Thermal Process Technology

Furnaces and Heat Treatment Systems for

Metals
Forming, Forging
Plastics, Rubber, Silicone
Surface Finishing
Fiber Composites, GFRP, CFRP
Drying Processes
Brazing, Soldering
Vacuum Technology
MIM
AMS 2750 D, NADCAP, CQI-9
Medtech
Energy Efficiency Technology

www.nabertherm.com
Made in Germany
Nabertherm with 350 employees worldwide have been developing and producing industrial furnaces for many different applications for over 60 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 inhouse manufacturing provide for individual project planning and construction of tailor-made thermal process systems 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
Centralized engineering and manufacturing and decentralized sales and service define our strategy to live up to your needs. Long term sales and distribution partners in all important world markets ensure individual on-site customer service and consultation. There are various reference customers in your neighborhood who have similar furnaces or systems.

Large Customer Test Center
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 world-wide. Due to our complete inhouse production, we can despatch most spare parts from stock over night or produce with short delivery time.

Experience in Many Fields of Thermal Processing
In addition to furnaces for thermal process technology, Nabertherm offers a wide range of standard furnaces and systems for many other thermal processing applications. The modular design of our products provides for customized solutions to your individual needs without expensive modifications.
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Which Furnace for Which Process?

Preheating for Forging

- Press Hardening
- Heating of sheet metals
- Preheating of molds

Hardening, Annealing

- Ageing
- Austempering
- Diffusion annealing
- Pack hardening
- Recovery annealing
- Coarse grain annealing

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

Quenching

- Water
- Air
- Oil
- Polymer

- Water quench tank with powerful water-circulation

Preheating for Forging

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- Bogie hearth furnaces gas-fired
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- Chamber furnaces gas-fired
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- Chamber furnaces
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Hardening, Annealing

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- Salt-bath furnaces
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- Salt-bath furnace TS 40/30
  with exhaust gas collection at crucible rim see page 52

Quenching

- Water quench tanks
  page 60 - 63

- Water quench tank with powerful water-circulation

Annealing furnace with electro-hydraulic lift-door
on transportable base for preheating of large steel sheets for the automotive industry see page 44

NR 200/11 H₂ for operation with hydrogen see page 10
### Tempering, Annealing

- Tempering
- Precipitation annealing
- Ageing
- Recovery annealing

### Heat Treatment Systems

- Solution annealing
- Preheating
- Reduced hydrogen annealing

#### Manual heat treatment systems for hardening of steel rods see page 62/63

#### in Air
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#### in Salt Bath
- Martempering furnaces
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#### Fully automatic tempering systems
- page 60/61
- Manual heat treatment systems
- page 62/63

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**Process Flow Chart**

[Image of process flow chart]
### Which Furnace for Which Process?

#### Brazing/Soldering

- Soft soldering
- Brazing
- High-temperature brazing

### Curing, Tempering, Drying

- Composites
- Molds
- Adhesive
- Plastics
- Lacquers
- PTFE
- Silicone
- Surface Drying
- Preheating
- Vulcanizing

#### under Protective Gases

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#### Water Based

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- Continuous furnaces page 56

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Brazing in a gas-supply box

VHT 500/22-GR H₂ with graphite insulation and heating see page 14
### Surface Treatment

**Thermal/Thermo-Chemical Processes**

- Carburizing
- Blueing (e.g. with water steam)
- Nitriding/nitrocarburizing
- Oxidizing
- Deoxidizing under hydrogen

### Sintering & Debinding

- Debinding
- MIM
- CIM
- Sintering

### In Salt Bath

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### Under Protective Gases, Reaction Gases or in Vacuum

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Blueing of drills in water steam atmosphere in a furnace of the NRA range see page 12

Sintering of MIM titan parts in a VHT furnace
Brazing, Forming, Plastics

The furnaces shown in this catalog can be used for various heat treatment processes. Nabertherm has developed interesting solutions for the processes described below as examples:

**Brazing**

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

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

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

The following furnace concepts are available for brazing:

- Brazing in an annealing box in the air circulation chamber furnace up to 850 °C in a protective gas atmosphere
- Brazing in an annealing box in a chamber furnace up to 1100 °C under a protective gas atmosphere
- Brazing in a hot-wall retort furnace NR/NRA series under protective gases or reaction gas up to 1100 °C
- Brazing in a cold-wall retort furnace VHT series under protective gases, reaction gases or under vacuum up to 2200 °C
- Brazing in a salt bath up to 1000 °C salt bath temperature
- Brazing or metallizing in a tube furnace up to 1800 °C under protective gases, reaction gases or in a vacuum up to 1400 °C (see separate Advanced Materials catalog)

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

**Pre-Heating for Hot Forming**

For traditional hot forming processes such as forging or die forming the piece must first be heated to a defined temperature. From the manufacture of individual parts to serial production, from thin metal sheets to components which are formed in the course of multiple passes – Nabertherm offers a broad range of furnaces and special solutions for these processes.

If, for example, only the ends of long components need to be heated, the furnace can be fitted with closable openings in the door to avoid any heat losses. To protect the operator, an isolating transformer is used which safely conducts away the electrical currents in case of touching the heating elements.

If the furnace is used near a forging hammer which causes strong vibrations, vibration dampers can be installed to separate the furnace from these frequencies. The needs of continuous forging processes are met by appropriate furnace models such as rotary hearth furnaces and continuous furnaces. The advantage of the rotary hearth furnace is its compact size and the charging/discharging of the work piece at one position.

If the task is to form sheet steel, for example in the automotive industry, the furnace needs a large width and depth in relation to its height. For easy charging, the furnaces are provided with a lift door and can, if necessary, be fitted with a charge support adapted for use with the charging stacker.
Tempering, Curing, Vulcanization and Degassing of Plastics, Rubber, Silicone, and Fiber Composite Materials

Many plastics and fiber composite materials must be heat-treated for product improvement or to ensure that they have the required product properties. In most cases, chamber dryers or ovens with air circulation are used for the respective process. The following examples outline the processes which these furnaces can perform.

PTFE (polytetrafluoroethylene)
One application is the heat treatment of PTFE. This process can be used to improve the adhesive properties, the mixture hardness or the sliding properties of the coating. In most cases, chamber dryers are used which, depending on the type of plastic, may or may not include safety technology based on EN 1539.

Silicone
One reason why silicone is tempered is to reduce the amount of silicone oil in the silicone to a certain percentage, i.e. to drive it out, in order to meet relevant food regulations. During the tempering process the silicone oil is vented out of the furnace chamber by continuous air exchange. To optimize the temperature uniformity in the furnace chamber, the fresh air supply is pre-heated. Depending on the furnace size, a heat-recovery system with heat exchangers can result in significant energy savings and pay for itself in just a short time.

Parts are prevented from sticking together by keeping them moving in a rotating rack in the oven.

Carbon Composite Materials
These days, carbon composite materials are used in many industries such as automotive, aerospace, wind power, agriculture, etc. Different materials and manufacturing processes require different heat-treatment processes for curing composite materials.

Some of the processes are done in autoclaves. Other materials are heat-treated in chamber dryers or ovens with air circulation. In this case, the composite materials are frequently evacuated in vacuum bags. For this purpose, the furnace is equipped with suitable connections for the evacuation of the air bags.

Pages 6/7 contain a description of which Nabertherm furnace ranges are suitable for tempering and curing of plastics.
Hot-Wall Retort Furnaces up to 1100 °C

NRA 17/06 - NRA 1000/11
These gastight 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 gastight retort with water cooling around the door to protect the special sealing. Equipped 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 required for the process:

Models NRA ../06 with Tmax 650 °C
- Heating elements located inside the retort
- Temperature uniformity up to \( \Delta T \leq 6 \) K inside the working chamber from 100 °C - 600 °C see page 64
- Retort made of 1.4571
- Gas circulation fan in the back of the retort provides for optimal temperature uniformity

Models NRA ../09 with Tmax 950 °C
- Outside heating with heating elements surrounding the retort as well as an additional door heater
- Temperature uniformity up to \( \Delta T \leq 6 \) K inside the working chamber from 200 °C - 900 °C see page 64
- Retort made of 1.4841
- Fan in the back of the retort provides for optimal temperature uniformity

Models NR ../11 with Tmax 1100 °C
- Outside heating with heating elements surrounding the retort as well as an additional door heater
- Temperature uniformity up to \( \Delta T \leq 10 \) K inside the working chamber from 200 °C - 1050 °C see page 64
- Retort made of 1.4841
Standard Equipment for all models

Basic version
- Compact housing in frame design with removable stainless steel sheets
- Controls and gas supply integrated in the furnace housing
- Welded charging supports in the retort or air-baffle box in the furnace with air circulation
- Swivel door hinged on right side with open cooling water system
- Multi-zone control for 950 °C and 1100 °C version, separated by furnace chamber and door. Depending on furnace chamber additionally subdivided into one or several heating zones
- Temperature control as charge control with temperature measurement inside and outside the retort
- Gas supply system for one nonflammable protective gas with flow meter and solenoid valve, switchable via the control system
- Operation under vacuum up to 600 °C with optional single-stage rotary vane pump
- Port for vacuum pump for cold evacuation
- PLC controls with touch panel H 700 for data input (resp. P 300 for 650 °C-version) see page 70

Additional equipment
- Upgrade for other nonflammable gases
- Automatic gas injection, including MFC flow controller for alternating volume flow, PLC controlled with touch panel H 3700
- Vacuum pump for evacuating of the retort up to 600 °C, attainable vacuum up to 10⁻⁵ mbar subject to selected pump
- Cooling system for shortening process times
- Heat exchanger with closed-loop cooling water circuit for door cooling
- Measuring device for residual oxygen content
Bayonet quick-lock for the retort, also with electric drive as additional equipment

**H₂ Version for Operation under Hydrogen**

When hydrogen is used as a process gas, the 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).

- H₂ supply at controlled overpressure of 50 mbar relative
- Certified safety concept
- PLC controls with graphic touch panel H 3700 for data input
- Redundant gas inlet valves for hydrogen
- Monitored pre-pressures of all process gases
- Bypass for safe flushing of furnace chamber with inert gas
- Torch for thermal afterburning of exhaust gases
- Emergency flood container for purging the furnace in case of failure

**IDB Version for Debinding under Protective Gas or for Pyrolysis Processes**

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

- Process control under monitored and controlled overpressure of 50 mbar relative
- Certified safety concept
- PLC controls with graphic touch panel H 1700 for data input
- Monitored gas pre-pressure of the process gas
- Bypass for safe flushing of furnace chamber with inert gas
- Torch for thermal afterburning of exhaust gases

<table>
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<th>Model</th>
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<td>650 or 950</td>
<td>1100</td>
<td>870</td>
<td>3-phase</td>
</tr>
<tr>
<td>NRA 25/1</td>
<td>650 or 950</td>
<td>1100</td>
<td>870</td>
<td>3-phase</td>
</tr>
<tr>
<td>NRA 50/1</td>
<td>650 or 950</td>
<td>1100</td>
<td>870</td>
<td>3-phase</td>
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<td>NRA 75/1</td>
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<td>650 or 950</td>
<td>1100</td>
<td>870</td>
<td>3-phase</td>
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*Please see page 70 for more information about mains voltage*
The retort furnaces SR and SRA (with gas circulation) are designed for operation with protective or reaction gases. The furnace is 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. The SR furnaces are available in different versions.

