NA 60/... N 60/...HA</td>
<td>220 300 130 318 468 297</td>
</tr>
<tr>
<td>631001051</td>
<td>631001056</td>
<td>NA 120/... N 120/...HA</td>
<td>330 480 320 418 568 412</td>
</tr>
<tr>
<td>631001052</td>
<td>631001057</td>
<td>NA 250/... N 250/...HA</td>
<td>430 580 370 518 668 532</td>
</tr>
<tr>
<td>631001053</td>
<td>631001058</td>
<td>NA 500/... N 500/...HA</td>
<td>560 810 530 648 898 692</td>
</tr>
</tbody>
</table>

¹ Without piping

Larger boxes and custom dimensions available upon request
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 42) 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)

---

### Table: Sealed Forced Convection Chamber Furnaces NA-I and NA-SI

<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>NA 20/45 I</td>
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<td>290 420 260</td>
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<td>1290 2100 1825</td>
<td>27.0</td>
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<td>900</td>
</tr>
</tbody>
</table>

¹Table-top model
²Heating only between two phases

*Please see page 73 for more information about supply voltage
Depending on furnace design connected load might be higher
*External dimensions vary when furnace is equipped with additional equipment. Dimensions on request.

---

Forced convection chamber furnace
NA 120/65 I

Forced convection chamber furnace
NA 15/65 i as tabletop model with manual gas supply system
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 see page 68
- 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 72

Additional equipment
- Charging hoist with swivel arm and charge basket
- Optimization of the temperature uniformity up to +/- 2 °C according to DIN 17052-1 see page 68
- 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 72

### Table: Technical Specifications

<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 - W mm</th>
<th>Outer dimensions - D mm</th>
<th>Outer dimensions - H mm</th>
<th>Heating power in kW</th>
<th>Electrical connection</th>
<th>Weight in kg</th>
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</tbody>
</table>

1Heating only between two phases
2Depending on furnace design connected load might be higher
3External dimensions vary when furnace is equipped with additional equipment. Dimensions on request.

---

Pit-type furnace SAL 120/65 with protective gas retort box and cooling station next to the furnace

Basket system for charging in different layers

Pit-type furnace SAL 250/65 with protective gas retort box and cooling station next to the furnace

Protective gas box, AMS 2750 E design

---

48
Charging 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

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 51
- Gas supply systems see page 52

### Furnace Total height in mm

<table>
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<th>Furnace</th>
<th>Total height in mm</th>
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</tbody>
</table>

¹ Without piping

Article no. 601655055, 1 sales unit of fiber insulation cord, 5 strips of 610 mm each
Forced Convection Pit-Type Retort Furnaces up to 850 °C

The forced convection pit-type furnaces of the SAL series (technical data see page 48) can be upgraded 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 52 - 53.

A gas supply system for operation under hydrogen, including safety technology, is also available as an additional equipment.
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>
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<tbody>
<tr>
<td>402000057</td>
<td>Temperature indicator with digital display, 230 V 1/N connection, in metal housing</td>
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<tr>
<td>542100028</td>
<td>Temperature indicator with digital display, battery-operated, manual device</td>
</tr>
<tr>
<td>V000808</td>
<td>Connecting cable between heat treatment with charge thermocouple and Article no. 402000057, 5 m</td>
</tr>
<tr>
<td>V000801</td>
<td>Connecting cable between heat treatment with charge thermocouple and Article no. 542100028, 3 m</td>
</tr>
</tbody>
</table>

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
**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>
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<th>Flow rate l/min</th>
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<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 Preflushing 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>
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<td>631000381</td>
<td>Non-flammable forming gas</td>
<td>0 - 30</td>
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</tbody>
</table>

Alternative connection threads on request

Gas Feed Fitting with Solenoid Valve
- Solenoid valve mounted on the furnace, controlled using the controller "Extra" function
- 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
- Available only in combination with furnace or switchgear

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<tr>
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<td>Non-flammable forming gas</td>
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</table>

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

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<td>Non-flammable forming gas</td>
<td>0 - 30</td>
</tr>
</tbody>
</table>

Alternative connection threads on request

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>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>W D H</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<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>
</tr>
</tbody>
</table>

*Article no. for other possible supply voltages on request
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>Outer dimensions in mm</th>
<th>Connected load kW</th>
<th>Supply voltage*</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>631000429</td>
<td>CW1 (up to N 17/HR)</td>
<td>550</td>
<td>610</td>
<td>760</td>
<td>0.2</td>
<td>230 V</td>
</tr>
<tr>
<td>631000529</td>
<td>CW1 (up to N 61/H)</td>
<td>335</td>
<td>1100</td>
<td>880 - 920</td>
<td>0.2</td>
<td>230 V</td>
</tr>
<tr>
<td>631000294</td>
<td>CW1 (up to N 161)</td>
<td>700</td>
<td>800</td>
<td>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

