Laboratory

Muffle Furnaces
Preheating Furnaces
Ashing Furnaces
Tube Furnaces
Ovens
Forced Convection Furnaces
Chamber Furnaces
Melting Furnaces
High-Temperature Furnaces
Retort Furnaces
Vacuum Furnaces
Annealing Furnaces
Clean Room Furnaces

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

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

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

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

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

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

Experience in Many Fields of Thermal Processing
In addition to furnaces for laboratory, Nabertherm offers a wide range of standard furnaces and plants for many other thermal processing applications. The modular design of our products provides for customized solutions to your individual needs without expensive modifications.
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3
Muffle Furnaces with Flap Door or Lift Door

The muffle furnaces L 1/12 - LT 40/12 are the right choice for daily laboratory use. These models stand out for their excellent workmanship, advanced and attractive design, and high level of reliability. The muffle furnaces come equipped with either a flap door or lift door at no extra charge.

- Tmax 1100 °C or 1200 °C
- Heating from two sides by ceramic heating plates (heating from three sides for muffle furnaces L 24/11 - LT 40/12)
- Ceramic heating plates with integral heating element which is safeguarded against fumes and splashing, and easy to replace
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- Housing made of sheets of textured stainless steel
- Dual shell housing for low external temperatures and high stability
- Optional flap door (L) which can be used as work platform or lift door (LT) with hot surface facing away from the operator
- Adjustable air inlet integrated in door (see illustration)
- Exhaust air outlet in rear wall of furnace
- Solid state relays provide for low-noise operation
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 72

Additional equipment
- Chimney, chimney with fan or catalytic converter (not for L 1)
- Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Protective gas connection to purge with non-flammable protective or reaction gases (not available in combination with chimney, chimney with fan or catalytic converter)
- Observation hole in the door
- Manual or automatic gas supply system
- Please see page 14 for more accessories
- Process control and documentation via VCD software package for monitoring, documentation and control see page 75
### Adjustable air inlet integrated in the door

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

### Model Tmax

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
<th>Outer dimensions² in mm</th>
<th>Connected load kW</th>
<th>Electrical connection*</th>
<th>Weight in kg</th>
<th>Minutes to Tmax²</th>
</tr>
</thead>
<tbody>
<tr>
<td>L 3/11</td>
<td>1100</td>
<td>160 140 100</td>
<td>3</td>
<td>385 330 405</td>
<td>1.2</td>
<td>1-phase</td>
<td>20</td>
<td>60</td>
</tr>
<tr>
<td>L 5/11</td>
<td>1100</td>
<td>200 170 130</td>
<td>5</td>
<td>385 390 460</td>
<td>2.4</td>
<td>1-phase</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>L 9/11</td>
<td>1100</td>
<td>230 240 170</td>
<td>9</td>
<td>415 455 515</td>
<td>3.0</td>
<td>1-phase</td>
<td>35</td>
<td>75</td>
</tr>
<tr>
<td>L 15/11</td>
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<td>280 340 250</td>
<td>15</td>
<td>415 555 515</td>
<td>3.5</td>
<td>1-phase</td>
<td>40</td>
<td>95</td>
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<tr>
<td>L 24/11</td>
<td>1100</td>
<td>320 490 250</td>
<td>24</td>
<td>490 555 580</td>
<td>4.5</td>
<td>3-phase</td>
<td>55</td>
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<tr>
<td>L 40/11</td>
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<td>320 490 250</td>
<td>40</td>
<td>530 705 580</td>
<td>6.0</td>
<td>3-phase</td>
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<td>95</td>
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<tr>
<td>L 1/12</td>
<td>1200</td>
<td>90 115 110</td>
<td>1</td>
<td>290 280 430</td>
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<td>1-phase</td>
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<td>25</td>
</tr>
<tr>
<td>L 3/12</td>
<td>1200</td>
<td>160 140 100</td>
<td>3</td>
<td>385 330 405</td>
<td>1.2</td>
<td>1-phase</td>
<td>20</td>
<td>75</td>
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<tr>
<td>L 5/12</td>
<td>1200</td>
<td>200 170 130</td>
<td>5</td>
<td>385 390 460</td>
<td>2.4</td>
<td>1-phase</td>
<td>30</td>
<td>75</td>
</tr>
<tr>
<td>L 9/12</td>
<td>1200</td>
<td>230 240 170</td>
<td>9</td>
<td>415 455 515</td>
<td>3.0</td>
<td>1-phase</td>
<td>35</td>
<td>90</td>
</tr>
<tr>
<td>L 15/12</td>
<td>1200</td>
<td>280 340 250</td>
<td>15</td>
<td>415 555 515</td>
<td>3.5</td>
<td>1-phase</td>
<td>40</td>
<td>110</td>
</tr>
<tr>
<td>L 24/12</td>
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<td>320 490 250</td>
<td>24</td>
<td>490 555 580</td>
<td>4.5</td>
<td>3-phase</td>
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<td>110</td>
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<tr>
<td>L 40/12</td>
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<td>530 705 580</td>
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<td>3-phase</td>
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</table>

¹Including opened lift door
²If connected at 230 V 1/N/PE resp. 400 V 3/N/PE
³External dimensions vary when furnace is equipped with additional equipment. Dimensions on request
With their unbeatable price/performance ratio, these compact muffle furnaces are perfect for many applications in the laboratory. Quality features like the dual shell furnace housing of rust-free stainless steel, their compact, lightweight constructions, or the heating elements encased in quartz glass tubes make these models reliable partners for your application.

- Tmax 1100 °C, working temperature 1050 °C
- Heating from two sides from heating elements in quartz glass tubes
- Maintenance-friendly replacement of heating elements and insulation
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- Housing made of sheets of textured stainless steel
- Dual shell housing for low external temperatures and high stability
- Flap door which can also be used as a work platform
- Exhaust air outlet in rear wall
- Solid state relays provide for low-noise operation
- Compact dimensions and light weight
- Controller mounted under the door to save space
- Defined application within the constraints of the operating instructions
- Controls description see page 72

Additional equipment
- Chimney, chimney with fan or catalytic converter (not for L 1)
- Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Protective gas connection to purge with non-flammable protective or reaction gases
- Manual gas supply system
- Observation hole in the door
- Please see page 14 for more accessories

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
<th>Outer dimensions¹ in mm</th>
<th>Connected load kW</th>
<th>Electrical connection*</th>
<th>Weight in kg</th>
<th>Minutes to Tmax¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>LE 1/11</td>
<td>1100</td>
<td>90 115 110</td>
<td>1</td>
<td>290 280 430</td>
<td>1.5</td>
<td>1-phase</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>LE 2/11</td>
<td>1100</td>
<td>110 180 110</td>
<td>2</td>
<td>330 385 430</td>
<td>1.8</td>
<td>1-phase</td>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>LE 6/11</td>
<td>1100</td>
<td>170 200 170</td>
<td>6</td>
<td>390 435 490</td>
<td>1.8</td>
<td>1-phase</td>
<td>18</td>
<td>35</td>
</tr>
<tr>
<td>LE 14/11</td>
<td>1100</td>
<td>220 300 220</td>
<td>14</td>
<td>440 535 540</td>
<td>2.9</td>
<td>1-phase</td>
<td>25</td>
<td>40</td>
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¹If connected at 230 V 1/N/PE rsp. 400 V 3/N/PE
*Please see page 73 for more information about supply voltage
²External dimensions vary when furnace is equipped with additional equipment. Dimensions on request
Heating elements on support tubes radiating freely into the furnace chamber provide for particularly short heating times for these muffle furnaces. Thanks to their robust lightweight refractory brick insulation, they can reach a maximum working temperature of 1300 °C. These muffle furnaces thus represent an interesting alternative to the familiar L(T) 3/11 models, when you need particularly short heating times or a higher application temperature.

- Tmax 1300 °C
- Heating from two sides
- Heating elements on support tubes ensure free heat radiation and a long service life
- Multi-layer insulation with robust lightweight refractory bricks in the furnace chamber
- Housing made of sheets of textured stainless steel
- Dual shell housing for low external temperatures and stability
- Optional flap door (L) which can be used as work platform or lift door (LT) with hot surface facing away from the operator
- Adjustable air inlet in the furnace door
- Exhaust air outlet in rear wall of furnace
- Solid state relays provide for low-noise operation
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 72

Additional equipment
- Chimney, chimney with fan or catalytic converter
- Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Protective gas connection to purge with non-flammable protective or reaction gases
- Manual or automatic gas supply system
- Observation hole in the door
- Please see page 14 for more accessories
- Process control and documentation via VCD software package for monitoring, documentation and control see page 75

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
<th>Outer dimensions in mm</th>
<th>Connected load kW</th>
<th>Electrical connection</th>
<th>Weight in kg</th>
<th>Minutes to Tmax</th>
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<td>L, LT 5/13</td>
<td>1300</td>
<td>200 170 130</td>
<td>5</td>
<td>490 450 580+320</td>
<td>2.4</td>
<td>1-phase</td>
<td>42</td>
<td>45</td>
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<tr>
<td>L, LT 9/13</td>
<td>1300</td>
<td>230 170 120</td>
<td>9</td>
<td>530 525 620+350</td>
<td>3.0</td>
<td>1-phase</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>L, LT 15/13</td>
<td>1300</td>
<td>260 170 120</td>
<td>15</td>
<td>530 625 630+350</td>
<td>3.5</td>
<td>1-phase</td>
<td>70</td>
<td>60</td>
</tr>
</tbody>
</table>

1Including opened lift door (LT models)  
2If connected at 230 V 1/N/PE or 400 V 3/N/PE  
3External dimensions vary when furnace is equipped with additional equipment. Dimensions on request
Muffle Furnaces up to 1400 °C

These models stand out for their excellent workmanship, advanced and attractive design, and high level of reliability. Heating elements on support tubes radiating freely into the furnace chamber provide for particularly short heating times and a maximum temperature of 1400 °C. These muffle furnaces are a good alternative to the familiar L(T) ../1 series when higher application temperatures are needed.

- Tmax 1400 °C
- Heating from two sides
- Heating elements on support tubes ensure free heat radiation and a long service life
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- Dual shell housing for low external temperatures and high stability
- Adjustable air inlet integrated in door
- Exhaust air outlet in rear wall of furnace
- Solid state relays provide for low-noise operation
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 72

Additional equipment
- Chimney, chimney with fan or catalytic converter
- Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Protective gas connection to purge with non-flammable protective or reaction gases (not available in combination with chimney, chimney with fan or catalytic converter)
- Manual or automatic gas supply system
- Please see page 14 for more accessories
- Process control and documentation via VCD software package for monitoring, documentation and control see page 75

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
<th>Outer dimensions² in mm</th>
<th>Connected load kW</th>
<th>Electrical connection*</th>
<th>Weight in kg</th>
<th>Minutes to Tmax³</th>
</tr>
</thead>
<tbody>
<tr>
<td>L, LT 5/14</td>
<td>1400</td>
<td>200 170 130</td>
<td>5</td>
<td>490 450 580+320</td>
<td>2.5</td>
<td>1-phase</td>
<td>38</td>
<td>55</td>
</tr>
<tr>
<td>L, LT 9/14</td>
<td>1400</td>
<td>230 240 170</td>
<td>9</td>
<td>530 525 650+350</td>
<td>3.0</td>
<td>1-phase</td>
<td>55</td>
<td>60</td>
</tr>
<tr>
<td>L, LT 15/14</td>
<td>1400</td>
<td>260 340 170</td>
<td>15</td>
<td>530 625 360+350</td>
<td>3.5</td>
<td>1-phase</td>
<td>65</td>
<td>70</td>
</tr>
</tbody>
</table>

¹Including opened lift door
²Recommended working temperature for processes with longer dwell times is 1300 °C
³If connected at 230 V 1/N/PE r. 400 V 3/N/PE
⁴External dimensions vary when furnace is equipped with additional equipment. Dimensions on request

*Please see page 73 for more information about supply voltage
Muffle Furnaces with Embedded Heating Elements in the Ceramic Muffle

We particularly recommend the muffle furnace L 9/11/SKM if your application involves aggressive substances. The furnace has a ceramic muffle with embedded heating from four sides. The muffle furnace thus combines a very good temperature uniformity with excellent protection of the heating elements from aggressive atmospheres. Another aspect is the smooth, nearly particle free muffle (furnace door made of fiber insulation), an important quality feature for some ashing processes.