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

Models SR .../11 with Tmax 1100 °C
- Heating from all sides outside the retort
- Temperature uniformity up to °T 14 K according to DIN 17052-1 within the working chamber of 500 °C - 1100 °C see page 64
- Retort made of 1.4841
- Top down multi-zone control of the furnace heating

Models SRA ../09 with Tmax 950 °C
Design like models SR.../11 with following differences:
- Atmosphere circulation with powerful fan in the furnace lid provides for temperature uniformity of up to °T 8 K according to DIN 17052-1 within the working chamber of 200 °C - 900 °C see page 64

Models SRA ../06 with Tmax 600 °C
Design like models SRA.../09 with following differences:
- Heating inside the retort
- Temperature uniformity up to °T 14 K according to DIN 17052-1 within the working chamber of 100 °C - 600 °C see page 64
- Single-zone control
- Retort made of 1.4841

Standard Equipment (all models)
Design like standard equipment of models NR and NRA with following differences:
- Charging from above with crane or other lifting equipment from customer
- Hinged lid with opening to the side

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

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Inside dimensions of alloy retort</th>
<th>Outer dimensions in mm</th>
<th>Supply power/kW</th>
<th>Electrical connection*</th>
<th>Weight in kg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>α in mm</td>
<td>h in mm</td>
<td>Volume in l</td>
<td>W</td>
<td>D</td>
</tr>
<tr>
<td>SRA 17/..</td>
<td>17/100</td>
<td>250</td>
<td>350</td>
<td>17</td>
<td>1300</td>
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<td>50</td>
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<td>2000</td>
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<tr>
<td>SRA 100/..</td>
<td>100/600</td>
<td>400</td>
<td>800</td>
<td>100</td>
<td>1400</td>
<td>2000</td>
</tr>
<tr>
<td>SRA 200/.. or 600</td>
<td>200/950</td>
<td>600</td>
<td>700</td>
<td>200</td>
<td>1600</td>
<td>2200</td>
</tr>
<tr>
<td>SRA 300/.. or 950</td>
<td>300/1000</td>
<td>600</td>
<td>1000</td>
<td>300</td>
<td>1600</td>
<td>2200</td>
</tr>
<tr>
<td>SRA 500/..</td>
<td>500/1000</td>
<td>800</td>
<td>1000</td>
<td>500</td>
<td>1800</td>
<td>2400</td>
</tr>
<tr>
<td>SRA 600/..</td>
<td>600/1200</td>
<td>800</td>
<td>1200</td>
<td>600</td>
<td>1800</td>
<td>2400</td>
</tr>
<tr>
<td>SRA 800/..</td>
<td>800/1000</td>
<td>1000</td>
<td>1000</td>
<td>800</td>
<td>2000</td>
<td>2600</td>
</tr>
<tr>
<td>SRA 1000/..</td>
<td>1000/1300</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>2000</td>
<td>2600</td>
</tr>
<tr>
<td>SRA 1500/..</td>
<td>1500/1500</td>
<td>1200</td>
<td>1300</td>
<td>1500</td>
<td>2200</td>
<td>2800</td>
</tr>
</tbody>
</table>

*Please see page 70 for more information about mains voltage
The compact furnaces of the VHT product line are available as electrically heated chamber furnaces with graphite, molybdenum or MoSi₂ heating. A wide variety of heating designs as well as a complete range of accessories provide for optimal 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 nonflammable protective 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.

For debinding applications under vacuum, we recommend the VDB version, which besides the corresponding safety technology has an additional debinding retort in the heating chamber and prevents the exhaust gases from contaminating the furnace chamber. The exhaust gases are channelled from the debinding retort into the exhaust gas torch.

**Alternative Heating Specifications**

The following heating systems are available for the different application temperatures:

- **VHT 8/18-GR - VHT 100/18-KE**
  - The compact furnaces of the VHT product line are available as electrically heated chamber furnaces with graphite, molybdenum or MoSi₂ heating. A wide variety of heating designs as well as a complete range of accessories provide for optimal 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 nonflammable protective 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.
  - For debinding applications under vacuum, we recommend the VDB version, which besides the corresponding safety technology has an additional debinding retort in the heating chamber and prevents the exhaust gases from contaminating the furnace chamber. The exhaust gases are channelled from the debinding retort into the exhaust gas torch.

**Alternative Heating Specifications**

The following heating systems are available for the different application temperatures:

- **VHT 8/18-GR with Graphite Insulation and Heating**
  - Suitable for processes under protective and reaction gases or under vacuum
  - Tmax 1800 °C or 2200 °C
  - Max. vacuum up to 10⁻⁵ mbar depending on pump type used
  - Graphite felt insulation
  - Temperature measurement using type B thermocouple (version to 1800 °C)
  - Temperature measurement using optical pyrometer (version to 2200 °C)
**VHT ..../MO or ..../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 5 x 10⁻⁵ mbar depending on pump type used
- Insulation made of Molybdenum steel sheets
- Temperature measurement with thermocouple, type S for models with 1200 °C
- Temperature measurement with thermocouple, type B for models with 1600 °C and 1800 °C

**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
- Temperature measurement by thermocouple type B

<table>
<thead>
<tr>
<th></th>
<th>VHT ...../GR</th>
<th>VHT ...-16/MO</th>
<th>VHT ...-18/W</th>
<th>VHT ...-18/KE</th>
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</thead>
<tbody>
<tr>
<td>Inert gas</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Air</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;10⁻² mbar)</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>High vacuum (&lt;10⁻³ mbar)</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>Oxygen</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

¹up to 1400 °C
²depending on Tmax

**Standard Equipment for all Models**

**Basic version**
- Standard furnace sizes 8, 40 and 100 liters
- A water-cooled stainless steel process reactor sealed with temperature-resistant o-rings
- 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 stopcocks in supply and return lines, automatic flowmeter monitoring, openloop cooling water system
- Adjustable cooling water circuits with flowmeter and temperature indicator and overtemperature fuses
- Switchgear and controller integrated in furnace housing
- H 700 PLC control with clearly laid out 5.7” touchpanel control for program entry and display, 10 programs each with 20 segments
- Over-temperature limit controller with manual reset for thermal protection class in accordance with EN 60519-2
- Manual operation of the process gas and vacuum functions
- Manual gas supply for one process gas (N₂ or Ar) with adjustable flow
- Bypass with manual valve for rapid filling or flooding of furnace chamber
- Manual gas outlet with overflow valve (20 mbar relative)
- 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

**Additional equipment**
- Tmax 2400 °C
- Housing, optionally divisible, for passing through narrow door frames (VHT 08)
- Manual gas supply for second process gas (N₂ or Ar) with adjustable flow and bypass
- Inner process box made of molybdenum 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. Due to a change in gas supply direction after debinding a clean process atmosphere for sintering is achieved.

<table>
<thead>
<tr>
<th>Model</th>
<th>Inner dimensions of retort in mm</th>
<th>Volume in l</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHT 8/..</td>
<td>120 210 150</td>
<td>4</td>
</tr>
<tr>
<td>VHT 40/..</td>
<td>280 430 250</td>
<td>30</td>
</tr>
<tr>
<td>VHT 100/..</td>
<td>430 530 400</td>
<td>91</td>
</tr>
</tbody>
</table>

Thermocouple, type S with automatic pull-out device for precise control results in the low temperature range.
Continuation of additional equipment

- Charge thermocouple with display
- Two-stage rotary vane pump with ball valve for pre-evacuating and heat-treating in a vacuum to $10^{-2}$ mbar
- Temperature measurement at 2200 °C with pyrometer and thermocouple, type S with automatic pull-out device for precise control results in the low temperature range (VHT 40 and larger)
- Turbo molecular pump with slide valve for pre-evacuation and for heat treatment in a vacuum to $10^{-5}$ mbar including electric pressure transducer and booster pump (only VHT../MO)
- Heat exchanger with closed-loop cooling water circuit
- Automation package with graphic touch panel H 3700
  - 12” graphic touch panel H 3700
  - 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 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)
  - Transducer for absolute and relative pressure
- MFC flow controller for alternating volume flow and generation of gas mixtures with second process gas (only with automation package)
- Partial pressure operation: protective gas flushing at controlled underpressure (only with automation package)
- PC control via NCC with corresponding optional documentation and connection to customer PC networks
**VHT gas supply diagram, debinding and sintering**

**VHT 08/16 MO with hydrogen extension**

package as automatic version

In the H₂ version the furnaces of the VHT.../MO or VHT.../GR product line 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 furnaces are controlled by a fail-safe PLC control system (S7-300F/safety controller).

- Certified safety concept
- Automation package (see additional equipment above)
- 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 process reactor starting from room temperature at controlled over pressure (50 mbar relative)

**Additional equipment**

- Partial pressure operation: H₂ flushing at underpressure in the process reactor starting from 750 °C furnace chamber temperature
- Retort in the process chamber for debinding under hydrogen

**VDB Version VHT.../MO-VDB or VHT.../GR-VDB for Debinding under Protective Gas, Hydrogen or in Vacuum**

Certain processes require debinding under protective gases or in vacuum. For these processes the models VHT.../MO-VDB or VHT.../GR-VDB are perfectly suited. They are equipped with the necessary safety technology for debinding. The furnace chamber has an additional debinding retort with a direct discharge into the exhaust gas torch. This system ensures that exhaust gases during debinding do not get into and contaminate the furnace chamber.

- Adapted safety concept for debinding
- Automation package (see additional equipment above)
- Exhaust gas torch for burning the exhaust gases
- Debinding retort in the furnace chamber with direct discharge of the exhaust gases into the exhaust gas torch
- Bypass for safe flushing of furnace chamber with inert gas
- Dry-running vacuum pump

**Additional equipment**

- Condensate trap for separation of large binder volumes during vacuum debinding
- Heated exhaust gas discharge to prevent condensate deposits in the exhaust gas section
- Exhaust gas treatment depending on the process with binder trap, washer or exhaust gas torch

---

**Model Comparison Table**

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
<th>Outer dimensions in mm</th>
<th>Outer load kW*</th>
<th>Connected load kW*</th>
<th>Weight in kg</th>
<th>Material heater/insulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHT  8/..-GR</td>
<td>1800</td>
<td>170</td>
<td>240</td>
<td>200</td>
<td>8</td>
<td>1250 (800)¹</td>
<td>1100</td>
<td>2000</td>
</tr>
<tr>
<td>VHT  40/..-GR</td>
<td>2200</td>
<td>375</td>
<td>500</td>
<td>375</td>
<td>70</td>
<td>1700</td>
<td>2500</td>
<td>2400</td>
</tr>
<tr>
<td>VHT  70/..-GR</td>
<td>2200</td>
<td>375</td>
<td>500</td>
<td>375</td>
<td>70</td>
<td>1700</td>
<td>2500</td>
<td>2400</td>
</tr>
<tr>
<td>VHT  8/..-MO</td>
<td>1200</td>
<td>170</td>
<td>240</td>
<td>200</td>
<td>8</td>
<td>1250 (800)¹</td>
<td>1100</td>
<td>2700</td>
</tr>
<tr>
<td>VHT  40/..-MO</td>
<td>1600</td>
<td>375</td>
<td>500</td>
<td>375</td>
<td>70</td>
<td>1700</td>
<td>2800</td>
<td>2400</td>
</tr>
<tr>
<td>VHT  70/..-MO</td>
<td>2200</td>
<td>375</td>
<td>500</td>
<td>375</td>
<td>70</td>
<td>1700</td>
<td>2800</td>
<td>2400</td>
</tr>
<tr>
<td>VHT  8/..-KE</td>
<td>1800</td>
<td>170</td>
<td>240</td>
<td>200</td>
<td>8</td>
<td>1250 (800)¹</td>
<td>1100</td>
<td>2700</td>
</tr>
<tr>
<td>VHT  40/..-KE</td>
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<td>375</td>
<td>500</td>
<td>375</td>
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<td>1700</td>
<td>2800</td>
<td>2400</td>
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<td>375</td>
<td>500</td>
<td>375</td>
<td>70</td>
<td>1700</td>
<td>2800</td>
<td>2400</td>
</tr>
<tr>
<td>VHT  8/18-W</td>
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<td>240</td>
<td>200</td>
<td>8</td>
<td>1250 (800)¹</td>
<td>1100</td>
<td>2700</td>
</tr>
<tr>
<td>VHT  40/18-W</td>
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<td>1700</td>
<td>2800</td>
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<tr>
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<td>375</td>
<td>500</td>
<td>375</td>
<td>70</td>
<td>1700</td>
<td>2800</td>
<td>2400</td>
</tr>
<tr>
<td>VHT  100/18-W</td>
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<td>550</td>
<td>450</td>
<td>100</td>
<td>1900</td>
<td>3000</td>
<td>2500</td>
</tr>
<tr>
<td>VHT  8/18-KE</td>
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<td>170</td>
<td>240</td>
<td>200</td>
<td>8</td>
<td>1250 (800)¹</td>
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<td>VHT  40/18-KE</td>
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</tr>
<tr>
<td>VHT  70/18-KE</td>
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<td>500</td>
<td>375</td>
<td>70</td>
<td>1700</td>
<td>2800</td>
<td>2400</td>
</tr>
<tr>
<td>VHT 100/18-KE</td>
<td>1800</td>
<td>450</td>
<td>550</td>
<td>450</td>
<td>100</td>
<td>1900</td>
<td>2600</td>
<td>2500</td>
</tr>
</tbody>
</table>

¹With the switching system unit removed
²Only heating between two phases
³For operation under hydrogen a higher power rating has to be considered

*Please see page 60 for more information about mains voltage.