- For charging larger workpieces and annealing boxes.
- 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)

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Designation</th>
<th>Furnace</th>
<th>Outer dimensions in mm</th>
<th>Connected load kW</th>
<th>Supply voltage*</th>
</tr>
</thead>
<tbody>
<tr>
<td>631000528</td>
<td>CW 1</td>
<td>N 31/H, N 41/.., N 61/.., N 30/../HA, N 60/../HA</td>
<td>330</td>
<td>1100</td>
<td>880 - 920</td>
</tr>
<tr>
<td>631001320</td>
<td>CW 15</td>
<td>LH(LF) 15/.. - LH(LF) 60/..</td>
<td>370</td>
<td>1100</td>
<td>760 - 800</td>
</tr>
<tr>
<td>631001321</td>
<td>CW 16</td>
<td>LH(LF) 120/.. - LH(LF) 216/..</td>
<td>470</td>
<td>1000</td>
<td>760 - 800</td>
</tr>
<tr>
<td>631000529</td>
<td>CWK 1</td>
<td>N 31/H, N 41/.., N 61/.., N 30/../HA, N 60/../HA</td>
<td>330</td>
<td>1100</td>
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<tr>
<td>631001322</td>
<td>CWK 15</td>
<td>LH(LF) 15/.. - LH(LF) 60/..</td>
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<td>1100</td>
<td>760 - 800</td>
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<tr>
<td>631001323</td>
<td>CWK 16</td>
<td>LH(LF) 120/.. - LH(LF) 216/..</td>
<td>470</td>
<td>1100</td>
<td>760 - 800</td>
</tr>
</tbody>
</table>

Art.-No. for NA 30/.. and NA 60/.. on request

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

- For charging larger workpieces and annealing boxes.
- 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)

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Designation</th>
<th>Furnace</th>
<th>Outer dimensions in mm</th>
<th>Connected load kW</th>
<th>Supply voltage*</th>
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<tbody>
<tr>
<td>631000530</td>
<td>CW 2</td>
<td>N 81/.., N 161/.., N 120/../HA</td>
<td>500</td>
<td>1120</td>
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</tr>
<tr>
<td>631000531</td>
<td>CW 3</td>
<td>N 321/..</td>
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<td>1490</td>
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<tr>
<td>631000468</td>
<td>CW 4</td>
<td>N 641/..</td>
<td>1040</td>
<td>1950</td>
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<tr>
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<tr>
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<td>1950</td>
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</table>

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

*Please see page 73 for more information about supply voltage

* Side switch

2 Without holding grip
Charging Cart WS 1

For charging of protective gas and annealing boxes.
- 2 casters, 2 fixed rollers for heavy loads
- With parallel guided lifting mechanism
- Only for boxes with preparation for charging device (standard since 07.2018)
- Will be delivered with drive-in aid for the relevant furnace model
- Guiding track and charging cart can be also ordered separately

<table>
<thead>
<tr>
<th>Article no.</th>
<th>Designation</th>
<th>Furnace</th>
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</thead>
<tbody>
<tr>
<td>6000004965</td>
<td>WS 1</td>
<td>N 61/H, N 81, N 60/..HA, N 120/..HA, NA 60/.., NA 120/.., LH 60/.., LH 120/..</td>
</tr>
</tbody>
</table>

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>
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<tbody>
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<td>NA 60/..</td>
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</tr>
<tr>
<td>6000006101</td>
<td>NA 120/..</td>
<td></td>
</tr>
<tr>
<td>6000005811</td>
<td>LH 60/..</td>
<td></td>
</tr>
<tr>
<td>6000005372</td>
<td>LH 120/..</td>
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</tr>
<tr>
<td>6000006155</td>
<td>N 61/H</td>
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<tr>
<td>on request</td>
<td>N 81</td>
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<tr>
<td>on request</td>
<td>N 60/..HA</td>
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</tr>
<tr>
<td>on request</td>
<td>N 120/..HA</td>
<td></td>
</tr>
</tbody>
</table>

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>
Ashing Furnaces with Integrated Exhaust Gas Cleaning

The ashing furnace L ./.11 BO is specially designed for processes in which larger sample quantities have to be incinerated. Fields of application are e.g. the ashing of food, thermal cleaning of injection molding tools or the determination of annealing loss. Another application is the debinding of ceramic products, e.g. after additive production.