- Tmax 1100 °C
- Muffle heated from four sides
- Furnace chamber with embedded ceramic muffle, high resistance to aggressive gasses and vapours
- Dual shell housing made of sheets of textured stainless steel
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- Optional flap door (L) which can be used as work platform or lift door (LT) with hot surface facing away from the operator
- Adjustable working air inlet in the door
- Exhaust air outlet in rear wall of furnace
- Solid state relays provide for low noise operation
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 72

Additional equipment
- Chimney, chimney with fan or catalytic converter
- Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Protective gas connection to purge with non-flammable protective or reaction gases
- Manual or automation gas supply system
- Observation hole in the door
- Please see page 14 for more accessories
- Process control and documentation via VCD software package for monitoring, documentation and control see page 75

### Model Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
<th>Outer dimensions¹ in mm</th>
<th>Connected load kW</th>
<th>Electrical connection</th>
<th>Weight in kg</th>
<th>Minutes to Tmax²</th>
</tr>
</thead>
<tbody>
<tr>
<td>L 9/11/SKM</td>
<td>1100</td>
<td>230 240 170</td>
<td>9 490 505 580</td>
<td>3.4 1-phase</td>
<td>50</td>
<td>90</td>
<td></td>
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<tr>
<td>LT 9/11/SKM</td>
<td>1100</td>
<td>230 240 170</td>
<td>9 490 505 580+320 ³</td>
<td>3.4 1-phase</td>
<td>50</td>
<td>90</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹Including opened lift door
²If connected at 230 V 1/N/PE rsp. 400 V 3/N/PE
³External dimensions vary when furnace is equipped with additional equipment. Dimensions on request

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

Muffle heated from four sides

Over-temperature limiter
Ashing Furnaces with Flap Door or Lift Door

The ashing furnaces LV 3/11 - LVT 15/11 are especially designed for ashing in the laboratory. A special air intake and exhaust system allows air exchange of more than 6 times per minute. Incoming air is preheated to ensure a good temperature uniformity.

- Tmax 1100 °C
- Heating from two sides
- Ceramic heating plates with integral heating element which is safeguarded against fumes and splashing, and easy to replace
- Air exchange of more than 6 times per minute
- Good temperature uniformity due to preheating of incoming air
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- Housing made of sheets of textured stainless steel
- Dual shell housing for low external temperatures and stability
- Optional flap door (LV) which can be used as work platform or lift door (LVT) with hot surface facing away from the operator
- Solid state relays provide for low noise operation
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 72

Observation hole in the door as additional equipment

Air inlet and exhaust flow principle in ashing furnaces

Ashing furnace LV 3/11
Additional equipment

- Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Observation hole in the door
- Please see page 14 for more accessories
- Process control and documentation via VCD software package for monitoring, documentation and control see page 75

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
<th>Outer dimensions² in mm</th>
<th>Connected load kW</th>
<th>Electrical connection¹</th>
<th>Weight in kg</th>
<th>Minutes to Tmax²</th>
</tr>
</thead>
<tbody>
<tr>
<td>LV 3/11</td>
<td>1100</td>
<td>160 140 100</td>
<td>3</td>
<td>385 360 735</td>
<td>1.2</td>
<td>1-phase</td>
<td>20</td>
<td>120</td>
</tr>
<tr>
<td>LV 5/11</td>
<td>1100</td>
<td>200 170 130</td>
<td>5</td>
<td>385 420 790</td>
<td>2.4</td>
<td>1-phase</td>
<td>35</td>
<td>120</td>
</tr>
<tr>
<td>LV 9/11</td>
<td>1100</td>
<td>230 240 170</td>
<td>9</td>
<td>415 485 845</td>
<td>3.0</td>
<td>1-phase</td>
<td>45</td>
<td>120</td>
</tr>
<tr>
<td>LV 15/11</td>
<td>1100</td>
<td>230 340 170</td>
<td>15</td>
<td>415 585 845</td>
<td>3.5</td>
<td>1-phase</td>
<td>55</td>
<td>120</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
<th>Outer dimensions² in mm</th>
<th>Connected load kW</th>
<th>Electrical connection¹</th>
<th>Weight in kg</th>
<th>Minutes to Tmax²</th>
</tr>
</thead>
<tbody>
<tr>
<td>LVT 3/11</td>
<td>1100</td>
<td>160 140 100</td>
<td>3</td>
<td>385 360 735</td>
<td>1.2</td>
<td>1-phase</td>
<td>20</td>
<td>120</td>
</tr>
<tr>
<td>LVT 5/11</td>
<td>1100</td>
<td>200 170 130</td>
<td>5</td>
<td>385 420 790</td>
<td>2.4</td>
<td>1-phase</td>
<td>35</td>
<td>120</td>
</tr>
<tr>
<td>LVT 9/11</td>
<td>1100</td>
<td>230 240 170</td>
<td>9</td>
<td>415 485 845</td>
<td>3.0</td>
<td>1-phase</td>
<td>45</td>
<td>120</td>
</tr>
<tr>
<td>LVT15/11</td>
<td>1100</td>
<td>230 340 170</td>
<td>15</td>
<td>415 585 845</td>
<td>3.5</td>
<td>1-phase</td>
<td>55</td>
<td>120</td>
</tr>
</tbody>
</table>

¹Including exhaust tube (Ø 80 mm)
²If connected at 230 V 1/N/PE resp. 400 V 3/N/PE
³External dimensions vary when furnace is equipped with additional equipment. Dimensions on request

Over-temperature limiter
Ashing Furnaces with Integrated Exhaust Gas Cleaning

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

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

### Specifications

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

1 Including exhaust tube (Ø 80 mm)

*Please see page 73 for more information about supply voltage

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

---

**Additional equipment**

- Tmax 600 °C for the incineration process
- Tmax 1100 °C for the subsequent process
- Three-side heating (both sides and bottom)
- Ceramic heating plates with embedded heating wire
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- Dual shell housing made of structured stainless steel provides for low outer temperature and high stability
- Steel collecting pan protects the bottom insulation
- Spring-assisted closing of the furnace door (flap door) with mechanical locking against unintentional opening
- Thermal/catalytic post combustion, integrated in the exhaust channel, up to 600 °C in function
- Temperature control of post combustion can be set up to 850 °C
- Monitored exhaust air
- Inlet-air preheated through the bottom heating plate
- Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabbertherm controller: recording of process data with USB-flash drive
- Controls description see page 72

**Process control and documentation via VCD software package for monitoring, documentation and control see page 75**
Weighing Furnace incl. Scale and Software for Determination of Combustion Loss

This weighing furnace with integrated precision scale and software, was designed especially for combustion loss determination in the laboratory. The determination of combustion loss is necessary, for instance, when analyzing sludges and household garbage, and is also used in a variety of technical processes for the evaluation of results. The difference between the initial total mass and the combustion residue is the combustion loss. During the process, the software included records both the temperature and the weight loss.

- Tmax 1100 °C or 1200 °C
- Heating from two sides
- Ceramic heating plates with integral heating element which is safeguarded against fumes and splashing, and easy to replace
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- Dual shell housing made of sheets of textured stainless steel
- Optional flap door (L) which can be used as work platform or lift door (LT) with hot surface facing away from the operator
- Adjustable working air inlet in the door
- Exhaust air outlet in rear wall of furnace
- Solid state relays provide for low noise operation
- Delivery includes base, ceramic plunger with base plate in the furnace lining, precision scale and software package
- 4 scales available for different maximum weights and scaling ranges
- Process control and documentation for temperature and combustion loss via VCD software package for monitoring, documentation and control see page 75
- Defined application within the constraints of the operating instructions
- Controls description see page 72

Additional equipment
- Chimney, chimney with fan or catalytic converter
- Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Observation hole in the door
- Please see page 14 for more accessories

<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>
<th>Weight in kg</th>
<th>Minutes to Tmax²</th>
</tr>
</thead>
<tbody>
<tr>
<td>L 9/11/SW</td>
<td>1100</td>
<td>230 x 240 x 170</td>
<td>9 x 415 x 455 x 740</td>
<td>3.0</td>
<td>1-phase</td>
<td>50</td>
<td>75</td>
</tr>
<tr>
<td>L 9/12/SW</td>
<td>1200</td>
<td>230 x 240 x 170</td>
<td>9 x 415 x 455 x 740</td>
<td>3.0</td>
<td>1-phase</td>
<td>50</td>
<td>90</td>
</tr>
</tbody>
</table>

<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>
<th>Weight in kg</th>
<th>Minutes to Tmax²</th>
</tr>
</thead>
<tbody>
<tr>
<td>LT 9/11/SW</td>
<td>1100</td>
<td>230 x 240 x 170</td>
<td>9 x 415 x 455 x 740+240</td>
<td>3.0</td>
<td>1-phase</td>
<td>50</td>
<td>75</td>
</tr>
<tr>
<td>LT 9/12/SW</td>
<td>1200</td>
<td>230 x 240 x 170</td>
<td>9 x 415 x 455 x 740+240</td>
<td>3.0</td>
<td>1-phase</td>
<td>50</td>
<td>90</td>
</tr>
</tbody>
</table>

1Including opened lift door
2If connected at 230 V 1/N/PE resp. 400 V 3/N/PE

4 scales available for different maximum weights and scaling areas

Software for documentation of the temperature curve and combustion loss using a PC

<table>
<thead>
<tr>
<th>Scale type</th>
<th>Readability</th>
<th>Weight range in g</th>
<th>Weight of plunger in g</th>
<th>Calibration value in g</th>
<th>Minimum load in g</th>
</tr>
</thead>
<tbody>
<tr>
<td>EW-2200</td>
<td>0.01</td>
<td>2200 incl. plunger</td>
<td>850</td>
<td>0.1</td>
<td>0.5</td>
</tr>
<tr>
<td>EW-4200</td>
<td>0.01</td>
<td>4200 incl. plunger</td>
<td>850</td>
<td>0.1</td>
<td>0.5</td>
</tr>
<tr>
<td>EW-6200</td>
<td>0.01</td>
<td>6200 incl. plunger</td>
<td>850</td>
<td>-</td>
<td>1.0</td>
</tr>
<tr>
<td>EW-12000</td>
<td>0.10</td>
<td>12000 incl. plunger</td>
<td>850</td>
<td>1.0</td>
<td>5.0</td>
</tr>
</tbody>
</table>
Exhaust Systems/Accessories

**Chimney** for connection to an exhaust pipe.

**Chimney with fan**, to remove exhaust gas from the furnace better. The B400 - P480 controllers can be used to activate the fan automatically (not for models L(T) 15.., L 1/12, LE 1/1 1, LE 2/1 1).*

**Catalytic converter with fan** for removal of organic components from the exhaust air. Organic components are catalytically oxidized at about 600 °C, broken into carbon dioxide and water vapour. Irritating odors are thus largely eliminated. The B400 - P480 controllers can be used to switch the catalytic converter automatically (not for models L(T) 15.., L 1/12, LE 1/1 1, LE 2/1 1).*

**Heat-resistant gloves** for protection of the operator when loading or removing hot materials, resistant to 650 °C or 700 °C.