¹200 °C/1600 °C
²1800 °C/2200 °C
Pit-Type Cold-Wall Retort Furnaces up to 2400 °C or up to 3000 °C

SVHT 2/24-W - SVHT 9/30-GR
Compared with the VHT models (page 14 ff), the furnaces of the SVHT product line offer improved performance data with regard to achievable vacuum and maximum temperature. Due to the design as pit-type furnace with tungsten heating, processes up to max. 2400 °C even in high vacuum can be implemented with models of the SVHT..-W product line. Models of the SVHT..-GR product line with graphite heating, also in pit-type design, can be operated in an inert gas atmosphere even up to max. 3000 °C.

- Standard sizes with a furnace chamber of 2 or 9 liters
- Designed as pit-type furnace, charged from above
- Frame construction with inserted sheets of textured stainless steel
- Double-walled water-cooled stainless steel container
- Manual operation of process gas and vacuum functions
- Manual gas supply for non-combustible process gas
- A step in front of the furnace for an ergonomic charging height
- Retort lid with gas-charged shock absorbers
- Controls and switchgear as well as gas supply integrated in furnace housing
- Further standard product characteristics see description for standard design of VHT models page 14

Heating options

SVHT ..-GR
- Applicable for processes:
  - under protective or reaction gases or in the vacuum up to 2200 °C
  - under inert gases (argon, helium) up to 3000 °C
- Max. vacuum up to $10^{-4}$ mbar depending on the type of pump used
- Heating: graphite heating elements in cylindrical arrangement
- Insulation: graphite felt insulation
- Temperature measurement by means of an optical pyrometer

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

Additional equipment such as automatic process gas control or design for the operation with flammable gases incl. safety system see VHT models page 14.

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Working chamber dimensions Ø x h in mm</th>
<th>Usefull volume in L</th>
<th>Outer dimensions in mm</th>
<th>Connected load KW</th>
<th>Electrical connection*</th>
</tr>
</thead>
<tbody>
<tr>
<td>SVHT 2/24-W</td>
<td>2400</td>
<td>150 x 150</td>
<td>2.5</td>
<td>1400 2500 2100</td>
<td>55</td>
<td>3-phase</td>
</tr>
<tr>
<td>SVHT 9/24-W</td>
<td>2400</td>
<td>230 x 230</td>
<td>9.5</td>
<td>1500 2750 2100</td>
<td>95</td>
<td>3-phase</td>
</tr>
<tr>
<td>SVHT 2/30-GR</td>
<td>3000</td>
<td>150 x 150</td>
<td>2.5</td>
<td>1400 2500 2100</td>
<td>55</td>
<td>3-phase</td>
</tr>
<tr>
<td>SVHT 9/30-GR</td>
<td>3000</td>
<td>230 x 230</td>
<td>9.5</td>
<td>1500 2750 2100</td>
<td>95</td>
<td>3-phase</td>
</tr>
</tbody>
</table>

*Please see page 70 for more information about mains voltage
The LBVHT model series with lift-bottom specification are especially suitable for production processes which require either protective or reaction gas atmosphere or a vacuum. The basic performance specifications of these models are similar to the VHT models. Their size and design with electro-hydraulically driven table facilitate charging during production. The 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 lift-bottom 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 1800 °C
- Frame structure filled with textured stainless steel sheets
- Standard design with gassing system for non-combustible protective 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 14

---

**LBVHT 100/16 - LBVHT 600/24**

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Model</th>
<th>Tmax °C</th>
<th>Model</th>
<th>Tmax °C</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
<th>Electrical connection*</th>
</tr>
</thead>
<tbody>
<tr>
<td>LBVHT 100/16-MO</td>
<td>1600</td>
<td>LBVHT 100/18-WO</td>
<td>1800</td>
<td>LBVHT 100/24-GR</td>
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<td>450 700 100</td>
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<tr>
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<td>LBVHT 600/16-MO</td>
<td>1600</td>
<td>LBVHT 600/18-WO</td>
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<td>LBVHT 600/24-GR</td>
<td>2400</td>
<td>800 1200 600</td>
<td>3-phase</td>
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</table>

*Please see page 70 for more information about mains voltage
Chamber Dryer
Electrically Heated or Gas-Fired

The chamber dryers of the KTR range can be used for complex drying processes and heat treatment of charges of normal weight and packing density to an application temperature of 260 °C. The high-performance air circulation enables optimum temperature uniformity throughout the usable space. A wide range of accessories allow the furnace to be modified to meet specific process requirements. The design for the heat treatment of combustible materials in conformance with EN 1539 is available for all sizes.

- Tmax 260 °C
- Electrically heated (via a heating register with integrated chrome steel heating elements) or gas-fired (direct gas heating including injection of the hot air into the intake duct)
- Temperature uniformity up to $\Delta T 6$ K according to DIN 17052-1 (for design without track cutouts) see page 64
KTR 8000 KTR 1500 with charging cart

- High-quality mineral wool insulation provides for outer temperatures of < 20 °C above room temperature
- High air exchange for fast drying processes
- Double-wing door for furnaces KTR 3100 and larger
- Over-temperature limit controller with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the dryer and load
- Incl. floor insulation
- Controls description see page 68

Additional equipment
- Entry ramp for pallet trucks or track cutouts for charging cart
- Optimal air circulation for individual charges by means of adjustable air outlets
- Fan system for faster cooling with manual or motor-driven control
- Programmed opening and closing of exhaust vents
- Observation window and furnace chamber lighting
- Safety technology according to EN 1539 for charges containing solvents see page 28
- Charging cart with or without rack system
- Custom-built sizes
- Design for clean heat treatment processes see page 29
- Process control and documentation with Controltherm MV software package see page 69

<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>
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</thead>
<tbody>
<tr>
<td>KTR 1500</td>
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<td>1500 1950 2315</td>
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<td>KTR 3100</td>
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<td>3100 2160 1930 2880 50 3-phase</td>
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<td></td>
</tr>
</tbody>
</table>

*Please see page 70 for more information about supply voltage

Air-circulation in the chamber dryer
These air circulation chamber furnaces are available for maximum operating temperatures of 260 °C, 450 °C, 600 °C or 850 °C and are perfectly suited for demanding processes. Due to their robust and solid design even heavy loads can be heat treated. These furnaces are suited for use with baskets, pallets, and mobile furnace racks. The charging can be carried out with fork lift, pallet truck, or charging trolley. The basic furnace is standing on the shop floor without floor insulation. Charging can be simplified by roller conveyors, if necessary also motorized. All furnaces are available with electric or gas heating.

Standard version for models up to 600 °C (850 °C models see page 24)

- Tmax 260 °C, 450 °C or 600 °C
- Electrically heated or gas-fired
- Electric heating by means of heater coils
- Direct gas heating or upon request with indirect gas heating with radiation tube, e.g. for heat treatment of aluminum
- Optimal air circulation for your charge by means of adjustable air outlets
- Horizontal air flow (type ../HA)
- High air exchange for perfect heat transfer
- Ground level charging without floor insulation for 260 °C models
- Temperature uniformity up to ΔT 8 K according to DIN 17052-1 see page 64
- Furnace chamber lined with alloy 1.4301 (DIN)
- High quality mineral wool insulation provides for low outer temperatures
- Inside unlocking device for furnaces with walk-in chambers
- Furnaces sizes suited for common charging systems, such as pallets, baskets, etc.
- Double-wing door for furnaces N 1500 and larger
Over-temperature limit controller with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load.

Controls description see page 68

Additional equipment for models up to 600 °C
- Optional floor insulation provides for improved temperature uniformity for 260 °C models
- Entry ramps or track cutouts for floor-level charging of models with bottom insulation (not for 600 °C models)
- Furnace positioned on base frame provides for ergonomic charging height
- Electro-hydraulic lift door
- Fan system for faster cooling with manual or motor-driven control
- Motor-driven control of air inlet and exhaust air vents for better ventilation of the furnace chamber
- Observation window and/or furnace chamber lighting (not for 600 °C models)
- Optimization of the temperature uniformity up to \( \Delta T \leq 6 \) K according to DIN 17052-1 see page 64
- Safety technology according to EN 1539 for charges containing solvents (not for 600 °C models) see page 28
- Charging systems or roller conveyors, also electrically driven provide for easy charging see page 48
- Catalytic or thermal exhaust gas cleaning systems
- Custom sizes up to 30,000 liters and charge weights up to 30 tons
- Process control and documentation with Controltherm MV software package see page 69
Air Circulation Chamber Furnaces > 500 Liters up to 850 °C
Electrically Heated or Gas-Fired

Standard version for models 850 °C
- Tmax 850 °C
- Electrically heated or gas-fired
- Electric heating with heating elements on supports tubes
- Direct gas heating into the outlet of the air circulation fan
- Optimal air circulation for your charge by means of adjustable air outlets
- Horizontal air-flow (type .../HA)
- High air exchange provides for perfect heat transfer
- Base frame with 900 mm charging height
- Temperature uniformity up to ΔT 10 K according to DIN 17052-1 see page 64
- Air baffles made of 1.4828 (DIN)
- Multi-layered insulation with fiber plates (not classified according to EU directive 67/548) provides for low outer temperatures
- Furnaces sizes perfectly suited to accommodate common charging systems, e.g. like pallets or pallet boxes
- Over-temperature limit controller with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Controls description see page 68

Additional equipment for models 850 °C
- Electro-hydraulic lift door
- Fan system for faster cooling with manual or motor-driven control
- Motor-driven air inlet and control of exhaust air vents for better ventilation of the furnace chamber
- Optimization of the temperature uniformity up to ΔT 6 K according to DIN 17052-1 see page 64
- Base frame for customized charging height
- Charging systems or roller conveyors, also electrically driven provide for easy charging see page 48
- Custom sizes up to 30,000 liters and charge weights up to 30 tons
- Designed for Tmax 950 °C, fan blade driven indirectly via a belt to protect the air recirculation motor against overheating
- Process control and documentation with Controltherm MV software package see page 69
<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>Circulation rate m³/h</th>
<th>Connected load kW</th>
<th>Electrical connection*</th>
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<td>260</td>
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<td>560</td>
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<td>2380 2400 2720</td>
<td>12800</td>
<td>54.0</td>
<td>3-phase</td>
</tr>
</tbody>
</table>

*Reduced connected power for plastics applications

*Please see page 70 for more information about supply voltage

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N 3668/80HAS for heat treatment of cutting tools