The ashing furnaces have a passive safety system and integrated exhaust gas post combustion. An exhaust gas fan extracts flue gases from the furnace and simultaneously supplies fresh air to the furnace atmosphere with the result that sufficient oxygen is always available for the incineration process. The incoming air is guided behind the furnace heating and preheated to ensure good temperature uniformity. Exhaust gases are led from the furnace chamber to the integrated post combustion system, where they are postburned and catalytically cleaned. Directly after the incineration process (up to max. 600 °C) a subsequent process up to max. 1100 °C can take place.

Additional equipment

- Tmax 600 °C for the incineration process
- Tmax 1100 °C for the subsequent process
- Three-side heating (both sides and bottom)
- Ceramic heating plates with embedded heating wire
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- Dual shell housing made of structured stainless steel provides for low outer temperature and high stability
- Steel collecting pan protects the bottom insulation
- Spring-assisted closing of the furnace door (flap door) with mechanical locking against unintentional opening
- Thermal/catalytic post combustion, integrated in the exhaust channel, up to 600 °C in function
- Temperature control of post combustion can be set up to 850 °C
- Monitored exhaust air
- Inlet-air preheated through the bottom heating plate
- 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
- 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 72

- Process control and documentation via VCD software package for monitoring, documentation and control see page 72

**Model** | Tmax | Inner dimensions in mm | Volume | Outer dimensions² in mm | Max. weight of hydrocarbons in g | Max. evaporation rate g/min | Connected load kW | Electrical connection | Weight in kg
--- | --- | --- | --- | --- | --- | --- | --- | --- | ---
L 9/11 BO | 1100 | 230 x 240 x 170 | 9 | 415 x 575 x 750 | 75 | 1.0 | 7.0 | 3-phase | 60
L 24/11 BO | 1100 | 280 x 340 x 250 | 24 | 490 x 675 x 800 | 150 | 2.0 | 9.0 | 3-phase | 90
L 40/11 BO | 1100 | 320 x 490 x 250 | 40 | 530 x 825 x 800 | 200 | 2.5 | 11.5 | 3-phase | 110

¹Including exhaust tube (Ø 80 mm)
²External dimensions vary when furnace is equipped with additional equipment. Dimensions on request

*Please see page 73 for more information about supply voltage
High-Temperature Furnaces with MoSi₂ Heating Elements up to 1800 °C

Designed as tabletop models, these compact high-temperature furnaces have a variety of advantages. The first-class workmanship using high-quality materials, combined with ease of operation, make these furnaces all-rounders in research and the laboratory. These high-temperature furnaces are also perfectly suited for the sintering of technical ceramics, such as zirconium oxide dental bridges.

- Tmax 1600 °C, 1750 °C, or 1800 °C
- High-quality molybdenum disilicide heating elements
- Dual shell housing made of textured stainless steel sheets with additional fan cooling for low surface temperature
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- Compact design with lift door, opening upwards
- Adjustable air inlet
- Exhaust air opening in the roof
- Type B thermocouple
- 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 72

### Additional equipment
- 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
- Square saggar for charging of up to three layers
- Protective gas connection to purge with non-flammable protective or reaction gases
- Manual or automatic gas supply system
- Process control and documentation via VCD software package for monitoring, documentation and control see page 72