**Square saggar for furnaces LHTC and LHT, Tmax 1600 °C**
The load is placed in ceramic saggars for optimal utilization of the furnace space. Up to three saggars can be stacked on top of each other in the furnace. Each saggar has cut-outs for better ventilation. The top saggar should be closed with a lid made of ceramics also.

**Round saggar (Ø 115 mm) for furnaces LHT/LB, Tmax 1650 °C**
These saggars are perfectly suited for furnaces LHT/LB. The load is placed in the saggars. Up to three saggars can be stacked on top of each other in order to use the overall furnace chamber.

---

Select between different **bottom plates** and **collecting pans** for protection of the furnace and easy loading (for models L, LT, LE, LV and LVT on pages 4 - 13).

**Ceramic ribbed plate, Tmax 1200 °C**
**Ceramic collecting pan, Tmax 1300 °C**
**Steel collecting pan, Tmax 1100 °C**

<table>
<thead>
<tr>
<th>For models</th>
<th>Ceramic ribbed plate</th>
<th>Ceramic collecting pan</th>
<th>Steel collecting pan (Material 1.4828)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L 1, LE 1</td>
<td>691601835 110 x 90 x 12.7</td>
<td>-</td>
<td>691404623 85 x 100 x 20</td>
</tr>
<tr>
<td>LE 2</td>
<td>691601097 170 x 110 x 12.7</td>
<td>691601099 100 x 160 x 10</td>
<td>691402096 110 x 170 x 20</td>
</tr>
<tr>
<td>L 3, LT 3, LV 3, LVT 3</td>
<td>691600507 150 x 140 x 12.7</td>
<td>691600510 150 x 140 x 20</td>
<td>691400145 150 x 140 x 20</td>
</tr>
<tr>
<td>LE 6, L 5, LT 5, LV 5, LVT 5</td>
<td>691600508 190 x 170 x 12.7</td>
<td>691600511 190 x 170 x 20</td>
<td>691400146 190 x 170 x 20</td>
</tr>
<tr>
<td>L 9, LT 9, LV 9, LVT 9, N 7</td>
<td>691600509 240 x 220 x 12.7</td>
<td>691600512 240 x 220 x 20</td>
<td>691400147 240 x 220 x 20</td>
</tr>
<tr>
<td>LE 14</td>
<td>691601098 210 x 290 x 12.7</td>
<td>-</td>
<td>691402097 210 x 290 x 20</td>
</tr>
<tr>
<td>L 15, LT 15, LV 15, LVT 15, N 11</td>
<td>691600506 340 x 220 x 12.7</td>
<td>-</td>
<td>691400149 230 x 330 x 20</td>
</tr>
<tr>
<td>L 24, LT 24</td>
<td>691600874 340 x 270 x 12.7</td>
<td>-</td>
<td>691400626 270 x 340 x 20</td>
</tr>
<tr>
<td>L 40, LT 40</td>
<td>691600875 490 x 310 x 12.7</td>
<td>-</td>
<td>691400627 310 x 490 x 20</td>
</tr>
</tbody>
</table>

Heat-resistant **gloves** for protection of the operator when loading or removing hot materials, resistant to 650 °C or 700 °C.

**Gloves, Tmax 650 °C**
**Gloves, Tmax 700 °C**
**Various tongs** for easy loading and unloading of the furnace.
These furnaces are especially used for the assay of precious metals and ashing processes where the insulation and heating must be protected from emerging gasses and vapours. The furnace chamber forms a ceramic muffle which can easily be replaced. The assay furnace is equipped with an integrated exhaust hood above the furnace door for connection to and exhaust system.

- Muffle heated from four sides (three sides for assay furnace N 25/13 CUP)
- Heating elements and insulation protected by muffle
- Simple replacement of muffle
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- Warm furnace can be opened
- Tool holder on furnace
- Stainless steel exhaust chimney above the door opening for connection of an exhaust system
- Dual shell housing with fan cooling to reduce exterior temperatures
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 72

Additional equipment
- Base frame on castors (not for assay furnace N 4/13 CUP)
- Process control and documentation via VCD software package for monitoring, documentation and control see page 75

### Pit-type furnace with rolling lid

For bigger charges we offer pit-type furnaces as assay furnaces

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
<th>Outer dimensions¹ in mm</th>
<th>Connected load kW</th>
<th>Electrical connection</th>
<th>Weight in kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>N 4/13 CUP</td>
<td>1280</td>
<td>185 250 80</td>
<td>3.7</td>
<td>750 675 520</td>
<td>3</td>
<td>1-phase</td>
<td>65</td>
</tr>
<tr>
<td>N 8/13 CUP</td>
<td>1300</td>
<td>260 340 95</td>
<td>8.0</td>
<td>900 1335 2100</td>
<td>22</td>
<td>3-phase</td>
<td>510</td>
</tr>
<tr>
<td>N 25/13 CUP</td>
<td>1300</td>
<td>250 500 250</td>
<td>25.0</td>
<td>1050 1200 1520²</td>
<td>15</td>
<td>3-phase</td>
<td>280</td>
</tr>
</tbody>
</table>

¹Plus 150 mm for exhaust hood
²Plus 200 mm for exhaust hood
³External dimensions vary when furnace is equipped with additional equipment. Dimensions on request

*Please see page 73 for more information about supply voltage*
Chamber Furnaces for Annealing, Hardening and Brazing

To withstand harsh use in the laboratory, e.g. when heat-treating metals, robust insulation with light refractory bricks is necessary. The chamber furnaces N 7/H - N 87/H are a perfect fit to solve this problem. The furnaces can be extended with a variety of accessories, like annealing boxes for operation under protective gas, roller guides, or a cooling station with a quench tank. Even high-performance applications like the annealing of titanium in medical applications can be implemented without the use of expensive and complicated annealing systems.

- **Tmax 1280 °C**
- Deep furnace chamber with three-sides heating: from both side walls and bottom
- Heating elements on support tubes ensure free heat radiation and a long service life
- Bottom heating protected by heat-resistant SiC plate
- Low energy consumption due to multi-layer insulation
- Exhaust opening in the side of the furnace, or on back wall of chamber furnace N 31/H and higher
- Base frame included in the delivery, N 7/H - N 17/HR designed as table-top model
- Parallel guided downward swinging door (user protected from heat radiation)
- Gas spring dampers provide for easy door opening and closing
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 72

### Model Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Inner dimensions in mm (w x d x h)</th>
<th>Volume in l</th>
<th>Outer dimensions in mm (W x D x H)</th>
<th>Connected load kW</th>
<th>Electrical connection</th>
<th>Weight in kg</th>
<th>Minutes to Tmax</th>
</tr>
</thead>
<tbody>
<tr>
<td>N 7/H</td>
<td>1280</td>
<td>250 x 250 x 140</td>
<td>9</td>
<td>800 x 650 x 600</td>
<td>3.0</td>
<td>1-phase</td>
<td>60</td>
<td>180</td>
</tr>
<tr>
<td>N 11/H</td>
<td>1280</td>
<td>250 x 350 x 140</td>
<td>11</td>
<td>800 x 750 x 600</td>
<td>3.5</td>
<td>1-phase</td>
<td>70</td>
<td>180</td>
</tr>
<tr>
<td>N 17/HR</td>
<td>1280</td>
<td>250 x 500 x 140</td>
<td>17</td>
<td>800 x 900 x 600</td>
<td>6.4</td>
<td>3-phase</td>
<td>90</td>
<td>120</td>
</tr>
<tr>
<td>N 31/H</td>
<td>1280</td>
<td>350 x 350 x 250</td>
<td>31</td>
<td>1040 x 1100 x 1340</td>
<td>15.0</td>
<td>3-phase</td>
<td>210</td>
<td>105</td>
</tr>
<tr>
<td>N 41/H</td>
<td>1280</td>
<td>350 x 500 x 250</td>
<td>41</td>
<td>1040 x 1250 x 1340</td>
<td>15.0</td>
<td>3-phase</td>
<td>260</td>
<td>120</td>
</tr>
<tr>
<td>N 61/H</td>
<td>1280</td>
<td>350 x 750 x 250</td>
<td>61</td>
<td>1040 x 1500 x 1340</td>
<td>20.0</td>
<td>3-phase</td>
<td>400</td>
<td>120</td>
</tr>
<tr>
<td>N 87/H</td>
<td>1280</td>
<td>350 x 1000 x 250</td>
<td>87</td>
<td>1040 x 1750 x 1340</td>
<td>25.0</td>
<td>3-phase</td>
<td>480</td>
<td>120</td>
</tr>
</tbody>
</table>

*Heating only between two phases

*Please see page 73 for more information about supply voltage

*If connected at 230 V 1/N/PE resp. 400 V 3/N/PE

*External dimensions vary when furnace is equipped with additional equipment. Dimensions on request
Accessories for Annealing Hardening and Brazing

Our wide selection of chamber furnaces for annealing, hardening and brazing can be extended with a variety of accessories to suit your application. The accessories shown below represent only a small fraction of the products available. For further details, please see our separate catalogues for heat-treatment furnaces and hardening accessories.

Annealing Boxes
- Annealing boxes with or without protective gas connectors, up to 1100 °C, also in a tailor-made variant for cold evacuation, for instance for the annealing of small parts and bulk goods

Annealing Tray with Holder
- Annealing tram with alloy bag and holder with protective gas connection for models N 7/H to N 87/H for annealing and hardening under protective gas and quenching in air

Hearth Plates
- Hearth plates for up to 1100 °C for protection of the furnace floor for models N 7/H to N 87/H, edged on three sides

Hardening Tongs
- Hardening tongs in various sizes and forms for use in annealing and hardening

Heat Treating Foil
- Heat treating foil for wrapping of samples for oxidation-free annealing and hardening of steels up to 1200 °C

Gloves
- Heat-resistant gloves to 650 °C or 700 °C for protection of operator during loading see page 14

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

- Tmax 1200 °C, 1300 °C, or 1400 °C
- Dual shell housing with rear ventilation, provides for low shell temperatures
- High furnace chamber with five-sided heating for very good temperature uniformity
- Heating elements on support tubes ensure free heat radiation and a long service life
- Controller mounted on furnace door and removable for comfortable operation
- Protection of bottom heating and flat stacking surface provided by embedded SiC plate in the floor
- LH models: multi-layered insulation of light refractory bricks and special backup insulation
- LF models: high-quality fiber insulation with corner bricks for shorter heating and cooling times. Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2.
- Door with brick-on-brick seal, hand fitted
- Short heating times due to high installed power
- Self-supporting arch for high stability and greatest possible protection against dust
- Quick lock on door
- Motor driven exhaust air flap
- Freely adjustable air inlet integrated in furnace floor
- Base included
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 72
Chamber furnace LF 60/14 with fresh air fan to accelerate the cooling times

Additional equipment
- Parallel swinging door, pivots away from operator, for opening when hot
- Lift door with electro-mechanic linear drive
- Separate wall-mounting or floor standing cabinet for switchgear
- Cooling fan for shorter cycle times
- Protective gas connection to purge with non-flammable protective or reaction gases
- Manual or automatic gas supply system
- Scale to measure weight reduction during annealing
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 75

<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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<tr>
<td>LH 60/12</td>
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<td>60</td>
<td>790 x 1080 x 1370</td>
<td>8.0</td>
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<td>120</td>
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<tr>
<td>LH 216/12</td>
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<td>890 x 1180 x 1470</td>
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<tr>
<td>LH 216/13</td>
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<td>890 x 1180 x 1470</td>
<td>18.0</td>
<td>3-phase</td>
<td>370</td>
</tr>
</tbody>
</table>

1 Heating only between two phases
2 *See page 73 for more information about supply voltage
3 External dimensions vary when furnace is equipped with additional equipment. Dimensions on request
High-Temperature Furnaces with SiC Rod Heating up to 1600 °C

These powerful laboratory muffle furnaces are available for temperatures up to 1400 °C, 1500 °C, 1550 °C or 1600 °C. The durability of the SiC rods in periodic use, in combination with their high heating speed, make these high-temperature furnaces to all-rounders in the laboratory. Heating times of 40 minutes to 1400 °C can be achieved, depending on the furnace model and the conditions of use.