N 4010/45HA with track cutouts, chamber lighting and observation window
Air Circulation Chamber Furnaces < 500 Liters
Electrically Heated

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

- $T_{\text{max}}$ 450 °C, 650 °C, or 850 °C
- Heating from bottom, sides and top
- Stainless steel air-baffle box in the furnace for optimum air circulation
- Swing door hinged on the right side
- Base frame included in the delivery, N 15/65 HA designed as table-top model
- Horizontal air circulation
- Temperature uniformity up to $\Delta T$ 8 K according to DIN 17052-1 see page 64
- Optimum air distribution enabled by high flow speeds
- One removable tray and rails for two additional trays included in the scope of delivery (N 15/65 HA without removable tray)
- Controls description see page 68

Additional equipment (not for model N 15/65HA)
- Optimization of the temperature uniformity up to $\Delta T$ 6 K according to DIN 17052-1 see page 64
- Fan cooling to accelerate the cooling process
- Motorized exhaust vents
- Manual lift door
- Pneumatic lift door
Adjustable air circulation for sensitive components
Additional removable trays
Roller conveyor in furnace chamber for heavy charges
Annealing boxes see page 50
Feed and charging aids see page 48
Designed for Tmax 950 °C, fan blade driven indirectly via a belt to protect the air recirculation motor against over-heating
Process control and documentation with Controltherm MV software package see page 69

<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>N 30/45 HA</td>
<td>450</td>
<td>290 420 260</td>
<td>30</td>
<td>607 + 255 1175 1315</td>
<td>3.6</td>
<td>1-phase</td>
<td>195</td>
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<tr>
<td>N 60/45 HA</td>
<td>450</td>
<td>350 500 350</td>
<td>60</td>
<td>667 + 255 1250 1400</td>
<td>6.6</td>
<td>3-phase</td>
<td>240</td>
</tr>
<tr>
<td>N 120/45 HA</td>
<td>450</td>
<td>450 600 450</td>
<td>120</td>
<td>767 + 255 1350 1500</td>
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<td>3-phase</td>
<td>310</td>
</tr>
<tr>
<td>N 250/45 HA</td>
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<td>600 750 600</td>
<td>250</td>
<td>1002 + 255 1636 1860</td>
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<td>610</td>
</tr>
<tr>
<td>N 500/45 HA</td>
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<td>750 1000 750</td>
<td>500</td>
<td>1152 + 255 1886 2010</td>
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<td>3-phase</td>
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<tr>
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<td>15</td>
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<tr>
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<td>607 + 255 1175 1315</td>
<td>6.0</td>
<td>3-phase¹</td>
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<tr>
<td>N 60/65 HA</td>
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<td>1152 + 255 1886 2010</td>
<td>31.0</td>
<td>3-phase</td>
<td>1030</td>
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</tbody>
</table>

¹Table-top model see page 26
²Heating only between two phases

*Please see page 70 for more information about supply voltage
Air Circulation Chamber Furnaces/Ovens with Safety Technology for Solvent-Containing Charges according to EN 1539 or NFPA 86

Safety Technology for Air Circulation Chamber Furnaces

Certain processes release and vaporize solvents or other flammable vapors. The concentration of these vapors must be kept below a certain limit to prevent ignition. European Norm EN 1539 and NFPA 86 in the USA prescribe the required safety equipment for these processes.

For these applications and processes, all air circulation furnaces of the KTR and air circulation chamber furnaces < 450 °C product lines are suited with safety technology for protection of a potential ignition in the furnace chamber.

To avoid an ignition in the furnace, flammable vapors must be diluted with air. Special care must be taken so high concentrations of flammable materials do not accumulate in “dead” areas within the furnace. For this purpose, the furnaces are equipped with an exhaust gas fan providing for a defined suction flow. A measurement system monitors this flow, while fresh air is simultaneously resupplied. In parallel, the furnace atmosphere is diluted by the inflow of fresh air. The air circulation is also monitored by the measurement system.

- Furnace sizes between 120 and 10,000 liters
- Powerful exhaust fan capable of maintaining negative furnace pressure
- Defined and monitored air circulation flow and exhaust air
- Visual and audible emergency signals
- Over-temperature limit controller with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
### Air Circulation Chamber Furnaces for Clean Room Processes

**Electrically Heated**

**NAC 120/65 - NAC 500/65**

Specific heat treatment processes require the reduction of particle contamination in the furnace chamber and on the work floor down to a minimum. For these applications the NAC air circulation chamber furnaces are recommended. The inner chamber is made of stainless steel and offers best possible protection against impurities from the insulation. Depending on design and required clean room class these furnaces can be equipped accordingly.

- **Tmax 650 °C**
- **Standard sizes between 120 and 500 liters furnace volume**
- **Customized dimensions, also available as production-scale furnaces up to 10000 l (KTR models)**
- **Dual shell housing provides for low surface temperatures**
- **Insulation made of mineral wool with aluminum protection cover provides for low emissions to the outside**
- **Welded inner housing made of stainless steel 1.4301**
- **Door with silicone sealing**
- **Horizontal airflow incl. air-guiding box provides for optimum temperature uniformity**
- **Tubular heating elements positioned behind the air-guiding box**
- **One shelf included in the delivery**

#### Additional equipment
- **Silicone-free design with door sealing made of Viton**
- **Electro-polished inner box**
- **Electrically driven air inlet and air outlet flaps**
- **Cooling system for reduction of process times**
- **Observation window in the door**
- **Manu

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Inner dimensions in mm</th>
<th>Outer dimensions in mm</th>
<th>Connected load/kW</th>
<th>Electrical connection*</th>
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</thead>
<tbody>
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<td>3-phase</td>
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<td>1050 + 255 x 1750 x 1750</td>
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<tr>
<td>NAC 500/65</td>
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<td>750 x 900 x 750</td>
<td>1120 + 255 x 1900 x 1900</td>
<td>27.6</td>
<td>3-phase</td>
</tr>
</tbody>
</table>

Rights to change technical data, especially with respect to outer dimensions reserved. Please see page 70 for more information about supply voltage.

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**Clean room production furnace KTR 8000**

Cleanroom/greyroom solution with charging and operation from the cleanroom.

**Industrial oven N 250/65 HAC with particle-free oven chamber. For charging, furnace door is located in cleanroom, class 100, furnace chamber in greyroom behind.**
With their maximum working temperature of up to 300 °C and forced 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.

**TR 60 - TR 1050**

- Tmax 300 °C
- Working range: + 5 °C above room temperature up to 300 °C
- Models TR 60 - TR 240 designed as tabletop models
- Models TR 450 and TR 1050 designed as floor standing models
- Horizontal, forced air circulation results in temperature uniformity better than ΔT 8 K see page 64
- Stainless steel chamber, alloy 304 (AISI)/(DIN material no. 1.4301), rust-resistant and easy to clean
- 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 60 - 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
- Controls description see page 68

**Additional equipment**

- Over-temperature limit controller with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace 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
Safety Technology according to EN 1539 for charges containing liquid solvents up to model TR 240, achievable temperature uniformity $\Delta T$ 16 K
Transport castors for model TR 450
Various modifications available for individual needs
Upgrading available to meet the quality requirements of AMS 2750 D or FDA
Process control and documentation with Controltherm MV software package see page 69

<table>
<thead>
<tr>
<th>Model</th>
<th>$T_{max}$ °C</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
<th>Outer dimensions in mm</th>
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<th>Electrical connection*</th>
<th>Weight in kg</th>
<th>Grids included</th>
<th>Grids max</th>
<th>Max. total load¹</th>
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¹Max load per layer 30 kg
²If EN 1539 is ordered power rating will increase

* Please see page 70 for more information about supply voltage.
Air Circulation Bogie Hearth Furnaces
Electrically Heated or Gas-Fired

The air circulation bogie hearth furnaces W 1000/60A - W 1000/85A are used when heavy charges weighing up to more than 25 t have to be heat-treated. They are ideal for processes such as solution annealing, artificial ageing, annealing or soft annealing, for which a high degree of temperature uniformity is crucial. The high-performance air circulation assures that the temperature uniformity achieved throughout the usable space is outstanding. A broad selection of additional equipment enables these furnaces to be optimally adapted to suit specific processes.

- Tmax 600 °C or 850 °C
- Dual shell housing with rear ventilation provides for low shell temperatures for the 850 °C models
- Swing door hinged on the right side
- Heating from chrome steel heating elements in the intake area of the air circulation system for the 600 °C models
- Heating from three sides (both side walls and the trolley) for the 850 °C models
- High-performance air circulation fan with vertical circulation
- Temperature uniformity up to ∆T 10 K according to DIN 17052-1 see page 64
- Bottom heating protected by SiC tiles on the bogie providing level stacking surface for the 850 °C models
- Furnace chamber fitted with inner sheets made of stainless steel 1.4301 for 600 °C models and of 1.4828 for 850 °C models

- Insulation structured with high-quality mineral wool for 600 °C models
- Insulation made of high-quality, non-classified fiber material for 850 °C models
- Bogies with flanged wheels running on rails for easy and precise movement of heavy loads
- Electric chain-driven bogie in combination with rail operation for smooth movement of heavy loads from model W 4800

W 3300/85S with chain drive

W 4000/60AS with charging basket made of 1.4828

Charge support in a circulating air bogie hearth furnace for 850 °C

Circulating air bogie hearth furnace for heat-treating coils
Over-temperature limit controller with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load.

Additional equipment:
- Direct gas heating or upon request with indirect gas heating with radiation tube
- Custom-built sizes
- Electric chain-driven bogie in combination with rail operation for smooth movement of heavy loads up to Model W 4000
- Optimization of the temperature uniformity up ΔT 6 K according to DIN 17052-1 see page 64
- Bogie running on steel wheels with gear rack drive, no rails in front of the furnace necessary
- Different possibilities for an extension to a bogie hearth furnace system:
  - Additional bogies
  - Bogie transfer system with parking rails to exchange bogies running on rails or to connect multiples furnaces
  - Motor-driven bogies and cross-traversal system
  - Fully automatic control of the bogie exchange
- Electro-hydraulic lift door
- Motor-driven exhaust air vents, adjustable via the program
- Controlled cooling system with frequency-controlled cooling fan and motorized exhaust air vent
- Multi-zone control adapted to the particular furnace model provides for optimum temperature uniformity in the 850 °C models
- Commissioning of the furnace with test firing and temperature uniformity measurement (also with load) for the purpose of process optimization
- Designed for Tmax 950 °C, fan blade driven indirectly via a belt to protect the air recirculation motor against over-heating
- Process documentation and control with Controltherm MV software package and the Nabertherm NCC control center for monitoring, documentation and control see page 68

<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>
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*Please see page 70 for more information about supply voltage
Air Circulation Ovens with Bogie Hearth
Electrically Heated or Gas-Fired

Ovens with bogie hearth from the WTR range are used to dry, temper, or vulcanize large quantities of material. The design of the oven corresponds basically to the bogie air circulation furnaces W 1000/60A ff. They can be individually adapted to suit the required process. These ovens can also be designed for heat treatment of combustible materials according to EN 1539.

- Tmax 260 °C
- Swing door hinged on the right side
- Heating from chrome steel heating elements in the intake area of the air circulation system
- High-performance air circulation fan with vertical circulation
- Temperature uniformity up to ΔT 8 K according to DIN 17052-1 see page 64
- Oven chamber with inner shelves made of galvanized steel sheet
- Insulation structured with high-quality mineral wool
- Bogies with flanged wheels running on rails for easy and precise movement
- Over-temperature limit controller with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 – as temperature limiter controller to protect the oven and load
- Manually adjustable air inlet and exhaust air vents
- High air exchange for fast drying processes
- Oven sizes suitable for common charging systems, such as pallets, baskets, etc.