### 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>
<th>Minutes to Tmax</th>
</tr>
</thead>
<tbody>
<tr>
<td>LHT 02/16</td>
<td>1600</td>
<td>90 150 150</td>
<td>2</td>
<td>470 630 760+260</td>
<td>3.0</td>
<td>1-phase</td>
<td>75</td>
<td>30</td>
</tr>
<tr>
<td>LHT 04/16</td>
<td>1600</td>
<td>150 150 150</td>
<td>4</td>
<td>470 630 760+260</td>
<td>5.2</td>
<td>3-phase</td>
<td>85</td>
<td>25</td>
</tr>
<tr>
<td>LHT 08/16</td>
<td>1600</td>
<td>150 300 150</td>
<td>8</td>
<td>470 810 760+260</td>
<td>8.0</td>
<td>3-phase</td>
<td>100</td>
<td>25</td>
</tr>
<tr>
<td>LHT 01/17 D</td>
<td>1650</td>
<td>110 120 120</td>
<td>1</td>
<td>385 425 525+195</td>
<td>2.2</td>
<td>1-phase</td>
<td>28</td>
<td>10</td>
</tr>
<tr>
<td>LHT 03/17 D</td>
<td>1650</td>
<td>135 155 200</td>
<td>4</td>
<td>470 630 760+260</td>
<td>3.0</td>
<td>1-phase</td>
<td>75</td>
<td>60</td>
</tr>
<tr>
<td>LHT 02/17</td>
<td>1750</td>
<td>90 150 150</td>
<td>2</td>
<td>470 630 760+260</td>
<td>3.0</td>
<td>1-phase</td>
<td>75</td>
<td>60</td>
</tr>
<tr>
<td>LHT 04/17</td>
<td>1750</td>
<td>150 150 150</td>
<td>4</td>
<td>470 630 760+260</td>
<td>5.2</td>
<td>3-phase</td>
<td>85</td>
<td>40</td>
</tr>
<tr>
<td>LHT 08/17</td>
<td>1750</td>
<td>150 300 150</td>
<td>8</td>
<td>470 810 760+260</td>
<td>8.0</td>
<td>3-phase</td>
<td>100</td>
<td>40</td>
</tr>
<tr>
<td>LHT 02/18</td>
<td>1800</td>
<td>90 150 150</td>
<td>2</td>
<td>470 630 760+260</td>
<td>3.6</td>
<td>1-phase</td>
<td>75</td>
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</tr>
<tr>
<td>LHT 04/18</td>
<td>1800</td>
<td>150 150 150</td>
<td>4</td>
<td>470 630 760+260</td>
<td>5.2</td>
<td>3-phase</td>
<td>85</td>
<td>60</td>
</tr>
<tr>
<td>LHT 08/18</td>
<td>1800</td>
<td>150 300 150</td>
<td>8</td>
<td>470 810 760+260</td>
<td>9.0</td>
<td>3-phase</td>
<td>100</td>
<td>60</td>
</tr>
</tbody>
</table>

*Heating only between two phases
*Please see page 73 for more information about supply voltage
*External dimensions vary when furnace is equipped with additional equipment. Dimensions on request
including opened lift door
High-temperature furnace HT 160/17 with gas supply system

Due to their solid construction and compact stand-alone design, these high-temperature furnaces are perfect for processes in the laboratory where the highest precision is needed. Outstanding temperature uniformity and practical details set unbeatable quality benchmarks. For configuration for your processes, these furnaces can be extended with extras from our extensive option list.

- **Tmax 1600 °C, 1750 °C, or 1800 °C**
- Recommended working temperature 1750 °C (for models HT ../18), increased wear and tear must be expected in case of working at higher temperatures
- Dual shell housing with fan cooling for low shell temperatures
- Heating from both sides via molybdenum disilicide heating elements
- High-quality fiber insulation backed by special insulation
- Side insulation constructed with tongue and groove blocks provides for low heat loss to the outside
- Long-life roof insulation with special suspension
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- Chain-guided parallel swivel door for defined opening and closing of the door
- Two-door design (front/back) for high-temperature furnaces > HT 276/..
- Labyrinth sealing ensures the least possible temperature loss in the door area
- Reinforced floor as protection for bottom insulation as standard from models HT 16/16 upwards
- Vapor vent in the furnace roof
- Heating elements switched via thyristors
- 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 72
### Model 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>
<tr>
<td>HT 04/16</td>
<td>1600</td>
<td>150 x 150 x 150</td>
<td>4</td>
<td>730 x 490 x 1400</td>
<td>5.2</td>
<td>3-phase 1</td>
<td>150</td>
</tr>
<tr>
<td>HT 08/16</td>
<td>1600</td>
<td>150 x 300 x 150</td>
<td>8</td>
<td>730 x 640 x 1400</td>
<td>8.0</td>
<td>3-phase 1</td>
<td>200</td>
</tr>
<tr>
<td>HT 16/16</td>
<td>1600</td>
<td>200 x 300 x 260</td>
<td>16</td>
<td>810 x 700 x 1500</td>
<td>12.0</td>
<td>3-phase 1</td>
<td>270</td>
</tr>
<tr>
<td>HT 29/16</td>
<td>1600</td>
<td>275 x 300 x 350</td>
<td>29</td>
<td>975 x 740 x 1620</td>
<td>8.0</td>
<td>3-phase 1</td>
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</tr>
<tr>
<td>HT 40/16</td>
<td>1600</td>
<td>300 x 350 x 350</td>
<td>40</td>
<td>1000 x 800 x 1620</td>
<td>12.0</td>
<td>3-phase 1</td>
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</tr>
<tr>
<td>HT 64/16</td>
<td>1600</td>
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<td>1130 x 900 x 1670</td>
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<td>550</td>
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<tr>
<td>HT 128/16</td>
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<td>400 x 800 x 400</td>
<td>128</td>
<td>1130 x 1290 x 1670</td>
<td>26.0</td>
<td>3-phase 1</td>
<td>750</td>
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<td>HT 160/16</td>
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<td>730 x 490 x 1400</td>
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<td>3-phase 1</td>
<td>150</td>
</tr>
<tr>
<td>HT 08/17</td>
<td>1750</td>
<td>150 x 300 x 150</td>
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<td>730 x 640 x 1400</td>
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<td>810 x 700 x 1500</td>
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</tr>
<tr>
<td>HT 29/17</td>
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<td>275 x 300 x 350</td>
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<td>975 x 740 x 1620</td>
<td>8.0</td>
<td>3-phase 1</td>
<td>350</td>
</tr>
<tr>
<td>HT 40/17</td>
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<td>300 x 350 x 350</td>
<td>40</td>
<td>1000 x 800 x 1620</td>
<td>12.0</td>
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</tr>
<tr>
<td>HT 64/17</td>
<td>1750</td>
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<td>64</td>
<td>1130 x 900 x 1670</td>
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<td>550</td>
</tr>
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<td>128</td>
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<td>26.0</td>
<td>3-phase 1</td>
<td>750</td>
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<tr>
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<td>500 x 550 x 550</td>
<td>160</td>
<td>1250 x 1050 x 1900</td>
<td>21.0</td>
<td>3-phase 1</td>
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<td>HT 276/17</td>
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<td>1100</td>
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<td>500 x 1150 x 780</td>
<td>450</td>
<td>1350 x 1740 x 2120</td>
<td>64.0</td>
<td>3-phase 1</td>
<td>1500</td>
</tr>
</tbody>
</table>