- Tmax 1400 °C, 1500 °C, 1550 °C or 1600 °C
- Working temperature 1500 °C (for high-temperature furnaces LHTC../16), increased wear and tear must be expected in case of working at higher temperatures
- Dual shell housing made of textured stainless steel sheets with additional fan cooling for low surface temperature
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- Optional flap door (LHTC) which can be used as work platform or lift door (LHTCT) with hot surface facing away from the operator (High-temperature furnace LHTCT 01/16 only with lift door)
- Switching system with solid-state-relays, power tuned to the SiC rods
- Easy replacement of heating rods
- Adjustable air inlet opening, exhaust air opening in the roof
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 72

Additional equipment
- Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Square saggar for charging of up to three layers see page 14
- Lid for top saggar
- Manual or automatic gas supply system
- Process control and documentation via VCD software package for monitoring, documentation and control see page 75

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
<th>Outer dimensions in mm</th>
<th>Connected load kW</th>
<th>Electrical connection</th>
<th>Weight in kg</th>
<th>Minutes to Tmax</th>
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<td>120 210 120</td>
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<td>40</td>
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<tr>
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<td>3.0</td>
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<td>50</td>
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<tr>
<td>LHTC(T) 08/15</td>
<td>1500</td>
<td>170 290 170</td>
<td>8.0</td>
<td>490 625 540</td>
<td>13.0</td>
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<td>50</td>
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<td>60</td>
</tr>
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</table>

1 Heating only between two phases

*Please see page 73 for more information about supply voltage

2 Plus maximum 240 mm for models LHTCT when open

3 If connected at 230 V 1/N/PE resp. 400 V 3/N/PE

4 External dimensions vary when furnace is equipped with additional equipment. Dimensions on request
High-Temperature Furnaces with MoSi₂ Heating Elements up to 1800 °C

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

- Tmax 1600 °C, 1750 °C, or 1800 °C
- High-quality molybdenum disilicide heating elements
- Dual shell housing made of textured stainless steel sheets with additional fan cooling for low surface temperature
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- Compact design with lift door, opening upwards
- Adjustable air inlet
- Exhaust air opening in the roof
- Type B thermocouple
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 72

Additional equipment
- Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Square saggars for charging of up to three layers see page 14
- Protective gas connection to purge with non-flammable protective or reaction gases
- Manual or automatic gas supply system
- Process control and documentation via VCD software package for monitoring, documentation and control see page 75

<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 kg</th>
<th>Minutes to Tmax</th>
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</thead>
<tbody>
<tr>
<td>LHT 02/16</td>
<td>1600</td>
<td>90 150 150 150</td>
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<td>470 810 760+260</td>
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<td>3-phase¹</td>
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<td>1-phase</td>
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<td>60</td>
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<td>2</td>
<td>470 630 760+260</td>
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<td>75</td>
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<td>3-phase¹</td>
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<td>470 810 760+260</td>
<td>9.0</td>
<td>3-phase¹</td>
<td>100</td>
<td>60</td>
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¹Heating only between two phases
²If connected at 230 V 1/N/PE resp. 400 V 3/N/PE
³Including opened lift door
⁴Connected load depends on supply voltage
⁵Please see page 73 for more information about supply voltage

Additional accessories available:
- Square saggars for charging of up to three layers see page 14
- Protective gas connection to purge with non-flammable protective or reaction gases
- Manual or automatic gas supply system
- Process control and documentation via VCD software package for monitoring, documentation and control see page 75

Additional equipment:
- Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Square saggars for charging of up to three layers see page 14
- Protective gas connection to purge with non-flammable protective or reaction gases
- Manual or automatic gas supply system
- Process control and documentation via VCD software package for monitoring, documentation and control see page 75

Over-temperature limiter

High-temperature furnace LHT 03/17 D

Saggars with top lid
High-Temperature Bottom Loading Furnaces up to 1700 °C

The motor-driven lifting table significantly simplifies the charging of the high-temperature furnaces LHT/LB. The heating all around the cylindrical furnace chamber provides for an optimal temperature uniformity. For the tabletop models LHT 01/17 LB and LHT 02/17 LB the charge can be placed in charge saggars made of technical ceramics. Up to three charge saggars can be stacked on top of each other resulting in a high productivity. Due to its volume the high-temperature furnace LHT 16/17 LB can also be used for applications in production.

- Tmax 1650 °C, 1700 °C (LHT 16/17 LB)
- High-quality heating elements made of molybdenum disilicide offer best possible protection against chemical interaction between charge and heating elements
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- Outstanding temperature uniformity due to all-round furnace chamber heating
- Furnace chamber with a volume of 1, 2 or 16 liters, table with large floor space
- Precise, motorized toothed belt drive of the table with button operation
- Appealing, dual shell stainless steel housing
- Exhaust air vent in the roof
- Type S thermocouple
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 72
High-Temperature Furnaces with Scale for Determination of Combustion Loss and Thermogravimetric Analysis (TGA)

These high-temperature furnaces were specially developed to determine combustion loss during annealing and for thermogravimetric analysis (TGA) in the lab. The complete system consists of the high-temperature furnace for 1600 °C or 1750 °C, a table frame, precision scale with feedthroughs into the furnace and powerful software for recording both the temperature curve and the weight loss over time.

- Defined application within the constraints of the operating instructions
- Technical description of the furnaces: see models LHT 04/16 and LHT 04/17 see page 21
- Description of the weighing system: see models L 9/... SW see page 13
- Process control and documentation for temperature and combustion loss via VCD software package for monitoring, documentation and control see page 75

---

**Model**

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax</th>
<th>Inner dimensions in mm</th>
<th>Volume</th>
<th>Outer dimensions in mm</th>
<th>Connected load kW</th>
<th>Electrical connection*</th>
<th>Weight in kg</th>
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<td>650 1250 1980</td>
<td>12.0</td>
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<td>410</td>
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</tbody>
</table>

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*Please see page 73 for more information about supply voltage*

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Software for documentation of the temperature curve and combustion loss using a PC

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23
High-temperature furnace HT 160/17 with gas supply system

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

- **Tmax 1600 °C, 1750 °C, or 1800 °C**
- **Recommended working temperature 1750 °C (for models HT ..18), increased wear and tear must be expected in case of working at higher temperatures**
- **Dual shell housing with fan cooling for low shell temperatures**
- **Heating from both sides via molybdenum disilicide heating elements**
- **High-quality fiber insulation backed by special insulation**
- **Side insulation constructed with tongue and groove blocks provides for low heat loss to the outside**
- **Long-life roof insulation with special suspension**
- **Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2**
- **Chain-guided parallel swivel door for defined opening and closing of the door**
- **Two-door design (front/back) for high-temperature furnaces > HT 276/..**
- **Labyrinth sealing ensures the least possible temperature loss in the door area**
- **Reinforced floor as protection for bottom insulation as standard from models HT 16/16 upwards**
- **Vapor vent in the furnace roof**
- **Heating elements switched via thyristors**
- **Defined application within the constraints of the operating instructions**
- **NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive**
- **Controls description see page 72**
<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>T</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
<th>Outer dimensions in mm</th>
<th>Weight in kg</th>
<th>Connected load kW</th>
<th>Electrical connection*</th>
<th>Weight in kg</th>
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</thead>
<tbody>
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<td>HT 04/16</td>
<td>1600</td>
<td>150</td>
<td>150 150 150</td>
<td>730 490 1400</td>
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<td>HT 08/16</td>
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</tr>
</tbody>
</table>

1 Heating only between two phases
2 External dimensions vary when furnace is equipped with additional equipment. Dimensions on request

Additional equipment:
- Uncontrolled or controlled cooling system with frequency-controlled cooling fan and motor-driven exhaust air flap
- Furnace in DB design featuring fresh air preheating, exhaust gas ventilation and an extensive safety package for debinding and sintering in one process, i.e., without transferring the material from the debinding furnace to the sintering furnace
- Stainless steel exhaust gas top hats
- Special heating elements for zirconia sintering provide for longer life service with respect to chemical interaction between charge and heating elements
- Protective gas connection to purge with non-flammable protective or reaction gases
- Manual or automatic gas supply system
- Inner process box to improve the gas tightness and to protect the furnace chamber against contamination
- Lift door
- Motorized exhaust air flap, switchable via the program
- Thermal or catalytic exhaust cleaning systems see page 70
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 75
High-Temperature Furnaces with SiC Rod Heating up to 1550 °C

The high-temperature furnaces HTC 16/16 - HTC 450/16 are heated by vertically hung SiC rods, which makes them especially suitable for sintering processes up to a maximum operating temperature of 1550 °C. For some processes, e.g. for sintering zirconium oxide, the absence of interaction between the charge and the SiC rods, these models are more suitable than the alternatives heated with molybdenum disilicide elements. The basic construction of these furnaces make them comparable with the already familiar models in the HT product line and they can be upgraded with the same additional equipment.

- Tmax 1550 °C
- Dual shell housing with fan cooling for low shell temperatures
- Heating from both sides via vertically mounted SiC rods
- High-quality fiber insulation backed by special insulation
- Side insulation constructed with tongue and groove blocks provides for low heat loss to the outside
- Long-life roof insulation with special suspension
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- Chain-guided parallel swivel door for defined opening and closing of the door without destroying the insulation

Additional equipment like HT models see page 25

<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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</table>

1 Heating only between two phases
2 External dimensions vary when furnace is equipped with additional equipment. Dimensions on request

*Please see page 73 for more information about supply voltage
High Temperature Furnaces with Molybdenum Disilicide Heating Elements with Refractory Brick Insulation up to 1700 °C

The high-temperature furnaces HFL 16/16 HFL 160/17 are characterized by their lining with robust light refractory bricks. This version is recommended for processes producing aggressive gases or acids, such as under glass melting.