Additional equipment, see air circulation bogie hearth furnaces on page 33
Air Circulation Pit-Type Furnaces
Electrically Heated

Pit-type furnaces with air circulation 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 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 ∆T 8 K according to DIN 17052-1 see page 64
- Interior walls from stainless steel
- Switchgear with solid-state relays
- Controls description see page 68

Additional equipment
- Charging hoist with swivel arm and charge basket
- Optimization of the temperature uniformity up to ∆T 4 K according to DIN 17052-1 see page 64
- Integrated fan for rapid cool down or separate cooling station for retort box cooling outside of the furnace
- Retort box with protective gas inlet and outlet for production in a defined atmosphere see page 50
- Manual or automatic gas supply systems see page 50

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
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¹Heating only between two phases
*Please see page 70 for more information about supply voltage
Due to their robust design, these pit-type furnaces with air circulation are particularly useful for a professional heat treatment demanding optimum temperature uniformity. Production processes such as tempering, solution annealing, artificial ageing, and soft annealing can be realized with these pit-type furnaces.

- Tmax 600 °C or 850 °C
- Useful for heavy charge weights
- Air circulation fans in the furnace lid, high circulation rate
- Temperature uniformity up to ∆T 6 K according to DIN 17052-1 see page 64
- Controls description see page 68

### Additional equipment
- Integral fan for fast cooling
- Optimization of the temperature uniformity up to ∆T 4 K according to DIN 17052-1 see page 64
- Variable rpm converter control of the air circulation velocity for sensitive parts
- Multiple zone control or special air circulation system for optimum temperature uniformity tailored to the charge
- Custom dimensions up to 10,000 liters
- Charge weights up to 7 tons
- Designed for Tmax 950 °C, fan blade driven indirectly via a belt to protect the air recirculation motor against overheating
- Process control and documentation with Controltherm MV software package see page 69

### Table of Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Inner dimensions cond. cylinder 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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</table>

*Please see page 70 for more information about supply voltage.*
Pit-Type and Top-Loading Furnaces with or without Air Circulation
Electrically Heated or Gas-Fired

Our top-loading furnaces are perfectly suited for the heat treatment of longer or heavier components. The furnace is usually charged with a factory crane. Due to their high-performance air recirculation system, the furnaces provide for excellent temperature uniformity up to a maximum temperature of 850 °C. The top-loading furnaces for the temperature range up to 1280 °C provide for very good temperature distribution due to their five-side heating. Alternatively, these furnaces can also be provided with gas heating. Customized dimensions are designed and produced to accommodate the size and weight of the components to be treated.

- Tmax 250 °C, 450 °C, 600 °C or 850 °C for furnaces with air recirculation
- Tmax 900 °C or 1280 °C for furnaces with radiant heating
- Electrically heated or gas-fired
- Heating from both long sides for furnaces with air recirculation
- Heating from all four sides and the floor with SiC plates in the floor as level stacking support for models to bis 900 °C or 1280 °C
- Hight-quality insulation, adapted to the specific maximum temperature
- Electrohydraulic opening system of the lid with two-hand operation
- Closable air supply vents in the lower area of the furnace chamber
- Closable exhaust air vents in the lid
- Over-temperature limit controller with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load

Additional equipment
- Motor-driven exhaust air flaps for faster cooling
- Controlled fan cooling with motor-driven exhaust air flaps
- Multi-zone control of the heating provides for optimum temperature uniformity
- Furnace chamber can be devided in length for short workparts, partitions can be controlled separately
- Customized dimensions
- Customized charging racks
- Designed for Tmax 950 °C, fan blade driven indirectly via a belt to protect the air recirculation motor against over-heating
- Process control and documentation with Controltherm MV software package see page 69
Bogie Hearth Furnaces
Electrically Heated

W 1000/G - W 10000
For annealing and hardening of larger parts, for example heavy cast parts or tool steel dies to temperatures between 800 °C and 1100 °C, we recommend our bogie hearth furnaces with radiation heating. The bogie can be loaded outside the furnace. When the design includes an electro-hydraulic lift door and a motorized bogie, the furnace can be opened while hot and the load can be removed for cooling or quenching. When several bogies are used together with a second door or bogie-transfer system, one bogie can be loaded outside the furnace while the other bogie is in the furnace. This shortens process times and the residual energy of the furnace can be used when the new charge is heated.

- Tmax 900 °C or 1280 °C
- Dual shell housing with rear ventilation, provides low shell temperatures
- Swing door hinged on the right side
- Heating from five sides (four sides and bogie) provides for a optimum temperature uniformity
- Bogie heating receives power via blade contacts when driven in
- Heating elements mounted on support tubes provide for free radiation and long service life.
- Bottom heating protected by SiC tiles on the bogie providing level stacking surface.
- Multi-layer insulation consisting of lightweight refractory bricks backed by microporous silica insulation.
- Self-supporting and long-life ceiling construction with bricks laid in arched construction.
- Bogies with flanged wheels running on rails for easy and precise movement of heavy loads.
- Adjustable air inlet damper.
- Over-temperature limit controller with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load.

Additional equipment:
- Customized dimensions.
- Fiber insulation for short heating time requirements.
- Electric chain-driven bogie in combination with rail operation for smooth movement of heavy loads.
- Bogie running on steel wheels with gear rack drive, no rails in front of the furnace necessary.
- Different possibilities for an extension to a bogie hearth furnace system:
  - Additional bogies
  - Bogie transfer system with parking rails to exchange bogies running on rails or to connect multiples furnaces.
  - Motor-driven bogies and cross-traversal system.
  - Fully automatic control of the bogie exchange.
- Electro-hydraulic lift door.
- Motor-driven exhaust air flap, switchable via the program.
- Controlled cooling system with frequency-controlled cooling fan and motorized exhaust air flap.
- Multi-zone control adapted to the particular furnace provides model for optimal the temperature uniformity.
- Commissioning of the furnace with test firing and temperature uniformity measurement (also with load) for the purpose of process optimization.
- Process documentation and control with Controltherm MV software package for Nabertherm Control Center (NCC) for monitoring, documentation and control see page 68.
**Bogie Hearth Furnaces**

**Electrically Heated**

Combi furnace system consisting of two furnaces W 5000/H and two additional bogies incl. bogie transfer system and incl. necessary park rails.

<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>
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<th>Electrical connection*</th>
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</table>

*Please see page 70 for more information about supply voltage*
Bogie Hearth Furnaces
Gas-Fired

Gas-fired bogie hearth furnaces distinguish by their unique efficiency. The use of high-speed burners allows for short heating times. The burners are arranged according to the furnace geometry providing for optimum temperature uniformity. Depending on the furnace dimensions, the burners can alternatively be equipped with recuperator technology to save energy. The high-quality, long-life fiber insulation with storage capacity provides for short heating and cooling times.

- Tmax 1300 °C
- Powerful, sturdy high-speed burner with pulse control and special flame control in the furnace chamber provide for optimum temperature uniformity
- Operation with city gas, natural gas or liquified gas
- Fully automatic PLC control of the temperature as well as monitoring of the burner function
- Reduction-resistant fiber insulation with low heat storage provides for short heating and cooling times
- Dual shell housing provides for low outside temperatures
- Exhaust hood with fittings for further discharge of the exhaust gases
- Over-temperature limit controller with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load

Additional equipment
- Customized furnace dimensions
- Automatic lambda control to set the furnace atmosphere
- Exhaust air and exhaust gas piping
- Recuperator burners utilizing part of the waste heat in the exhaust tract to preheat the combustion air and considerably contribute to energy saving
- Thermal or catalytic exhaust cleaning systems
- Process documentation and control with Controltherm MV software package for Nabertherm
- Control Center (NCC) for monitoring, documentation and control see page 68
- Other additional equipment for bogie hearth furnaces see pages 39
Certain heat treatment processes require a gas-fired chamber furnace. Short heating times due to the high power are a convincing argument. The chamber furnaces with powerful atmospheric gas burners cover a wide variety of these processes. In the basic version the burners are manually ignited once at the start of the process. The automatic control system then takes over control of the temperature curve. At program end, the burners are automatically switched off. Depending on the process, the furnaces can be equipped with automatically controlled fan burners and safety technology for debinding. Depending on the model, these furnaces can be upgraded with fully automatic fan burners and additional accessories.

- Tmax 1300 °C
- Powerful, atmospheric burners for operation with liquified gas or natural gas
- Special positioning of the gas burners with flame guide top-down provides for optimum temperature uniformity
- Fully automatic temperature control
- Gas fittings with flame control and safety valve in accordance with DVGW (German Technical and Scientific Association for Gas and Water)
- Multi-layer, reduction-proof insulation with light-weight refractory bricks and special back-up insulation result in low gas consumption
- Self-supporting and rugged ceiling, bricks laid in arched construction or as fiber insulation
- Dual shell housing, side panels made of stainless steel (NB 300), for low outside temperatures
- Solid, double-walled door
- Exhaust hood with 150 mm (NB 300) and 200 mm (NB 440, NB 600) diameter connection
- Over-temperature limit controller with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load

Additional equipment
- Customized furnace dimensions
- Fan burner with fully automatic control
- Exhaust air and exhaust gas piping
- Thermal or catalytic exhaust cleaning systems
- Recuperator technology for heat recovery see page 59
- Process documentation and control with Controltherm MV software package for Nabertherm Control Center (NCC) for monitoring, documentation and control see page 68
These universal chamber furnaces with radiation heating have been specifically designed to withstand heavy-duty use in the heat treatment 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
- Three-sides heating: from both side walls and floor
- High-quality, free-radiating heating elements mounted on support tubes for longest service life
- Floor heating protected by heat conducting SiC tiles
- Parallel guided downward swinging door (user protected from heat radiation)
- Stainless steel upper door jamb protects furnace structure when furnace is opened hot
- Exhaust opening in the side of the furnace, or on back wall of furnace in the N 31/H models and higher
- Temperature uniformity up to ∆T 20 K according to DIN 17052-1 see page 64
- 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 N81 and larger)
- Controls description see page 68

### Additional equipment see page 44/45

<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 connections*</th>
<th>Weight in kg</th>
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¹Table-top model
²Heating only between two phases
*Please see page 70 for more information about supply voltage
These very rugged chamber furnaces with radiation heating are designed for continuous heat-treatment processes. They are ideally suited for forming processes such as forging or hot forming steel sheets. The use of a wide variety of accessories enables these furnaces to be tailored to the relevant application.

- Tmax. 1200 °C
- Very rugged design
- Heating from three sides (both sides and the floor)
- Heating elements installed on ceramic support tubes enable unimpaired heat radiation
- Floor heating protected by heat-conducting SiC plate
- Manual lift door for models to N 951
- Electro-hydraulic lift door for models from N 1296
- Heating operated with low-wear semi-conductor relay (for models to 60 kW) see page 43
- Temperature uniformity up to $\Delta T$ 20 K according to DIN 17052-1 see page 64
- Closable measuring port for customer’s temperature measuring system
- Holding time measurement for the charge until it goes to forging or forming of steel sheets: After charging, the operator presses a key and the previously defined holding time for the load begins to run. The end of the holding time is indicated by both acoustic and optical signals, meaning that the charge can be removed.
- Heat resistant zinc paint for protection of door and door frame
- Controls description see page 68

Additional equipment
- Other temperatures on request
- SiC plates to protect the wall heating elements
- Electro-hydraulic lift door for models to N 951
- Protective gas ports in combination with silicone sealing of the chamber
- Annealing boxes for powder nitriding, annealing and hardening under protective gas
- Loading devices and charging aids
- Charging grates for heavy loads
Cooling fan in combination with motor-driven exhaust air vents in the top of the furnace
Heating elements also in door and rear wall for optimized temperature uniformity up to $\Delta T$ 10 K according to DIN 17052-1 see page 64
Commissioning of the furnace with test firing and temperature uniformity measurement using 11 thermocouples including record of the measurement results
Furnace chamber with optional heating elements in the ceiling when used for preheating of sheetmetal plates
Process control and documentation with Controltherm MV software package see page 69

<table>
<thead>
<tr>
<th>Model</th>
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*Please see page 70 for more information about supply voltage

N 761 with annealing box and charging cart

Furnace chamber with optional heating elements in the ceiling when used for preheating of sheetmetal plates
Lift-Top Furnaces
Electrically Heated

**H 125/LB or LT - H 3000/LB or LT**

Lift-top furnaces have the advantage that they are highly accessible for charging. The heating from all four sides and the table provides for very uniform temperatures. The basic furnace is equipped with a fixed table under the hood. The system can be expanded by adding one or several exchangeable tables which can be driven manually or motorically. Another option is to remove the hood completely with a shop crane. In such cases, the furnace heating system has a plug-in power supply.