*Heating only between two phases

*Please see page 73 for more information about supply voltage

---

Additional equipment:
- Uncontrolled or controlled cooling system with frequency-controlled cooling fan and motor-driven exhaust air flap
- Furnace in DB design featuring fresh air preheating, exhaust gas ventilation and an extensive safety package for debinding and sintering in one process, i.e. without transferring the material from the debinding furnace to the sintering furnace
- Stainless steel exhaust gas top hats
- Special heating elements for zirconia sintering provide for longer service life with respect to chemical interaction between charge and heating elements
- Protective gas connection to purge with non-flammable protective or reaction gases
- Manual or automatic gas supply system
- Inner process box to improve the gas tightness and to protect the furnace chamber against contamination
- Lift door
- Motorized exhaust air flap, switchable via the program
- Thermal or catalytic exhaust cleaning systems see page 66
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 72

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**High-temperature furnace HT 64/16S** with pneumatically driven and parallel lift door

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**Two-door design for high-temperature furnaces > HT 276/..**
Ovens, also with Safety Technology According to EN 1539

With their maximum working temperature of up to 300 °C and air circulation, the ovens achieve a perfect temperature uniformity which is much better than in ovens of most competitors. They can be used for various applications such as e.g. drying, sterilizing or warm storing. Ample warehousing of standard models provides for short delivery times.

- Tmax 300 °C
- Working temperature range: +5 °C above room temperature up to 300 °C
- Ovens TR 30 - TR 240 designed as tabletop models
- Ovens TR 450 and TR 1050 designed as floor standing models
- Horizontal, air circulation results in temperature uniformity better than +/- 5 °C (oven TR 30 up to +/- 4 °C) with closed exhaust flap in the empty workspace according to DIN 17052-1 see page 68
- Stainless steel chamber, alloy 304 (AISI)/(DIN material no. 1.4301), rust-resistant and easy to clean
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- Large handle to open and close the door
- Charging in multiple layers possible using removable grids (number of removable grids included, see table to the right)
- Large, wide-opening swing door, hinged on the right with quick release for models TR 30 - TR 450
- Double swing door with quick release for TR 1050
- TR 1050 equipped transport rollers
- Infinitely adjustable exhaust at the rear wall with operation from the front
- PID microprocessor control with self-diagnosis system
- Solid state relays provide for low noise operation
- 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 72
Oven TR 1050 with double door

Additional equipment
- Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the oven and load
- Infinitely adjustable fan speed of the air circulation fan
- Window for charge observing
- Further removable grids with rails
- Side inlet
- Stainless steel collecting pan to protect the furnace chamber
- Door hinges on the left side
- Reinforced bottom plate
- Safety technology according to EN 1539 for charges containing liquid solvents (TR .. LS) up to model TR 240 LS, achievable temperature uniformity +/- 8 °C see page 68
- Transport castors for model TR 450
- Various modifications available for individual needs
- Upgrading available to meet the quality requirements of AMS 2750 E or FDA
- Process control and documentation via VCD software package for monitoring, documentation and control see page 72