Standard equipment like high-temperature furnaces HT, except:
- Tmax 1600 °C or 1700 °C
- Robust refractory brick insulation and special backing insulation
- Furnace floor made of lightweight refractory bricks accommodates high charge weights
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 72

Additional equipment like HT models see page 25

<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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</table>

1 Heating only between two phases
2 External dimensions vary when furnace is equipped with additional equipment. Dimensions on request

*Please see page 73 for more information about supply voltage
Ovens, also with Safety Technology According to EN 1539

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

- Tmax 300 °C
- Working temperature range: + 5 °C above room temperature up to 300 °C
- Ovens TR 30 - TR 240 designed as tabletop models
- Ovens TR 450 and TR 1050 designed as floor standing models
- Horizontal, air circulation results in temperature uniformity better than +/- 5 °C see page 71
- Stainless steel chamber, alloy 304 (AISI)/(DIN material no. 1.4301), rust-resistant and easy to clean
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- Large handle to open and close the door
- Charging in multiple layers possible using removeable grids (number of removeable grids included, see table to the right)
- Large, wide-opening swing door, hinged on the right with quick release for models TR 30 - TR 450
- Double swing door with quick release for TR 1050
- TR 1050 equipped transport rollers
- Infinitely adjustable exhaust at the rear wall with operation from the front
- PID microprocessor control with self-diagnosis system
- Solid state relays provide for low noise operation
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 72
### Additional equipment
- Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the oven and load.
- Infinitely adjustable fan speed of the air circulation fan.
- Window for charge observing.
- Further removable grids with rails.
- Side inlet.
- Stainless steel collecting pan to protect the furnace chamber.
- Door hinges on the left side.
- Reinforced bottom plate.
- Safety technology according to EN 1539 for charges containing liquid solvents (TR .. LS) up to model TR 240 LS, achievable temperature uniformity +/- 8 °C see page 71.
- Transport castors for model TR 450.
- Various modifications available for individual needs.
- Upgrading available to meet the quality requirements of AMS 2750 E or FDA.
- Process control and documentation via VCD software package for monitoring, documentation and control see page 75.

### Model Specifications

<table>
<thead>
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<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>Grids included max.</th>
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</table>

*Max load per layer 30 kg

*Please see page 73 for more information about supply voltage

*If EN 1539 is ordered connected load will increase

*External dimensions vary when furnace is equipped with additional equipment. Dimensions on request.
Chamber Ovens
Electrically Heated or Gas-Fired

The chamber ovens of the KTR range can be used for complex drying processes and heat treatment of charges to an application temperature of 260 °C. The high-performance air circulation enables optimum temperature uniformity throughout the work space. A wide range of accessories allow the chamber ovens to be modified to meet specific process requirements. The design for the heat treatment of flammable materials in conformance with EN 1539 (NFPA 86) is available for all sizes.

- Tmax 260 °C
- Electrically heated (via a heating register with integrated chrome steel heating elements) or gas-fired (direct or indirect gas-fired including injection of the hot air into the intake duct)
- Temperature uniformity up to +/- 3 °C according to DIN 17052-1 (for design without track cutouts) see page 71
- High-quality mineral wool insulation provides for outer temperatures of < 25 °C above room temperature
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- High air exchange for fast drying processes
- Double-wing door for furnaces KTR 3100 and larger
KTR 3100/S for curing of composites in vacuum bags incl. pump and necessary connections in the oven chamber

Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the oven and load

Incl. floor insulation

Defined application within the constraints of the operating instructions

NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive

Controls description see page 72

Additional equipment

- Track cutouts for level drive-in of charging cart
- Base frame to charge the oven via a charging forklift
- Additional Door in the back for charging from both sides or to use the oven as lock between two rooms
- Fan system for faster cooling with manual or motor-driven control of the exhaust flaps
- Programmed opening and closing of exhaust air flaps
- Air circulation with speed control, recommendable for processes with light or sensitive charge
- Observation window and furnace chamber lighting
- Safety technology according to EN 1539 (NFPA 86) (models KTR .. LS) for charges containing solvents
- Charging cart with or without rack system
- Design for clean room heat treatment processes see page 37
- Rotating systems for tempering processes
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 75

Chamber oven KTR 22500/S with chamber lightning and drive-in tracks with insulated plugs which provide for an optimal temperature uniformity

KTR 3100/S for curing of composites in vacuum bags incl. pump and necessary connections in the oven chamber

Direct gas-firing at a chamber dryer
Chamber Ovens
Electrically Heated or Gas-Fired

### Charging cart with pull-out trays

### KTR 4500 with platform cart, inner lightning and observation windows

### Drive-in tracks with sealing shoes

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

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

### Model Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax</th>
<th>Inner dimensions in mm</th>
<th>Volume</th>
<th>Outer dimensions in mm²</th>
<th>Heating power in kW</th>
<th>Electrical connection*</th>
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<td>2500 x 2500 x 4000 x 4000</td>
<td>54/3000</td>
<td>3-phase</td>
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</tbody>
</table>

*Depending on furnace design connected load might be higher
*Outer dimensions from chamber ovens KTR .. LS are different
*Please see page 73 for more information about supply voltage
To ensure safe operation of the oven when tempering silicone, the fresh air supply of the oven must be monitored. A fresh air volume flow of 100 - 120 l/min/kg silicone (6-7.2 m³/h/kg silicone) has to be considered. The graph shows the maximum amount of silicone depending on the operating temperature for various KTR models at a fresh air supply of 120 l/min/kg silicone. The oven will be carried out in accordance with the requirements of the standard EN 1539 (NFPA 86).

KTR 3100 DT with rotating system for tempering of silicone parts. Four baskets will be charged in the frame and can be taken out separately.

Adjustable plate shutters to adapt the air guide to the charge.
High-Temperature Ovens, Forced Convection Chamber Furnaces

These chamber furnaces with air circulation are characterized by their extremely high temperature uniformity. Hence, they are especially suitable for processes such as cooling, crystalizing, preheating, curing, but also for numerous processes in tool making. Due to the modular concept, the forced convection furnaces can be adjusted to the process requirements by adding suitable equipment.

- Tmax 450 °C, 650 °C, or 850 °C
- Horizontal air circulation
- Swing door hinged on the right
- Temperature uniformity up to +/- 4 °C according to DIN 17052-1 (model NA 15/65 up to +/- 5 °C) see page 71
- Optimum air flow and temperature uniformity through high circulation rates
- One frame sheet and rails for two additional trays included in the scope of delivery (NA 15/65 without frame sheet)
- Stainless steel air-baffles in the furnace for optimum air circulation
- Base frame included in the delivery, NA 15/65 designed as table-top model
- Air inlet and exhaust air flaps as additional equipment for using as drying oven
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 72

For additional information about forced convection chamber furnaces please ask for our separate catalog!

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
<th>Outer dimensions(^3) in mm</th>
<th>Connected load kW</th>
<th>Electrical connection(^*)</th>
<th>Weight in kg</th>
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<td>NA 30/45</td>
<td>450</td>
<td>290 420 260</td>
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<tr>
<td>NA 250/45</td>
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<td>600 750 600</td>
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<td>1350 1650 1725</td>
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<td>1550 1900 1820</td>
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</tbody>
</table>

1 Table-top model
2 Heating only between two phases
3 External dimensions vary when furnace is equipped with additional equipment. Dimensions on request

For additional information about forced convection chamber furnace NA 120/46 with lift door please see page 73 for more information about supply voltage.
Sealed Forced Convection Chamber Furnaces NA-I and NA-SI

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

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

### NA-I design

Like forced convection chamber furnaces < 675 l (page 34) with the following changes:
- Tmax 450 °C and 650 °C
- Silicone door seal
- Furnace housing sealed with silicone
- Protective gas connection in the back wall
- Defined application within the constraints of the operating instructions
- Residual oxygen concentration < 1 % depending on the volume and type of protective gas
- For non-flammable protective and reaction gases such as argon, nitrogen, and forming gas (national regulations must be considered)

### NA-SI design

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

### Table: Model Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
<th>Outer dimensions* in mm</th>
<th>Heating power in kW</th>
<th>Electrical connection*</th>
<th>Weight in kg</th>
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<tbody>
<tr>
<td>NA 20/45 I</td>
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<td>350 600 600</td>
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<td>3050 3700 3050</td>
<td>27.0</td>
<td>3-phase</td>
<td>900</td>
</tr>
</tbody>
</table>

1Table-top model
2Heating only between two phases
3External dimensions vary when furnace is equipped with additional equipment. Dimensions on request

*Please see page 73 for more information about supply voltage
4Depending on furnace design connected load might be higher
The chamber furnaces of the model series N(B) .. BO are used for processes with large amounts of organic matters or high vaporization rates. These models can be used for products which are insensitive against temporarily uncontrolled temperature increases. Processes in which the product or contaminations on the product are ashed by ignition can be also carried out safely in this type of chamber furnace. Examples include residual wax removal of pouring clusters followed by sintering, or thermal cleaning of oxide catalytic honey combs from soot or fuel residues. The electrically heated N...BO furnaces can be used for processes with exact temperature control and uniformity. For safety reasons, they are equipped with an integrated gas torch for igniting the flammable components in the gas mixture. The accumulation of flammable components is avoided and their safe combustion is ensured.

The gas-fired NB...BO furnaces are designed for processes which require a heat-up time to temperatures > 500 °C.

The burning of unwanted organic ingredients can take place at temperatures > 500 °C. Following this, a subsequent process can take place up to max. 1400 °C (electrically) or up to 1000 °C (gas-fired).

For safety, the furnace door locks after the program was started and cannot be opened again until the temperature has dropped below a defined value. In case of burner malfunction or gas shortage the process is aborted.

Chamber furnaces N 100 BO - N 650/14 BO, electrically heated and gas-fired ignition flame
- Tmax 1000 °C or 1400 °C
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- Exhaust hood
- Fully automatic temperature control
- Optional thermal afterburning
- Ignition flame using natural gas or liquid gas (LPG)
- Defined application within the constraints of the operating instructions
- Controls description see page 72

Chamber furnaces models NB 300 BO and NB 650 BO, gas-fired
- Tmax 1000 °C
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- Standard sizes up to 650 liters furnace chamber, additional sizes on request
- Integrated thermal afterburning
- Gas burners operating with natural gas or liquid gas (LPG)
- Defined application within the constraints of the operating instructions
- Controls description see page 72
Clean Room Solutions

Clean room applications impose particularly high requirements to the design of the chosen furnace. If the complete furnace is operated in a clean room an essential contamination of the clean room atmosphere must be avoided. Especially, the particle contamination must be reduced to a minimum.

The specific application determines the choice of the required furnace technology. In many cases forced convection furnaces are required to achieve the necessary temperature uniformity at lower temperatures. For higher temperatures, Nabertherm has also delivered many furnaces with radiant heating.

Furnace Installation in the Clean Room
If the complete furnace is supposed to be positioned in the clean room, then it is important that both the furnace chamber and the furnace housing as well as the controls provide for good protection against contamination. Surfaces must be easy to clean. The furnace chamber is tightly sealed to the insulation behind it. If necessary, additional equipment such as filters for the fresh air supply or the air circulation in the furnace can be used to improve the cleanliness class. It is recommended to install the switchgear and the furnace controls outside the clean room.

Furnace Installation in the Grey Room, Furnace Charging from the Clean Room
Optimal results with respect to cleanness will be achieved by placing the furnace in the grey room with charging from the clean room. This significantly reduces the amount of costly space needed in the clean room to a minimum. The front and the furnace interior in the clean room are designed for easy cleaning. With this configuration even the highest clean room classes can be achieved.