- Tmax 1200 °C
- Dual shell housing with rear ventilation for low shell temperatures
- Electrohydraulically driven hood with fixed table
- Five-sided heating from all four sides and from the table provides for a temperature uniformity up to $\Delta T$ 20 K according to DIN 17052-1 see page 64
- Heating elements mounted on support tubes provide for free radiation and long service life of the heating wire

Lift-top furnace system with three exchangeable tables and protective gas boxes for heat treatment in protective gas
Bottom heating protected by SiC tiles which provide for a level stacking surface

Multilayer insulation consisting of lightweight refractory bricks backed by special insulation

Long-life ceiling design with fiber insulation

Manual exhaust air flap on the furnace roof

Over-temperature limit controller with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load

Additional equipment

- Customized dimensions
- Controlled cooling system with frequency-controlled cooling fan and motor-driven exhaust air flap
- Multi-zone control adapted to the particular furnace provides model for optimal the temperature uniformity
- Additional tables, table changing system, also automatically driven
- Hood, removable by customer’s crane, hood heating connected with plug-in power supply
- Commissioning of the furnace with test firing and temperature uniformity measurement using 11 thermocouples including record of the measurement results
- Process documentation and control with Controltherm MV software package for Nabertherm Control Center (NCC) for monitoring, documentation and control see page 68

<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>
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*Please see page 70 for more information about supply voltage
Charging Devices and Accessories for Chamber and Bogie Hearth Furnaces

Semi automatic heat treatment system with two furnaces N 250/65HA, each equipped with pneumatic lifting door and movable roller conveyor for easy furnace unloading.

By upgrading a furnace with useful accessories and devices for charging, you can considerably accelerate and simplify your heat processing which increases your productivity. The solutions shown on the following pages are only a part of our program, available in this product range. Ask us about accessories you may need. Our team of skilled engineers is prepared to develop a custom solution with you for any particular problem.

Air circulation furnace system consisting of two air circulation furnaces N 250/65 HA with pneumatic swing door opening for cooling and convenient furnace charging.

Air circulation furnace with charging grill shelves. The shelves can be moved individually on telescoping guides and can be taken out individually.

Air circulation furnace system with charging cart for sheet metal tempering.
Quench Tanks

Subject to process, charge size and weight a customized quench tank will be designed and delivered. Standard sizes are also available. Water, oil or polymer are available as quenching medium. Various examples of different quench tank design as part of manual and fully automatic heat treatment systems are described on page 60.

Available quenching mediums:
- Water
- Oil
- Polymer

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

Our protective gas and carburization modules allow you to upgrade our annealing and hardening furnaces into a compact annealing and hardening system as an economical alternative to expensive vacuum systems and protective gas furnaces. We can recommend different systems based on your application. Our professional test center will be pleased to test your product samples in order to specify the right heat treatment equipment for you.

**Annealing Box**
Our annealing boxes with lid sealing may be used for carburizing, annealing and hardening in neutral atmospheres, powder nitriding or boriding. Your charge is placed in the box and bedded in carburizing granulate, neutral annealing coal or nitriding or boriding powder. The box is sealed, and when heated, the resulting atmosphere in the closed annealing box provides for the respective surface reaction of the charge. For carburizing and similar processes, the annealing box may be removed while hot, opened and the charge quenched in fluid. For annealing processes, the box may remain in the furnace until it is cooled down.

**Annealing Tray with Alloy Bag**
This system, consisting of a lightweight tray with gas port and alloy bag, is particularly useful for air-quenched steels. The thin-walled alloy bag allows fast heat transfer. Its protective gas connections allow you to process your charge in a defined atmosphere. The small size of the gas lightweight tray you to pre-flush or cool the unit outside the furnace or place it on a cooling table for fast cooling by fan.

**Annealing Box with Protective Gas Inlet and Outlet**
The boxes are equipped with lid and protective gas inlet and outlet. The lid is sealed by means of a sealing channel with a high-temperature rope gasket before it is introduced into the furnace. The furnace is equipped with a special passage for the protective gas connections. The box is connected to a gas supply panel to introduce the required atmosphere in the box. When the heating process is finished, the box may be removed from the furnace, the lid removed and the parts quenched in liquid or air.

**Annealing Box with Protective Gas Inlet and Outlet constructed for Evacuation Ambient Temperatures**
This version of our annealing box is designed to be evacuated prior to the heating cycle. After evacuation, the box is refilled with a protective atmosphere for the heating cycle. This system is particularly useful for bright annealing of bulk materials, and nonferrous and noble metals, since oxygen can be more efficiently removed from the box by evacuation than through purging. Temperature-resistant seals allow this version of the annealing box to maintain a vacuum at ambient temperatures.

**Additional Accessories**
Nabertherm offers a wide range of hardening accessories for the a.m. heat treatment system. From the simple sealing cord for the gas supply box up to a fully automatic gas supply system, we offer interesting solutions for your problem. Please ask for our catalog thermal process technology II.
Powder nitriding in an annealing box

Powder carburizing of steel

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

Custom-sized box for fork-lift loading

Annealing tray with alloy bag

Bulk material bright annealing in an annealing box with evacuation facility
Salt-Bath Furnaces for Heat Treatment of Steel or Light Metals
Electrically Heated or Gas-Fired

TS 20/15 - TSB 90/80
Salt-bath furnaces offer remarkably high temperature uniformity and excellent heat transfer to the work piece. Our salt-bath furnaces TS 20/15 - TSB 90/80 are especially useful for heat-treating of metals in neutral or active salt baths. Processes such as carbonitriding (e.g. Tenifer) up to 600 °C, carburizing up to 950 °C, or bright annealing up to 1000 °C can be realized. In their standard version these furnaces are equipped with safety technology for heat treatment of steel. As additional feature they can be equipped with extended safety technology for heat treatment of light metals.

- Tmax 750 °C or 1000 °C in the salt bath
- Safety technology according to EN 60519-2
- Useful for heat treatment of steel
- Bath temperature control
- Electric (TS) all-round heating or gas heating (TSB)
- Removable collar plate made of solid steel
- Insulated swing-a-way lid
- Temperature uniformity up to ΔT 4 K according to DIN 17052-1 in the bath see page 64
- Over-temperature limit controller in the furnace chamber to prevent dangerous conditions for the furnace or personnel
- Bath control of salt bath and furnace chamber

Crucibles
- Type P: low carbon steel, CrNi plated and corundum coated for carburizing baths up to 950 °C, neutral salt and annealing baths up to 850 °C
- Type C: high alloy CrNi steel for neutral salt and annealing baths up to 1000 °C and for dip brazing of Aluminium

Additional equipment
- Exhaust gas collection at crucible rim as additional equipment
- Custom dimensions
- Enhanced safety systems for heat treatment of aluminium and magnesium in the salt bath with second over-temperature limit controller and PLC-bath control with thermocouples in the salt bath and in the furnace chamber

<table>
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<th>Model</th>
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<th>Volume in l</th>
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¹Only for electric version
²Salt bath temperature
*Please see page 70 for more information about supply voltage
Martempering Furnaces using Neutral Salts
Electrically Heated

**WB 20 - WB 400**

WB 20 - WB 400 martempering furnaces are filled with neutral salt and offer remarkably rapid and intensive heat transmission to the workpiece while ensuring optimum temperature uniformity. For working temperatures at between 180 °C and 500 °C these furnaces are ideal for quenching or cooling with minimal workpiece distortion, retempering, austempering for optimal toughness, recrystallization annealing after electrical discharge machining (EDM) and for blueing.

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

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

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

- Tmax 500 °C
- Optimal temperature uniformity
- Martemper bath temperature control
- Over-temperature limit controller with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Heating with immersion heating elements
- Charging basket

**Additional equipment**
- Charging aid mounted on side of furnace
- Process control and documentation with Controltherm MV software package see page 69

<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>WB 20</td>
<td>500</td>
<td>300 210 460</td>
<td>20 610 580 920</td>
<td>2.6 1-phase</td>
<td>110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WB 30</td>
<td>500</td>
<td>300 210 580</td>
<td>30 610 580 920</td>
<td>3.2 1-phase</td>
<td>140</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WB 70</td>
<td>500</td>
<td>400 300 680</td>
<td>70 750 680 980</td>
<td>7.5 3-phase</td>
<td>240</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WB 200</td>
<td>500</td>
<td>540 520 880</td>
<td>200 900 900 1200</td>
<td>18.0 3-phase</td>
<td>660</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WB 400</td>
<td>500</td>
<td>730 720 980</td>
<td>400 1100 1100 1300</td>
<td>24.0 3-phase</td>
<td>1150</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Please see page 70 for more information about supply voltage

**Information about salts by Petrofer and Durferrit and their application**

<table>
<thead>
<tr>
<th>Salt</th>
<th>Application</th>
<th>Working temperature in °C</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS 135/140</td>
<td>Salt-bath hardening, tempering, austempering</td>
<td>180 - 500</td>
<td>Not for use with workpieces which are heated up to above 950 °C and salts which contain more than 13 % KCN</td>
</tr>
<tr>
<td>AS 220/225</td>
<td>Tempering, austempering</td>
<td>250 - 500</td>
<td>Nitrite-free in the as-received condition</td>
</tr>
<tr>
<td>AS 200/235</td>
<td>Tempering, austempering</td>
<td>280 - 500</td>
<td></td>
</tr>
<tr>
<td>AS 200/235</td>
<td>Tempering</td>
<td>340 - 500</td>
<td></td>
</tr>
</tbody>
</table>
Rotary Hearth Furnaces up to 1300 °C with and without Air Circulation
Electrically Heated or Gas-Fired

The compact furnaces of the DH product line are optimally suited for continuous processes on a small floor space. They are designed for preheating processes such as the preheating of metal parts for forging. Charging and discharging can be done at one position – either by a person or fully automatic. The hearth rotates in pre-set segments individually reconciled with the workpart geometry. The rotational speed and rotational intervals can be defined by the control system or by manual switching.

The rotary hearth furnaces are specifically designed for the required throughput and charge dimensions. They are heated electrically or alternatively gas-fired by means of powerful gas burners. Subject to the temperature range these furnaces are equipped with or without air circulation.