Model | T_max °C | Inner dimensions in mm | Volume in l | Outer dimensions in mm | Weight in kg | Minutes to Tmax | Grids included | Grids max. | Max. total load
--- | --- | --- | --- | --- | --- | --- | --- | --- | ---
TR 30 | 300 | 360 | 300 | 300 | 610 | 520 | 665 | 2.1 | 1-phase | 45 | 25 | 1 | 4 | 80
TR 60 | 300 | 450 | 390 | 350 | 60 | 700 | 610 | 710 | 3.1 | 1-phase | 90 | 25 | 1 | 4 | 120
TR 60 LS | 260 | 450 | 360 | 350 | 57 | 700 | 680 | 710 | 5.2 | 3-phase | 92 | 25 | 1 | 4 | 120
TR 120 | 300 | 650 | 390 | 500 | 120 | 900 | 610 | 860 | 3.1 | 1-phase | 120 | 45 | 2 | 7 | 150
TR 120 LS | 260 | 650 | 360 | 500 | 117 | 900 | 680 | 860 | 6.2 | 3-phase | 122 | 45 | 2 | 7 | 150
TR 240 | 300 | 750 | 550 | 600 | 240 | 1000 | 780 | 970 | 3.1 | 1-phase | 165 | 60 | 2 | 8 | 150
TR 240 LS | 260 | 750 | 530 | 600 | 235 | 1000 | 850 | 970 | 6.2 | 3-phase | 167 | 60 | 2 | 8 | 150
TR 450 | 300 | 750 | 550 | 1100 | 450 | 1000 | 780 | 1470 | 6.2 | 3-phase | 235 | 60 | 3 | 15 | 180
TR 1050 | 300 | 1200 | 670 | 1400 | 1050 | 1470 | 940 | 1920 | 9.4 | 3-phase | 450 | 80 | 4 | 14 | 250

*Please see page 73 for more information about supply voltage

1Max load per layer 30 kg
2If EN 1539 is ordered connected load will increase
3External dimensions vary when furnace is equipped with additional equipment. Dimensions on request
4In the empty oven with closed flaps, connected to 230 V 1/N/PE resp. 400 V 3/N/PE
The chamber ovens of the KTR range can be used for complex drying processes and heat treatment of charges to an application temperature of 260 °C. The high-performance air circulation enables optimum temperature uniformity throughout the work space. A wide range of accessories allow the chamber ovens to be modified to meet specific process requirements. The design for the heat treatment of flammable materials in conformance with EN 1539 (NFPA 86) is available for all sizes.

- Tmax 260 °C
- Electrically heated (via a heating register with integrated chrome steel heating elements) or gas-fired (direct or indirect gas-fired including injection of the hot air into the intake duct)

- Temperature uniformity up to +/- 3 °C according to DIN 17052-1 (for design without track cutouts)
- High-quality mineral wool insulation provides for outer temperatures of < 25 °C above room temperature
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- High air exchange for fast drying processes
- Double-wing door for furnaces KTR 3100 and larger
Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the oven and load.
- Incl. floor insulation
- 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 72

Additional equipment
- Track cutouts for level drive-in of charging cart
- Base frame to charge the oven via a charging forklift
- Additional door in the back for charging from both sides or to use the oven as lock between two rooms
- Fan system for faster cooling with manual or motor-driven control of the exhaust flaps
- Programmed opening and closing of exhaust air flaps
- Air circulation with speed control, recommendable for processes with light or sensitive charge
- Observation window and furnace chamber lighting
- Safety technology according to EN 1539 (NFPA 86) (models KTR .. LS) for charges containing solvents
- Charging cart with or without rack system
- Design for clean room heat treatment processes
- Rotating systems for tempering processes
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 72
Chamber Ovens
Electrically Heated or Gas-Fired

Charging cart with pull-out trays

Chamber oven KTR 6250 with double doors in the front and in the back as well as guide-in tracks for use as sluice oven

Drive-in tracks with sealing shoes

Accessories
- Adjustable plate shutters to adapt the air guide to the charge and improve temperature uniformity
- Guide-in tracks and shelves
- Shelves with 2/3 extraction with evenly distributed load on the whole shelf surface
- Platform cart in combination with drive-in tracks
- Charging cart with rack system in combination with drive-in tracks
- Sealing shoes for ovens with drive-in tracks to improve temperature uniformity in the work space

All KTR-models are also available with Tmax 300 °C.