Sluice Furnace between Grey Room and Clean Room
Logistics between clean room and grey room can often be easily sorted out. Lock furnaces with one door in the grey room and the other door in the clean room are the perfect choice for these applications. The inner chamber as well as the furnace front in the clean room will be especially designed for lowest particle contamination.

Please contact us if you are looking for a heat treatment solution under clean room conditions. We would be pleased to quote for the oven or furnace model that meets best your requirements.
Compact Tube Furnaces

The RD tube furnaces convince with their unbeatable price-performance ratio, very compact outer dimensions and their low weight. These all-rounders are equipped with a working tube which also serves as support for the heating wires. Thus, the working tube is part of the furnace heating which has the advantage that the furnaces achieve very high heat-up rates. The tube furnaces can be supplied for 1100 °C or 1300 °C.

Both models are designed for horizontal application. If the customer requires protective gas atmosphere, a separate working tube incl. gas supply system 1, e.g. made of quartz glass, must be inserted in the working tube.

- Tmax 1100 °C or 1300 °C
- Dual shell housing made of sheets of textured stainless steel
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- Inner diameter of the tube: 30 mm, heated length: 200 mm
- Working tube made of C 530 material including two fiber plugs as standard
- Thermocouple type K (1100 °C) or type S (1300 °C)
- Solid state relays provide for low-noise operation of the heating
- Heating wires wound directly around the working tube resulting in very fast heat-up rates
- Defined application within the constraints of the operating instructions
- Controls description see page 72

Additional equipment

- Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Gas supply system for non-flammable protective or reactive gas

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Outer dimensions³ in mm</th>
<th>Inner tube Ø in mm</th>
<th>Heated length in mm</th>
<th>Length constant temperature +/- 5 K in mm³</th>
<th>Connected load kW</th>
<th>Minutes to Tmax²</th>
<th>Electrical connection</th>
<th>Weight in kg</th>
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<td>12</td>
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<td>RD 30/200/13</td>
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<td>350 200 350 30</td>
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<td>1.5</td>
<td>25</td>
<td>1-phase</td>
<td>12</td>
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</table>

¹Values outside the tube. Difference to temperature inside the tube up to +50 K
²If connected at 230 V 1/N/PE resp. 400 V 3/N/PE
³External dimensions vary when furnace is equipped with additional equipment. Dimensions on request
These compact tube furnaces with integrated control systems can be used universally for many processes. Equipped with a standard working tube of C 530 ceramic and two fiber plugs, these tube furnaces have an unbeatable price/performance ratio.

- Tmax 1200 °C or 1300 °C
- Single-zoned design as standard
- Dual shell housing made of sheets of textured stainless steel
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- Outer tube diameter of 50 mm to 170 mm, heated length from 250 mm to 1000 mm
- Working tube of C 530 ceramic including two fiber plugs as standard equipment
- Tmax 1200 °C: Type N thermocouple
- Tmax 1300 °C: Type S thermocouple
- Solid state relays provide for low noise operation
- Standard working tube see chart on page 51
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 72

Additional equipment
- Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Charge control with temperature measurement in the working tube and in the furnace chamber outside the tube see page 54
- Three-zoned design (heated length from 500 mm)
- Working tubes see chart on page 51
- Please see page 52 for additional equipment
- Gas supply systems for protective gas or vacuum operation see page 52
- Process control and documentation via VCD software package for monitoring, documentation and control see page 75

### Tube furnace R 170/1000/13

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Outer dimensions in mm</th>
<th>Outer tube Ø</th>
<th>Heated length in mm</th>
<th>Length constant temperature +/- 5 K in mm</th>
<th>Tube length in mm</th>
<th>Connected load kW</th>
<th>Electrical connection*</th>
<th>Weight in kg</th>
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<td>330</td>
<td>1400</td>
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</table>

- Values outside the tube. Difference to temperature inside the tube up to + 50 K
- External dimensions vary when furnace is equipped with additional equipment. Dimensions on request
- Please see page 73 for more information about supply voltage
- *Please see page 73 for more information about supply voltage
- Tube furnace R 50/250/13 with gas supply system 2

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**Notice**: The table above provides technical specifications for different models of tube furnaces, including their maximum operating temperatures, outer dimensions, heated lengths, and connected loads. Each model is designed for specific applications, and their configurations vary. Always consult the latest specifications and operating instructions provided by the manufacturer.
Tube Furnaces with Stand for Horizontal or Vertical Operation

These compact tube furnaces are used when laboratory experiments must be performed horizontally, vertically, or at specific angles. The ability to configure the angle of tilt and the working height, and their compact design, also make these tube furnaces suitable for integration into existing process systems.

- Tmax 1100 °C, 1300 °C, or 1500 °C
- Compact design
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- Vertical or horizontal operation freely adjustable
- Working height freely adjustable
- Working tube made of C 530 ceramic
- Type S thermocouple
- Operation also possible separate from stand if safety guidelines are observed
- Control system integrated in furnace base
- Please see page 52 for additional equipment
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 72

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax</th>
<th>Outer dimensions in mm</th>
<th>Inner tube Ø</th>
<th>Heated length in mm</th>
<th>Length constant temperature +/- 5 K in mm²</th>
<th>Tube length in mm</th>
<th>Connected load kW</th>
<th>Electrical connection</th>
<th>Weight in kg</th>
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</tbody>
</table>

¹Values outside the tube. Difference to temperature inside the tube up to + 50 K
²External dimensions vary when furnace is equipped with additional equipment. Dimensions on request

*Please see page 73 for more information about supply voltage
High-Temperature Tube Furnaces with SiC Rod Heating
Gas Atmosphere or Vacuum

These compact tube furnaces with SiC rod heating and integrated switchgear and controller can be used universally for many processes. With an easy to replace working tube as well as additional standard equipment options, these furnaces are flexible and can be used for a wide range of applications. The high-quality fiber insulation ensures fast heating and cooling times. The SiC heating rods installed parallel to the working tube ensure excellent temperature uniformity. The price-performance ratio for this temperature range is unbeatable.

- Tmax 1500 °C
- Dual shell housing made of sheets of textured stainless steel
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- Active cooling of housing for low surface temperatures
- Type S thermocouple
- Solid state relays provide for low-noise operation
- Prepared for assembly of working tubes with water-cooled flanges
- Ceramic tube, C 799 quality
- Standard working tube see chart on page 51
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 72

Additional equipment
- Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Charge control with temperature measurement in the working tube and in the furnace chamber outside the tube see page 54
- Fiber plugs
- Check valve at gas outlet avoids intrusion of false air
- Working tubes for operation with water-cooled flanges
- Display of inner tube temperature with additional thermocouple
- Alternative gas supply systems for protective gas or vacuum operation see page 52
- Alternative working tubes see chart on page 51
- Process control and documentation via VCD software package for monitoring, documentation and control see page 75

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Outer dimensions (in mm)</th>
<th>Outer tube Ø</th>
<th>Heated length</th>
<th>Length constant temperature +/− 5 K</th>
<th>Tube length in</th>
<th>Connected load kW</th>
<th>Electrical connection</th>
<th>Weight in kg</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>W D H</td>
<td>in mm</td>
<td>in mm</td>
<td>in mm²</td>
<td>in mm</td>
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<td>150 800</td>
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<td>1080</td>
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</table>

²Heating only between two phases
³Heating only between phase 1 and neutral
⁴External dimensions vary when furnace is equipped with additional equipment. Dimensions on request

*Please see page 73 for more information about supply voltage

1Heating only between two phases
2Heating only between phase 1 and neutral
3Values outside the tube. Difference to temperature inside the tube up to + 50 K
High-Temperature Tube Furnaces for Horizontal and Vertical Operation up to 1800 °C
Gas Atmosphere or Vacuum

The high-temperature tube furnaces are available in either horizontal (type RHTH) or vertical (type RHTV) designs. High-quality insulation materials made of vacuum-formed fiber plates enable energy-saving operation and a fast heating time due to low heat storage and heat conductivity. By using different gas supply systems, operations can be performed under non-flammable or flammable protective or reactive gases or under vacuum.

- $T_{\text{max}}$ 1600 °C, 1700 °C, or 1800 °C
- MoSi$_2$ heating elements, mounted vertically for easy replacement
- Insulation with vacuum-formed ceramic fiber plates
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- Rectangular outer housing with slots for convection cooling
- Tube furnaces RHTV with frame for vertical operation
- Dual shell housing made of sheets of textured stainless steel
- Ceramic working tube made of material C 799 incl. fiber plugs for operation under air
- Type B thermocouple
- Power unit with low-voltage transformer and thyristor
- Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load and with selectable maximum temperature gradient as tube protection
- Switchgear and control unit separate from furnace in separate floor standing cabinet
- Standard working tube see chart on page 51
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 72
Additional equipment

- Charge control with temperature measurement in the working tube and in the furnace chamber outside the tube see page 54
- Display of inner tube temperature with additional thermocouple
- Gas tight flanges for protective gas and vacuum operation
- Manual or automatic gas supply system
- Three-zone control for optimization of temperature uniformity (only tube furnaces RHTH)
- Check valve at gas outlet avoids intrusion of false air
- Alternative working tubes designed for process requirements see chart on page 51
- For more additional equipment see page 52
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 75

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax</th>
<th>Outer dimensions a in mm</th>
<th>Max. outer tube Ø in mm</th>
<th>Heated length in mm</th>
<th>Length constant temperature +/- 5 K in mm²</th>
<th>Tube length in mm</th>
<th>Connected load kW</th>
<th>Electrical connection*</th>
<th>Weight in kg</th>
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<tr>
<td>RHTV 50/150/..</td>
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<td>50 150</td>
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<td>3-phase 70</td>
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<td>RHTV 80/300/..</td>
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<td>80 300</td>
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<td>3-phase 110</td>
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</tbody>
</table>

- Heating only between two phases

*Please see page 73 for more information about supply voltage

*Values outside the tube. Difference to temperature inside the tube up to + 50 K

For more additional equipment see page 52

Over-temperature limiter

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

Charge control with temperature measurement in the working tube and in the furnace chamber outside the tube see page 54
Split-Type Tube Furnaces for Horizontal or Vertical Operation up to 1300 °C
Gas Atmosphere or Vacuum

These tube furnaces can be used for horizontal (RSH) or vertical (RSV) operation. The split-type design makes it easy to change the working tube. It allows for a comfortable exchange of various working tubes (e.g. working tubes made of different materials).

Using the wide range of accessories these professional tube furnaces can be optimally tailored to your process. By upgrading the furnaces with different gas supply systems the operation in a protective gas atmosphere, under vacuum or under flammable protective or reactive gases is possible. Besides convenient standard controllers for process control modern PLC control systems are also available.