- Tmax 1100 °C, 1200 °C or 1300 °C without air circulation
- Tmax 260 °C, 600 °C or 850 °C with air circulation
- Wire heating elements in the furnaces ceiling for furnaces up to 1200 °C
- SiC heating rods in the furnace ceiling for furnaces up to 1300 °C
- Gas heating as an alternative to electrical heating
- Models for 650 °C and 850 °C with powerful air circulation for better heat transfer onto the charge and to optimize the temperature uniformity
- Very compact design compared with continuous furnaces
- Designed for continuous operation at one working temperature
- Table diameter up to 3000 mm
- Hearth movement in defined segments
- Low-vibration movement of the rotary hearth
- Parallel swivel door
- Motor-driven or rotational motion initiated by foot switch
- Furnace floor can be lowered using a forklift truck for maintenance purposes
Rotary hearth furnace DH 1200/-/300/11

Additional equipment

- Customized dimensions
- Exhaust hood above the door opening for discharge of the warm exhaust air when door is open
- Pneumatic drive of the parallel swivel door
- Charging aids for ease of loading and unloading
- Multi-zone control for adjustable thermal profile during the cycle
- Protective gas connections
- Process control and documentation with Controltherm MV software package see page 69

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Pre-heating of steel rings for forging

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Furnace floor can be lowered for maintenance purposes

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*Please see page 70 for more information about supply voltage
Continuous furnaces are the right choice for processes with fixed cycle times such as drying or pre-heating, curing or degassing, etc. The furnaces are available for various temperatures up to a maximum of 1000 °C. The furnace design depends on the required throughput, the process requirements for heat treatment and the required cycle time. The conveyor technology (e.g. belt, rollers) is tailored to the required working temperature and the geometry of the charge. The conveyor speed and the number of control zones are defined by the process specifications.

Alternative furnace design subject to process specifications:

- Conveyor concepts
  - Conveyor belt
  - Metal conveyor belt with adjusted mesh gauges
  - Drive chain
  - Roller conveyors
  - Pusher-type furnace
Heating systems
- Electric heating, radiant or convection
- Direct or indirect gas-firing
- Infrared heating
- Heating with the use of external heat sources

Temperature cycles
- Control of working temperature across the whole length of the furnace, such as for drying or pre-heating
- Automatic control of a process curve applying defined heat-up, dwell and cooling time
- Control of a temperature curve including a final quenching of the charge

Process atmosphere
- In air
- Under protective gases such as nitrogen, argon or forming gas (95/5)
- Under reaction gases such as hydrogen incl. the necessary safety technology

Basic configuration criteria
- Conveyor speed
- Temperature uniformity
- Operating temperature
- Process curve
- Charge space width
- Charge weights
- Cycle time or throughput
- Length of charge and discharge zone
- Generated exhaust gases
- Specific industry standards such as AMS, CQI-9, FDA etc.
- Other individual customer requirements
Wire and Strand Annealing Furnaces

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

**D 20/S - D 320/S**
- Tmax 1200 °C
- Modular design, variable length
- Small outer dimensions due to efficient microporous silica insulation
- Special heating elements that can be changed during operation
- Heating from the ceiling
- Optimum temperature uniformity by means of multiple zone control
- Controls description see page 68

**Additional equipment**
- Gas supply systems for protective gas including hydrogen in the muffle tubes, with burn off torch and safety technology
- Process and charge documentation
- Double chamber furnace system with parallel chambers for simultaneous operation at different temperatures

<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>
</tr>
</thead>
<tbody>
<tr>
<td>D 20/S</td>
<td>1200</td>
<td>400 1000 50</td>
<td>20</td>
<td>900 1200 1350</td>
<td>9</td>
<td>3-phase</td>
</tr>
<tr>
<td>D 30/S</td>
<td>1200</td>
<td>600 1000 50</td>
<td>30</td>
<td>1100 1300 1350</td>
<td>12</td>
<td>3-phase</td>
</tr>
<tr>
<td>D 50/S</td>
<td>1200</td>
<td>200 3600 50</td>
<td>50</td>
<td>700 4000 1150</td>
<td>15</td>
<td>3-phase</td>
</tr>
<tr>
<td>D 60/S</td>
<td>1200</td>
<td>200 3600 50</td>
<td>50</td>
<td>700 4000 1150</td>
<td>15</td>
<td>3-phase</td>
</tr>
<tr>
<td>D 70/S</td>
<td>1200</td>
<td>200 3600 50</td>
<td>50</td>
<td>980 5000 1450</td>
<td>36</td>
<td>3-phase</td>
</tr>
<tr>
<td>D 10/S</td>
<td>1200</td>
<td>200 3600 50</td>
<td>50</td>
<td>980 5000 1450</td>
<td>36</td>
<td>3-phase</td>
</tr>
<tr>
<td>D 130/S</td>
<td>1200</td>
<td>200 3600 50</td>
<td>50</td>
<td>980 5000 1450</td>
<td>36</td>
<td>3-phase</td>
</tr>
<tr>
<td>D 180/S</td>
<td>1200</td>
<td>200 3600 50</td>
<td>50</td>
<td>980 5000 1450</td>
<td>36</td>
<td>3-phase</td>
</tr>
<tr>
<td>D 250/S</td>
<td>1200</td>
<td>200 3600 50</td>
<td>50</td>
<td>980 5000 1450</td>
<td>36</td>
<td>3-phase</td>
</tr>
<tr>
<td>D 320/S</td>
<td>1200</td>
<td>200 3600 50</td>
<td>50</td>
<td>980 5000 1450</td>
<td>36</td>
<td>3-phase</td>
</tr>
</tbody>
</table>

*Please see page 70 for more information about supply voltage.
Energy Efficiency Technology

In face of rising energy prices and stricter environmental regulations there is increasing demand for heat treatment systems with greater energy efficiency.

Depending on the furnace size and the process there is always a certain amount of potential energy which can be recovered from the waste heat and re-used. This is especially true for large furnace systems or long process times which allow for huge energy savings that the additional investment has a short pay-back time. The thermal energy from finished charges can also be used to pre-heat cold charges which is also an efficient way of saving energy.

The following examples outline engineering alternatives for heat recovery:

Heat Exchangers
The principle of the counterflow heat exchanger is to use the hot exhaust gas coming from the furnace to pre-heat the cold fresh air channelled into the furnace. In many cases, there is no need anymore for a separate fresh air preheating unit. Such a system is recommended if the process requires continuous air exchange in the furnace chamber, such as when tempering silicone, or during drying processes that are covered by the EN 1539 industrial standard.

Recuperator Burners
Large gas-heated heat-treatment furnaces are especially advantageous for the installation of recuperator burners. Recuperator burners also use hot exhaust gas; to pre-heat the combustion air. Depending on the furnace model and the process, substantial energy savings of as much as 25% can be realized by using recuperator burners so that there is a short pay-back time for the additional purchase costs.

Heat Transfer Chambers
Heat transfer chambers, which can also be described as cooling/heating chambers, offer two enormous advantages. For one, they help save energy, and for another, using a heat transfer chamber increases productivity.

The load is removed from the furnace while it is still hot and placed in the heat transfer chamber. The chamber also has room for a new, cold charge. Circulating the air cools the hot charge and, at the same time, preheats the cold charge before it is put into the furnace. Consequently, the furnace heating does not have to provide the thermal energy and through-put capacity of the furnace is increased of the same time.

The above systems for enhancing energy efficiency are only a few examples of technical alternatives. We would be happy to advise you on whether an additional heat recovery module would also be a sensible add-on to your furnace or system.
Tempering Plants for Steel and NE-Metals

Fully Automatic Tempering System with Air-Circulating Pit-Furnace S 1780/65 AS for Solution Annealing, Water Bath, Lift Conveyor and Pit Furnace S 3180/26AS for Artificial Aging

This tempering system is available for the tempering of aluminum parts with a quenching time of 30 seconds. All functional processes are fully automated. Both, the solution annealing and the artificial aging furnaces are designed as pit furnaces.

To save time, the conveyor unit picks-up the lid of the solution annealing furnace after solution annealing, along with the attached load basket and transports it to the water bath. The lid is then unlinked and conveyed back to the solution annealing furnace. After quenching, the basket is parked in a free spot.

The subsequent artificial aging process also takes place in a pit furnace. Due to the longer period needed for artificial aging, the artificial aging furnace is equipped for the introduction of two baskets, while the solution annealing furnace can only handle one.

The entire heat treatment, including all movements, is fully automated. The PLC controls handle all movement and locking processes. The system automatically detects occupied parking spaces and furnaces and starts the programmed processes according to priority. Charge documentation takes place on an ongoing basis, that is, the loaded basket is documented from the time it is loaded into a parking place until removal after the end of the process.

Systems design
- Pit furnace S 1780/65 AS for solution annealing of one basket, Tmax 650 °C, volume 1780 liters
- Pit furnace S 3180/26 AS for artificial aging of two baskets, Tmax 260 °C, volume 3180 liters
- Water bath with powerful circulation and heating, along with control of the water temperature
- Linear lift conveyor for all movement processes
- PLC controls with Nabertherm Control Center (NCC) for temperature regulation, control of all movements, and parallel batch documentation
- 6 parking spots with automatic occupancy detection, loading with forklift
- Safety fence around the entire system
Fully Automated Heat Treatment System with Air-Circulating Bogie Hearth Furnace W 2780/60 AS for Solution Annealing, W 2780/26 AS for Artificial Aging, Lift Conveyor, and Heated Water Bath

This tempering system is available for the tempering of T6 aluminum alloys with a quenching time of 10 seconds. All functional processes are fully automated. Both the solution annealing furnace and the artificial aging furnace are mounted on a platform and are designed as bogie hearth furnaces. After solution annealing, the conveyor unit positions itself in front of the furnace, the door opens, the bogie moves out, and the basket is automatically picked-up by the lift conveyor. The bogie moves back into the furnace and the load is quenched in the water bath underneath.

After the quenching process, the basket is lifted back out of the water bath, drips off, and is conveyed to the artificial aging furnace. After artificial aging, the lift conveyor transports the basket to a free parking spot.

The entire heat treatment, including all movements, is fully automated. The PLC controls handle all movement and locking processes. The system automatically detects occupied parking spaces and furnaces and starts the programmed processes according to priority. Charge documentation takes place on an ongoing basis, that is, the loaded basket is documented from its process start in the parking space until removal after the end of the process.

System Design
- Bogie hearth furnace W 2780/60 AS for solution annealing, Tmax 600 °C, volume 2780 liters
- Bogie hearth furnace W 2780/26 AS for artificial aging, Tmax 260 °C, volume 2780 liters
- Water bath with powerful circulation and heating, along with control of the water temperature
- Linear lift conveyor for all movement processes
- PLC controls with Nabertherm Control Center (NCC) for temperature regulation, control of all movements, and parallel batch documentation
- 5 parking spots with automatic occupancy detection, loading with forklift
- Safety fence around the entire system
Heat Treatment Systems for Steel and NE-Metals


This tempering system was built for the tempering of aluminum parts for automotive industry. The movement processes are performed manually using the customer’s crane. These solution annealing furnaces are designed as pit furnaces, while the artificial aging furnace is a bogie hearth furnace.

Solution annealing of the components takes place in two pit furnaces with 3570 liter furnace chambers. After the solution annealing process is concluded, the lid of the furnace is opened pneumatically, the basket is removed using the crane, and it is placed into the water bath. For better quench results, the water bath is equipped with a powerful circulation pump.

After quenching, the operator uses the crane to move the load onto the bogie of furnace W 7440/26 AS for artificial aging. The bogie hearth furnace is equipped with a chain-driven bogie which is moved out of the furnace electrically. The furnace is dimensioned to accept the loads from both solution annealing furnaces.

The furnace has PLC controls for temperature measurement and charge documentation. Every load can be assigned a name or a charge number, which is then stored along with the date.

System Design

- 2 pit furnaces S 3570/65 AS for solution annealing of one basket each, Tmax 650 °C, volume 3570 liters
- Bogie hearth furnace W 7440/26 AS for artificial aging of two baskets, Tmax 260 °C, volume 7440 liters
- Water bath with powerful circulation and heating, along with control of the water temperature
- PLC controls with Nabertherm Control Center (NCC) for charge documentation
Manual Heat Treatment System for Steel with Top-Hat Furnace H 4263/12S and Water Bath

This tempering system is available for the tempering of 8 meter steel profiles with a quenching time of 30 seconds. The furnace is a top-hat furnace which is loaded with a crane. After heat treatment, the operator positions the crane with attached C-hook in front of the furnace. The furnace is electrohydraulically opened by the operator at 1150 °C and the bogie is moved out of the furnace.