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax</th>
<th>Inner dimensions in mm</th>
<th>Volume</th>
<th>Outer dimensions in mm²</th>
<th>Heating power in kW 1</th>
<th>Electrical connection</th>
<th>Electrical connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>KTR 1000 (LS)</td>
<td>260</td>
<td>1000 1000 1000</td>
<td>1000</td>
<td>1900 1430 1815</td>
<td>18/on request</td>
<td>3-phase</td>
<td>3-phase</td>
</tr>
<tr>
<td>KTR 1500 (LS)</td>
<td>260</td>
<td>1000 1000 1500</td>
<td>1500</td>
<td>1900 1430 2315</td>
<td>18/36</td>
<td>3-phase</td>
<td>3-phase</td>
</tr>
<tr>
<td>KTR 3100 (LS)</td>
<td>260</td>
<td>1250 1250 2000</td>
<td>2000</td>
<td>2400 1930 2905</td>
<td>27/45</td>
<td>3-phase</td>
<td>3-phase</td>
</tr>
<tr>
<td>KTR 4500 (LS)</td>
<td>260</td>
<td>1500 1500 2000</td>
<td>2000</td>
<td>2650 2200 3000</td>
<td>45/54</td>
<td>3-phase</td>
<td>3-phase</td>
</tr>
<tr>
<td>KTR 6125 (LS)</td>
<td>260</td>
<td>1750 1750 2000</td>
<td>2000</td>
<td>2650 2200 3000</td>
<td>45/63</td>
<td>3-phase</td>
<td>3-phase</td>
</tr>
<tr>
<td>KTR 6250 (LS)</td>
<td>260</td>
<td>1250 2500 2000</td>
<td>2000</td>
<td>2900 2450 3000</td>
<td>54/30</td>
<td>3-phase</td>
<td>3-phase</td>
</tr>
<tr>
<td>KTR 8000 (LS)</td>
<td>260</td>
<td>1500 3000 2000</td>
<td>2000</td>
<td>2900 2900 3000</td>
<td>54/81</td>
<td>3-phase</td>
<td>3-phase</td>
</tr>
<tr>
<td>KTR 9000 (LS)</td>
<td>260</td>
<td>1750 3500 2000</td>
<td>2000</td>
<td>2900 4900 3000</td>
<td>72/on request</td>
<td>3-phase</td>
<td>3-phase</td>
</tr>
<tr>
<td>KTR 12300 (LS)</td>
<td>260</td>
<td>1750 3500 2000</td>
<td>2000</td>
<td>2900 4900 3000</td>
<td>90/on request</td>
<td>3-phase</td>
<td>3-phase</td>
</tr>
<tr>
<td>KTR 16000 (LS)</td>
<td>260</td>
<td>2000 4000 2000</td>
<td>2000</td>
<td>3200 5400 3000</td>
<td>108/on request</td>
<td>3-phase</td>
<td>3-phase</td>
</tr>
<tr>
<td>KTR 21300 (LS)</td>
<td>260</td>
<td>2650 3550 2300</td>
<td>2300</td>
<td>3750 4300 3500</td>
<td>108/on request</td>
<td>3-phase</td>
<td>3-phase</td>
</tr>
<tr>
<td>KTR 22500 (LS)</td>
<td>260</td>
<td>2650 4500 2500</td>
<td>2500</td>
<td>3900 5400 3500</td>
<td>108/on request</td>
<td>3-phase</td>
<td>3-phase</td>
</tr>
</tbody>
</table>

1 Depending on furnace design connected load might be higher
2 Outer dimensions from chamber ovens KTR . LS are different
*Please see page 73 for more information about supply voltage
To ensure safe operation of the oven when tempering silicone, the fresh air supply of the oven must be monitored. A fresh air volume flow of 100 - 120 l/min/kg silicone (6-7.2 m³/h/kg silicone) has to be considered. The graph shows the maximum amount of silicone depending on the operating temperature for various KTR models at a fresh air supply of 120 l/min/kg silicone. The oven will be carried out in accordance with the requirements of the standard EN 1539 (NFPA 86).
For exhaust gas cleaning, in particular in debinding, Nabertherm offers exhaust gas cleaning systems tailored to the process. The afterburning system is permanently connected to the exhaust gas fitting of the furnace and accordingly integral part of the control system and the safety matrix of the furnace. For existing furnaces, independent exhaust gas cleaning systems are also available that can be separately controlled and operated.