- Tmax 1100 °C or 1300 °C
- Dual shell housing made of sheets of textured stainless steel
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- Tmax 1100 °C: Type N thermocouple
- Tmax 1300 °C: Type S thermocouple
- Frame for vertical operation (RSV)
- Split-type design for simple insertion of the working tube
- Working tube made of material C 530 incl. fiber plugs for operation under air in scope of delivery
- Heating elements on support tubes provide for free radiation
- RSV: switchgear and control unit separate from furnace in own wall or standing cabinet
- RSH: switchgear and control unit integrated in furnace housing
- Standard working tube see chart on page 51
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 72

Tube furnace RSH 50/500/13
Tube furnace RSV 170/1000/11 with gas supply system 2
Gas supply system for non-flammable protective or reactive gas with shutoff valve and flow meter with regulator valve, optionally with magnetic valve
Tube furnace RSH 120/1000/11S, three-zone controlled, incl. zone separators to reach a temperature gradient
Tube furnace RS 120/750/13 with gas supply system 4, hydrogen applications
Additional equipment
- Charge control with temperature measurement in the working tube and in the furnace chamber outside the tube see page 54
- Display of inner tube temperature with additional thermocouple
- Different gas supply systems for non-flammable or flammable protective or reactive gases and vacuum operation see page 52
- Three-zone control for optimization of temperature uniformity
- Cooling systems for accelerated cooling of the working tube and charge
- Check valve at gas outlet avoids intrusion of false air
- Base frame with integrated switchgear and controller
- Alternative working tubes designed for process requirements see chart on page 51
- For additional equipment see page 52
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 75

### Tube Furnace RSH 80/500/13

- With gas tight tube and water-cooled flanges

### Quartz Glass and Flanges

- For protective gas operation as optional equipment

---

### Model Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax</th>
<th>Outer dimensions</th>
<th>Max. outer tube Ø</th>
<th>Heated length</th>
<th>Length constant temperature +/- 5 K in mm</th>
<th>Tube length</th>
<th>Connected load</th>
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<td>250</td>
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<td>750</td>
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<td>1350</td>
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<td>3-phase</td>
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<td>250 / 375</td>
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<td>170</td>
<td>1000</td>
<td>330 / 500</td>
<td>1350</td>
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<td>3-phase</td>
<td>76</td>
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<tr>
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<td>120</td>
<td>1000</td>
<td>330 / 500</td>
<td>1350</td>
<td>13.7 / 13.7</td>
<td>3-phase</td>
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<td>3-phase</td>
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<td>13.7 / 13.7</td>
<td>3-phase</td>
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<td>1350</td>
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<td>3-phase</td>
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<tr>
<td>RSV 170/1000/..</td>
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<td>590 x 1725</td>
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<td>1000</td>
<td>330 / 500</td>
<td>1350</td>
<td>13.7 / 13.7</td>
<td>3-phase</td>
<td>91</td>
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</table>

1 Values outside the tube. Difference to temperature inside the tube up to +50 K
2 Without tube
3 At 3-phase execution an N conductor is required (3/N/PE)
4 External dimensions vary when furnace is equipped with additional equipment. Dimensions on request
5 Please see page 73 for more information about supply voltage

---

*At 415 volt
Rotary Tube Furnaces for Batch Operation up to 1100 °C

The rotary tube furnaces of the RSRB series are ideally suited for batch operation. The permanent rotation of the working tube ensures that the charge is constantly in motion. Due to the special shape of the quartz reactor with the tapered pipe ends the batch is kept in the rotary tube furnace and can be heat-treated an arbitrarily long time period; a controlled heating to the temperature profiles is also possible.

- Tmax 1100 °C
- Thermocouple type K
- Dual shell housing made of sheets of textured stainless steel
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- Tube furnace designed as table-top model with quartz glass reactor which opens on both sides, tapered ends
- Reactor is removed for emptying out of the rotary tube furnace. Beltless drive and hinged furnace housing (opening temperature < 180 °C) provide for very easy removal through
- Adjustable drive of approx. 2-45 rpm
- Switchgear and control unit separate from tube furnace in own wall or standing cabinet
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 72

Additional equipment
- Three-zone control for the optimization of temperature uniformity
- Temperature display unit in the working tube with measurement by means of an additional thermocouple
- Charge control by means of an additional thermocouple in the working tube
- Different gassing ensures good flushing of the charge with process gas through inlet on one side and outlet on other side of tube
- Gas-tight rotary feedthrough for connection of the rotating reactor to a gas supply system
Check valve at gas outlet avoids intrusion of false air

Vacuum design, up to $10^{-2}$ mbar depending on the applied pump

Open on both sides reactor made of quartz glass with knobs for better mixing of the charge in the tube

Package for improved charging and discharging of the working tube in the following design:
- Mixing reactor made of quartz glass with integrated blade for better mixing of the batch, closed on one side, large opening on the other side
- Tilting mechanism to the left/to the right. For charging and heat treatment, the furnace is tilted towards the right side until the stop so that the load is charged into the rotary tube furnace. For discharge, the furnace is tilted towards the other side to discharge the powder from the reactor. It is no longer necessary to remove the reactor.
- Rotary tube furnace assembled on base with integrated switchgear and controller, incl. transport casters

Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 75

---

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax</th>
<th>Outer dimensions $^1$ (in mm)</th>
<th>Max. outer tube Ø</th>
<th>Ø Terminal end</th>
<th>Heated length</th>
<th>Length constant temperature $^1$</th>
<th>Tube length</th>
<th>Connected load</th>
<th>Electrical connection</th>
<th>Weight in kg</th>
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<tr>
<td></td>
<td>°C</td>
<td>W</td>
<td>D</td>
<td>H</td>
<td>in mm</td>
<td>in mm</td>
<td>500</td>
<td>170</td>
<td>250</td>
<td>in mm²</td>
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<td>RSRB 80-500/11</td>
<td>1100</td>
<td>1145</td>
<td>475</td>
<td>390</td>
<td>76</td>
<td>28</td>
<td>500</td>
<td>170</td>
<td>250</td>
<td>1140</td>
</tr>
<tr>
<td>RSRB 80-750/11</td>
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<td>475</td>
<td>390</td>
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<td>28</td>
<td>750</td>
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<td>375</td>
<td>1390</td>
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<td>RSRB 120-500/11</td>
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<td>28</td>
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<td>RSRB 120-750/11</td>
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<td>106</td>
<td>28</td>
<td>1000</td>
<td>330</td>
<td>500</td>
<td>1640</td>
</tr>
</tbody>
</table>

$^1$Heating only between two phases

$^2$Heating only between phase 1 and neutral

$^3$External dimensions vary when furnace is equipped with additional equipment. Dimensions on request

$^4$Values outside the tube. Difference to temperature inside the tube up to $+50$ K

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*Please see page 73 for more information about supply voltage
The RSRC rotary tube furnaces are particularly suitable for processes where continuously running batch material is heated for a short time.

The rotary tube furnace is positioned slightly inclined heated-up to the target temperature. The material is then continuously supplied at the upper end of the tube. It passes through the heated area of the tube and falls on the lower end out of the tube. The time of heat treatment results from the inclination angle, the rotational speed and the length of the working tube, as well as from the flow properties of the batch material.

Equipped with the optional closed loading system for 5 liter charge material incl. receptacle, the rotary tube furnace can also be used for processes under protective gas or vacuum.

Depending on process, charge and required maximum temperature, different working tubes made of quartz glass, ceramics or metal are used (see page 50). This rotary tube furnace is therefore highly adaptable for different processes.

- Tmax 1100 °C
  - Working tube made of quartz glass open at both sides
  - Thermocouple type K

- Tmax 1300 °C
  - Open tube made of ceramics C 530
  - Thermocouple type S

- Heating elements on support tubes provide for free radiation
- Dual shell housing made of sheets of textured stainless steel
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
- Adjustable drive of approx. 2-45 rpm
- Digital display unit for the tilting angle of the rotary tube furnace
- Beltless drive and split-type furnace housing (opening temperature < 180 °C) provide for very easy tube removal
- Compact system, rotary tube furnace positioned on a base frame with
  - Manual spindle drive with crank to preset the tilting angle
  - Switchgear and controls integrated
  - Castors

- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 72
Additional equipment

- Three-zone control for the optimization of temperature uniformity
- Temperature display unit in the working tube with measurement by means of an additional thermocouple
- Charge control by means of an additional thermocouple in the working tube
- Different gassing systems with good flushing of the charge with process gas (also possible with hydrogen) in counterflow (only in combination with feeding system below)
- Vacuum design, up to $10^{-2}$ mbar depending on the applied pump
- Vibrating channel and extension piece on the rotary tube for convenient material supply/removal, suitable for processes in normal atmosphere
- Charging system for continuous material transport, consisting of:
  - Stainless steel funnel incl. electric vibration generator to optimize the material feeding into the working tube
  - Electrically driven screw-conveyor at the inlet of the working tube with 10, 20 or 40 mm pitch and adjustable speed between 0.28 and 6 revolutions per minute, different gear transmissions for other speeds on request
  - Collecting bottle made of laboratory glass at the outlet of the working tube
  - Suitable for operation in gas atmosphere or vacuum
- Working tubes made of different materials see page 50
- Quartz glass batch reactors, $T_{\text{max}}$ 1 100 °C
- Higher temperatures up to 1500 °C available on request
- Digital display unit for the tilting angle of the furnace
- PLC controls for temperature control and the control of connected aggregates such as gearshift and speed of the screw-conveyor, speed of the working tube, switching of the vibration generator, etc.
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 75

<table>
<thead>
<tr>
<th>Model</th>
<th>$T_{\text{max}}$ °C</th>
<th>Outer dimensions in mm</th>
<th>Max. outer tube Ø in mm</th>
<th>Heated length in mm</th>
<th>Length constant Temperature +/- 5 K in mm³</th>
<th>Tube length in mm</th>
<th>Connected load kW</th>
<th>Electrical connection*</th>
<th>Weight in kg</th>
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1 Heating only between two phases
2 Heating only between phase 1 and neutral
3 External dimensions vary when furnace is equipped with additional equipment. Dimensions on request
4 Values outside the tube. Difference to temperature inside the tube up to $+50$ K

---

Vibrating channel on the rotary tube for convenient material feeding

Vibration generator at the charging funnel for improved powder supply
### Working Tubes

There are various working tubes available, depending on application and temperatures. The technical specifications of the different working tubes are presented in the following table:

<table>
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<tr>
<th>Material</th>
<th>Tube outside Ø mm</th>
<th>Max. heat-up ramp K/h</th>
<th>Tmax in air* °C</th>
<th>Tmax in vacuum operation °C</th>
<th>Gas tight</th>
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¹ The max. allowed temperature might be reduced operating under aggressive atmospheres.

1Tubes/reactors incl. mounted sleeves for connection to the rotary drive. Spare tubes come without sleeves.
### Working Tubes: Standard (●) and Options (○)

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1With grinded tube ends for the use with water-cooled end flanges
2With attached holder for gas tight flange

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### Vacuum Tube

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### Vacuum Quartz Glass Tube

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1With grinded tube ends for the use with water-cooled end flanges
2With attached holder for gas tight flange
Gas Supply Systems/Vacuum Operation for Tube Furnaces

When equipped with various equipment packages, the tube furnace product lines can be adapted for operation with nonflammable or flammable gasses or for vacuum operation.

**Gas Supply System 1** for non-flammable protective or reactive gases

Not gastight, no vacuum operation

This package represents a basic version sufficient for many applications, for operation with non-flammable protective or reactive gasses. The standard working tube made of ceramic C 530 delivered with the furnace can still be used.

- Available for tube furnaces RD, R, RT, RSH and RSV
- Standard working tube can be used
- 2 plugs made of porous, non-classified ceramic fiber incl. protective gas connections
- Gas supply system for nonflammable protective gas (Ar, N₂, forming gas, others on request) with shutoff valve and flow meter with control valve, optionally with magnetic valve. One gas intake pressure at 300 mbar to be provided by customer.