The charge holder on the bogie and the C-hook are designed in such a way that the charge is positioned into the C-hook directly when the bogie drives out. The crane only needs to lift it up. The operator then moves the material over the water bath and lowers it for quenching. After the quenching process, the basket is lifted back out of the water bath, drips dry, and is manually placed onto a free parking spot with the crane.

The system has PLC controls for temperature measurement and charge documentation. Every load can be assigned a name or a charge number, which is then stored along with the date.

System Design
- Top-hat furnace H 4263/12S, T\textsubscript{max} 1200 °C, volume 4260 liters, electrohydraulic hood drive, chain drive for bogie
- Water bath with powerful circulation
- PLC controls with Nabertherm Control Center (NCC) for temperature regulation and charge documentation
- Safety fence around the entire system
Temperature Uniformity and System Accuracy

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

**Specification of Temperature Uniformity in $\Delta$ K in the Standard Furnace**
In the standard design the temperature uniformity is specified as the relative, maximum deviation from a defined reference temperature within the useful space in the empty furnace at dwell time. Temperature uniformity is defined as $\Delta T$ in K. If, for example, a standard temperature uniformity of $\Delta T$ 10 K at 750 °C is specified, it means that the actual temperature in the furnace can vary between 740 °C and 750 °C or between 750 °C and 760 °C.

**Specification of the Temperature Uniformity in +/- °C as Additional Feature**
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 °C 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 useful space.

**System Accuracy**
Tolerances may occur not only in the useful space, they also exist with respect to the thermocouple and in the controls. If an absolute temperature uniformity in +/- °C at a defined set temperature or within a defined reference 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 useful 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 Useful Space incl. Protocol**
In standard furnaces a temperature uniformity is guaranteed as $\Delta T$ without measurement of temperature uniformity. However, as additional feature, a temperature uniformity measurement at a reference temperature in the useful 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 11 defined measurement positions. The measurement of the temperature uniformity 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.
AMS 2750 D, NADCAP, CQI-9

Standards such as the AMS 2750 D (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 D 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 charge 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 D

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 x x x x</td>
<td>1</td>
<td>+/- 3</td>
</tr>
<tr>
<td>Recording of the temperature measured by the control thermocouple</td>
<td>x x x</td>
<td>2</td>
<td>+/- 6</td>
</tr>
<tr>
<td>Sensors for recording the coldest and hottest spots</td>
<td>x x</td>
<td>3</td>
<td>+/- 8</td>
</tr>
<tr>
<td>Each control zone has a charge thermocouple with recording system</td>
<td>x x</td>
<td>4</td>
<td>+/- 10</td>
</tr>
<tr>
<td>Each control zone has an over-temperature protection unit</td>
<td>x x x x x</td>
<td>5</td>
<td>+/- 14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>+/- 24</td>
</tr>
</tbody>
</table>

Regular Inspections

The furnace or the heat treatment system must be designed so that the requirements of the AMS 2750 D 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 68
- Data recording, visualization, time management via the Nabertherm Control Center (NCC), based on Siemens WinCC software see page 60
- Commissioning at site, incl. the first TUS and SAT inspection
- Connection of existing furnace systems to meet norm requirements
- Documentation of the complete process chain in line with the corresponding norm
Implementation of AMS 2750 D

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.
Instrumentation for TUS Measurements as a Separate Model

The TUS standard requires that the temperature uniformity of the furnace be tested with a TUS measurement at regular intervals. This measurement must be performed by an independent measurement system and not by the instrumentation used for process control. The testing intervals are filed in the NCC in days. The system reminds in time that a test must be performed.

This test can be performed either using an independent temperature recorder (see page 68) with the customer’s calibrated testing thermocouples or using the Nabertherm TUS module that is connected to the Nabertherm Control Center as a separate module.

The TUS module has its own PLC which converts the measurement results of the testing thermocouples. The evaluation, including an easy-to-navigate and simply log function, is then performed via the furnace’s Nabertherm Control Center.

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 68).
HiProSystems Control and Documentation
This professional control system 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 dampers, 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 telediagnostic service is required. It is flexible and is easily tailored to your process or documentation needs.

Alternative User Interfaces

**Touch panel H 700**
This basic panel accommodates most basic needs and is very easy to use.

**Touch panel H 1700**
Firing cycle data and the extra functions activated are clearly displayed in a table. Messages appear as text.

**Touch panel H 3700**
All functions and process data are stored and displayed in easy to read charts. The data can be exported through various interfaces (Ethernet TCP/IP, MPI, Profibus) to a local PC or your company network for further processing. A CF card also gives the opportunity for data storage and transfer to a PC with a card reader.

For Control, Visualisation and Documentation

**Nabertherm Control Center NCC**
Upgrading the HiProSystems-Control individually into an 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 can be used also in accordance with the AMS 2750 D (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 existing Enterprise Database systems (e.g. SAP, Oracle)
- Connection to mobile phone network for alarm message transmission via SMS
- Control from various locations over the network
- Calibration of each measuring point for a specific temperature possible
- Extendable for calibration of a polygonal line with up to 18 temperatures per measuring point for use at different temperatures e.g. for AMS 2750 D applications

For Documentation

**Nabertherm Documentation Center NDC and data recording via NT Log**
If the process data of the HiProSystems control unit only need to be recorded, this can be done using a personal computer (PC) with the high-performance NDC software. The data are documented, forgery-proof, and can be evaluated both in the form of a table or a chart. Individual charge data can be entered by the customer and are archived together with the process data. A low-cost alternative which can be used is the NT Log package. The data is recorded on a USB stick during the firing. After the heat treatment has been completed, the recorded value can be read out on the PC with the free analysis software.

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>Feature</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></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Evaluation software included</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Applicable for TUS-measurements acc. to AMS 2750 D</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>
Controltherm MV Software for Control, Visualisation and Documentation

Documentation and reproducibility gain increased attention with steadily rising quality standards. The powerful Nabertherm software Controltherm MV provides for an optimum solution for the control and documentation of one or more furnaces as well as charge data on basis of Nabertherm controllers.

In the basic version one furnace can be connected to the MV-software. The system can be extended to four, eight or even 16 multi-zone controlled furnaces. Up to 400 different heat treatment programs can be stored. The process will be documented and filed. Process data can be read-out graphically or in table format. A data transfer to MS-Excel is also possible.

For furnaces which are not controlled via a Nabertherm controller, the furnace temperature can be documented with the MV-software. We deliver an extension package as optional equipment. With respect to the individual version, three, six or even nine independent thermocouples can be connected. Independent of the control system, the values of each thermocouple will be read-out and evaluated by the MV-software.

Features
- Simple installation without specific knowledge
- All Nabertherm controllers with interface connectable
- Manipulation protected storage of temperature curves of up to one, four, eight or 16 furnaces (also multizone-controlled), depending on the version of MV-software
- Redundant storage on a network server possible
- Programming, archiving and printing of programs and graphics
- Free input of descriptive charge data text with comfortable search function
- Data exportable into Excel format for further evaluation
- Start/stop of the controller from the local PC (only with Nabertherm controllers mit interface)
- Selectable languages: German, English, French, Italian or Spanish
- 400 additional programs storable (only with Nabertherm controllers with interface)

Extension Package II for Connection of one Additional Temperature Measuring Point, Independent of the Controller
- Connection of an independent thermocouple, type K or S with display of the measured temperature on the included controller C 6 D, e.g. for documentation of charge temperature
- Conversion and transmission of measured data to the MV-software
- For data evaluation, please see MV-software features

Extension Package II for Connection Three, Six or Nine Temperature Measuring Points, Independent of the Controller
- Connection of three thermocouples, type K, S, N or B to the supplied connection box
- Extendable to two or three connection boxes for up to nine temperature measuring points
- Conversion and transmission of measured data to the MV-software
- For data evaluation, please see MV-software features
Nabertherm has many years of experience in the design and construction of both standard and custom control systems. 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. The standard controllers are developed and fabricated within the Nabertherm group. When developing controllers, our focus is on ease of use. 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, PID microprocessor control with self-diagnosis system and a computer interface, we have a solution to meet your requirements.

**Assignment of Standard Controllers to Furnace Families**

<table>
<thead>
<tr>
<th>Controller</th>
<th>P 300</th>
<th>P 310</th>
<th>P 330</th>
<th>R 6</th>
<th>B 130</th>
<th>B 150</th>
<th>B 180</th>
<th>C 280</th>
<th>C 42</th>
<th>3208</th>
<th>3504</th>
<th>H 700/PLC</th>
<th>H 1700/PLC</th>
<th>H 3700/PLC</th>
<th>NCC</th>
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<tbody>
<tr>
<td>Catalog page</td>
<td>10</td>
<td>12</td>
<td>12</td>
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</table>

**Functionality of the Standard Controllers**

<table>
<thead>
<tr>
<th>Feature</th>
<th>B 130</th>
<th>C 280</th>
<th>P 300</th>
<th>P 310</th>
<th>R 6</th>
<th>B 150</th>
<th>3208</th>
<th>C 42</th>
<th>B 180</th>
<th>P 330</th>
<th>3504</th>
<th>H 700</th>
<th>H 1700</th>
<th>H 3700</th>
<th>NCC</th>
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<tbody>
<tr>
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<td>Segments</td>
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<td>5</td>
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<td>Extra functions (e.g. fan or autom. flaps)</td>
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<td>Graphic color display</td>
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<td>12&quot;</td>
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<td>Start time configurable (e.g. to use night power rates)</td>
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<td>Program entry in steps of 1 °C or 1 min.</td>
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<tr>
<td>USB-Interface for data read-out via USB stick and visualisation via NT Log see page 68 NEW</td>
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<td>kWh meter</td>
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<td>Real-time clock</td>
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</tr>
<tr>
<td>Bath control/charge control</td>
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<tr>
<td>Data entry via touchpanel</td>
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<tr>
<td>Data input via number pad</td>
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</tr>
</tbody>
</table>

**Mains Voltages for Nabertherm Furnaces**

**Single-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.

---

¹ As an extra feature in ovens with air circulation

² Not for melt bath control
Advanced Materials
With our broad range of furnaces for advanced materials we offer interesting solutions for many applications in powder metallurgy and technical ceramics, for the manufacture of fuel cells and other innovative areas of application. Our electric or gas heating furnaces can be operated in air, protective gas atmospheres or in a vacuum. From our laboratory furnaces to fully automated multi-purpose furnace systems with exhaust gas cleaning systems, we are sure to find a solution to meet your needs.

Laboratory
Apart from the furnaces shown for production Nabertherm offers a wide range of standard furnaces for laboratories. We keep standard units in stock for short delivery times. Please ask for our special laboratory brochure which provides more detailed information on the furnaces which could be of interest to you.

Glass
For glass applications Nabertherm offers a wide range of furnaces for slumping/bending, decorating, laminating or annealing of different glass types. Also heat-soak ovens or fully automatic cooling lines are available in different standard sizes. Based on our wide standard range we are able to develop also customized solutions for your application.

Thermal Process Technology II
Annealing, ageing, hardening, nitriding, brazing in protective gas, tempering, drying, curing – these are only some of the applications which can be realized with our broad range of furnaces and heat treatment accessories. From the simple charging plate, via annealing boxes to compact multi-purpose tool shop hardening systems with quenching bath, we are sure to find a reasonably-priced solution for your heat treatment needs.

Foundry
From electrically or gas heated melting furnaces, dewaxing furnaces or core drying furnaces to fully automatic annealing plants for aluminum or steel, Nabertherm covers professionally all applications for the foundry industry.
Please visit our website www.nabertherm.com and find out all you want to know about us - and especially about our products.

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

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

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