**Catalytic afterburning systems (KNV)**

Catalytic exhaust cleaning is recommended due to energetic reasons when only pure hydrocarbon compounds must be cleaned during the debinding process in air. They are recommended for small to medium exhaust gas amounts.

- Perfectly suited for debinding processes in air with only organic exhaust gases
- Decomposition of gases in carbon dioxide and water
- Integrated in a compact stainless steel housing
- Electric heating provides for preheating of the exhaust gas to the optimal reaction temperature for catalytic treatment
- Cleaning in different layers of catalytic honeycombs within the system
- Thermocouples for measuring the temperatures of raw gas, reaction honeycombs and discharge
- Over-temperature limiter with adjustable cutout temperature protects the catalyst
- Tight connection between the exhaust gas outlet of the debinding furnace and the exhaust gas fan with corresponding integration into the overall system with respect to control and safety technology
- Catalyst dimensioned in relation to the exhaust gas flow
- Measuring port for clean gas measurements (FID)
Thermal afterburning systems (TNV)
Thermal afterburning systems are used if large volumes of exhaust gas from the debinding process in air must be cleaned and/or if there is a risk that the exhaust gases might damage the catalyst. Thermal afterburning is also used for debinding applications under non-flammable or flammable protective or reaction gases.

- Optimally suited for debinding processes in air with large exhaust gas flow, erratic large exhaust gas volumes, large volume flow or for debinding processes under non-flammable or flammable protective or reaction gases
- Gas-fired to burn the exhaust gases
- Burn-off at temperatures up to 850 °C provides for thermal decomposition of the exhaust gases
- Heating with compact gas burner with automatic firing device

Exhaust Gas Washer
An exhaust gas washer will be often used if the generated gases cannot be effectively treated with a thermal afterburner system or with a torch. To clean, detox or decontaminate the exhaust gas stream a liquid us used to wash or neutralize unwanted pollutants. The exhaust gas washer can be adapted to the process by designing its liquid distribution and contact area and by selecting the most suitable washing liquid. Liquids may simply be water or special reagents or even suspensions to successfully remove unwanted gases, liquids or particles from the exhaust gas.
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 measurement is 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.

<table>
<thead>
<tr>
<th>Instrumentation</th>
<th>Type</th>
<th>Furnace class</th>
<th>Temperature uniformity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Each control zone has a thermocouple connected to the controller</td>
<td>x</td>
<td>x x x x x</td>
<td>1 +/- 3 /+/- 5</td>
</tr>
<tr>
<td>Recording of the temperature measured by the control thermocouple</td>
<td>x</td>
<td>x x x x</td>
<td>2 +/- 6 /+/- 10</td>
</tr>
<tr>
<td>Sensors for recording the coldest and hottest spots</td>
<td>x</td>
<td>x</td>
<td>3 +/- 8 /+/- 15</td>
</tr>
<tr>
<td>Each control zone has a charge thermocouple with recording system</td>
<td>x</td>
<td></td>
<td>4 +/- 10 /+/- 20</td>
</tr>
<tr>
<td>Each control zone has an over-temperature protection unit</td>
<td>x</td>
<td>x x x</td>
<td>5 +/- 14 /+/- 25</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6 +/- 24 /+/- 50</td>
</tr>
</tbody>
</table>

**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 51
- Data recording, visualization, time management via the Nabertherm Control Center (NCC), based on Siemens WinCC software see page 72
- 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 straight-forward 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 up-coming 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 72).

**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.
Process Control and Documentation

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.

Visualization with NTGraph for Single-Furnace Control

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/RU). In addition, selected texts can be generated in other languages.

Software NTEdit for Entering Programs on the PC

By using the software NTEdit (Freeware) the input of the programs becomes clearer and thus easier. The program can be entered on customers PC and then be imported into the controller with a USB stick. The display of the set curve 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 eight languages (DE/EN/FR/SP/IT/CH/RU/PT).

Temperature Recorder

Besides the documentation via the software which is connected to the controls, Nabertherm offers different temperature recorders which can be used with respect to the application.

<table>
<thead>
<tr>
<th></th>
<th>Model 6100e</th>
<th>Model 6100a</th>
<th>Model 6180a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data input using touch panel</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Size of colour display in inch</td>
<td>5.5</td>
<td>5.5</td>
<td>12.1</td>
</tr>
<tr>
<td>Number of thermocouple inputs</td>
<td>3</td>
<td>18</td>
<td>48</td>
</tr>
<tr>
<td>Data read-out via USB-stick</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Input of charge data</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Evaluation software included</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Applicable for TUS-measurements acc. to AMS 2750 E</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>
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 charge 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 at a PC. 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 independent 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

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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.

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