Additional equipment
- Extension of gas supply system with a second or third nonflammable type of gas
- Bottle pressure regulator for use with bottled gas
- Automatic switching on/off by means of the program segments of the controller, only possible with control systems which include programmable extra functions

**Gas Supply System 2** for non-flammable protective or reactive gases/vacuum operation

For increased atmospheric purity requirements in the working tube, we recommend this gas supply system. The system can also be equipped for vacuum operation.

- Available for tube furnaces R, RSH, RSV, RSRB, RSRC, RHTC, RHTH, RHTV
- Gas supply system for nonflammable protective gas (Ar, N₂, forming gas, others on request) with shutoff valve and flow meter with control valve, optionally with magnetic valve. One gas intake pressure at 300 mbar to be provided by customer.
- Additional equipment for static tube furnaces:
  - Longer, gas tight working tube of ceramic C 610 for furnaces to 1300 °C or of C 799 for temperatures above 1300 °C
  - 2 vacuum-tight, water-cooled stainless steel flanges with fittings on the outlet side (cooling water supply with NW9 hose connector to be provided by the customer)
  - Mounting system on furnace for the flanges
- Additional equipment for RSRC models (continuous operation): charging system
- Additional Equipment for RSRB models: gas-tight rotarylead-outs on gas inlet and outlet, gas cooler and gas outlet valve

Additional equipment
- Extension of gas supply system with a second or third nonflammable type of gas
- Bottle pressure regulator for use with bottled gas
- Automatic switching on/off by means of the program segments of the controller, only possible with control systems which include programmable extra functions
- Gas-supply programmable via mass-flow controllers (only in combination with PLC-controls)
- Process tubes made of different materials
- Quick-locks for watercooled flanges
- Cooling unit for closed loop water circuit
- Window for charge observation in combination with gas tight flanges

* Country-specific guidelines with respect to the possible gas mixing ration have to be considered
Vacuum Operation

- Vacuum package for evacuation of the working tube, consisting of connector for the gas outlet, ball valve, manometer, manually operated rotary vane vacuum pump with corrugated stainless steel hose connected to the gas outlet, max. attainable end pressure in working tube depending on pump type
- Pumps for max. final pressure of up to $10^{-5}$ mbar (models RSRB/RSRC up to $10^{-2}$ mbar) on request see page 53
- The decrease in strength of the working tube at high temperatures limits the maximum operating temperature under vacuum see page 50

Gas Supply System 4 for hydrogen, fully-automatic, unattended operation

Adding gas supply system 4 to the tube furnace allows operation under a hydrogen atmosphere. During hydrogen operation, a safety pressure of approx. 30 mbar is ensured in the working tube. Surplus hydrogen is burnt off in an exhaust gas torch. With extended safety logic and an integrated nitrogen purge container, the system can be used for fully-automatic, unattended operation. Equipped with a Safety-PLC control system, pre-purging, hydrogen inlet, operation, fault monitoring and purging at the end of the process are carried out automatically. In case of default, the tube is immediately purged with nitrogen and the system is automatically switched to a safe status.

- Available for tube furnaces RSH, RSV, RSRC, RHTH and RHTV
- Safety system for operation with flammable gases including monitoring of torch function and overpressure
- Extended safety control system with emergency tube purging in case of default
- Emergency purge container
- Safety-PLC control system with touchpanel for data input
- Exhaust gas torch
- Pressure switch for monitoring the safety pressure
- Gas supply system for $H_2$ and $N_2$. Volume adjustment is carried out by hand (the customer provides an $H_2$ supply at 1 bar, an $N_2$ supply at 10 bar, an $O_2$ supply at 6-8 bar and a propan supply at 300 mbar)

Additional equipment

- Gas supply system extension for additional nonflammable gas types
- Operation with other flammable gases on request
- Bottle pressure reducer for use with bottled gas
- Cooling unit for closed loop water circuit
- Vacuum packages (with hydrogen operation, this package can only be used for pre-evacuation)
- Gas supply via program-dependent, controllable mass flow controllers

Vacuum Pumps

With respect to the final pressure different pumps are available see page 67:

- Single-step rotary piston pump for a max. final pressure of approx. 20 mbar.
- Two-step rotary piston pump for a max. final pressure of approx. $10^{-2}$ mbar.
- Turbomolecular pump stand (rotary vane pump with following turbomolecular pump for a max. final pressure of $10^{-5}$ mbar.
- Independent pressure gauge for a pressure range of $10^{-5}$ mbar or $10^{-9}$ mbar as additional equipment

Information:
For protection of the vacuum pump only cold stage evacuation is allowed.
Control Alternatives for Tube Furnaces

Three-Zone Furnace Chamber Control
The temperature is measured by thermocouples positioned outside of the working tube, one in the middle and two on the sides. The outer zones are controlled with a setpoint-offset in relation to the middle zone. This allows the heat loss at the ends of the tube to be compensated to ensure an extended zone of constant temperature (+/- 5 K).

Furnace Chamber Control
with temperature measurement in furnace chamber outside the working tube.
- Advantages: Thermocouple protected against damage and aggressive load, very even control, attractive price
- Disadvantage: Temperature difference between displayed temperature on the controller and inside the tube

Extension Package for Furnace Chamber Control
with additional temperature measurement in the working tube and display of the measured temperature

Charge Control
with temperature measurement both in the furnace chamber outside the working tube as well as in the working tube.
- Advantages: Very precise and rapid control adjustment
- Disadvantage: Costs

Furnace Chamber vs. Charge Control Comparison

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

Charge Control
If the charge control is switched on, both the charge temperature and furnace chamber temperature are measured. By setting different parameters the heat-up and cooling processes can be individually adapted. This results in a more precise temperature control at the charge.

1. Furnace setpoint value
2. Actual value furnace chamber, 1-zone
3. Actual value furnace chamber, 3-zone
4. Actual value furnace chamber
5. Actual value load/bath/muffle/retort
6. Charge setpoint value

Sintering under hydrogen in a tube furnace of RHTH product line

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

With their high level of flexibility and innovation, Nabertherm offers the optimal solution for customer-specific applications.

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

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

RS 120/1000/11S with bogie for different inclination angles

RS 250/2500/08, five-zone controlled, for wire annealing in high-vacuum or under protective gases, incl. forced cooling and exhaust hood

RS 460/1000/16S for integration in a production plant

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

These compact melting furnaces for the melting of non-ferrous metals and alloys are one of a kind and have a number of technical advantages. Designed as tabletop models, they can be used for many laboratory applications. The practical counter balanced hinge with shock absorbers and the spout (not for KC) on the front of the furnace make exact dosing easy when pouring the melt. The melting furnaces are available for furnace chamber temperatures of 1000, 1300, or 1500 °C. This corresponds to melt temperatures of about 80 °C - 110 °C lower.

- T max 1000 °C, 1300 °C, or 1500 °C, with melt temperature about 80 °C - 110 °C lower
- Crucible sizes of 0.75, 1.5 or 3 liters
- Crucible with integrated pouring spout of iso-graphite included with delivery
- Additional spout (not for KC), mounted at the furnace for exact pouring
- Compact bench-top design, simple emptying of crucible by tilting system with gas damper
- Crucible for heating up of melting furnace insulated with a hinged lid, lid opened when pouring
- Defined application within the constraints of the operating instructions
- Controls description see page 72

Additional equipment
- Other crucible types available, e.g. steel
- Design as bale-out furnace without tilting device, e.g. for lead melting
- Over-temperature limiter for the furnace chamber with automatic reset to protect against overtemperature. The limit controller switches off the heating when the pre-set limit temperature has been reached and does not switch it on again until the temperature falls below the setting again.
- Observation hole for melt

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Crucible</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>
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<tbody>
<tr>
<td>K 1/10</td>
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<td>A 6</td>
<td>0.75</td>
<td>520 660 660</td>
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<td>A10</td>
<td>1.50</td>
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<td>A25</td>
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<td>1-phase</td>
<td>110</td>
</tr>
<tr>
<td>K 1/132</td>
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<td>A 6</td>
<td>0.75</td>
<td>520 660 660</td>
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<td>1-phase</td>
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</tr>
<tr>
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<td>A10</td>
<td>1.50</td>
<td>520 660 660</td>
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<td>K 4/132</td>
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<td>A25</td>
<td>3.00</td>
<td>570 755 705</td>
<td>5.5</td>
<td>3-phase</td>
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<td>0.75</td>
<td>580 630 580</td>
<td>10.5</td>
<td>3-phase</td>
<td>170</td>
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<tr>
<td>KC 2/153</td>
<td>1500</td>
<td>A10</td>
<td>1.50</td>
<td>580 630 580</td>
<td>10.5</td>
<td>3-phase</td>
<td>170</td>
</tr>
</tbody>
</table>

*Heating only between two phases
*Please see page 73 for more information about supply voltage
*Switchgear and controller mounted in a floor standing cabinet
*External dimensions vary when furnace is equipped with additional equipment. Dimensions on request
**Fast-Firing Furnaces**

These fast-firing furnaces are ideal for simulation of typical fast-firing processes up to a maximum firing temperature of 1300 °C. The combination of high performance, low thermal mass and powerful cooling fans provides for cycle times from cold to cold up to 35 minutes with an opening temperature of approx. 300 °C.

- Tmax 1300 °C
- Very compact design
- Ceramic grid tubes as charge support
- Floor and lid heating
- Two-zone control, bottom and lid
- Integrated cooling fans, programmable to speed up charge cooling including housing cooling
- Programmable lid opening of approximately 60 mm for faster cooling without activating the fan
- Thermocouple type S for top and bottom zone
- Castors for easy furnace moving
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 72

### Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Inner dimensions in mm</th>
<th>Volume in l</th>
<th>Outer dimensions in mm</th>
<th>Connected load kW</th>
<th>Electrical connection*</th>
<th>Weight in kg</th>
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<td>900 x 1030 x 1150</td>
<td>22</td>
<td>3-phase</td>
<td>160</td>
</tr>
</tbody>
</table>

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

### Gradient or Lab Strand Annealing Furnaces

The furnace chamber of the gradient furnace GR 1300/13 is divided in six control zones of equal length. The temperature in each of the six heating zones is separately controlled. The gradient furnace is usually charged from the side through the parallel swivel door. A maximum temperature gradient of 400 °C can then be stabilized over the heated length of 1300 mm. On request the furnace also is designed as a lab strand annealing furnace with a second door on the opposite side. If the included fiber separator are used charging is carried-out from the top.

- Tmax 1300 °C
- Heated length: 1300 mm
- Heating elements on support tubes providing for free heat radiation in the kiln chamber
- Charging from the top or through the right side door
- Gas damper suspension of the lid
- 6-zone control
- Separate control of heating zones (each 160 mm long)
- Temperature gradient of 400 °C over the entire length of the kiln chamber, each zone can individually be controlled
- Fiber separators dividing the chamber in six equally sized chambers
- Defined application within the constraints of the operating instructions
- Controls description see page 72

### Additional Equipment

- Up to ten control zones
- Second parallel swivel door for use as lab strand annealing furnace
- Vertical instead of horizontal strand furnace
- Process control and documentation via Nabertherm Control Center (NCC) for monitoring, documentation and control
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 72

### Specification

<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>
<th>Weight in kg</th>
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<tbody>
<tr>
<td>GR 1300/13</td>
<td>1300</td>
<td>1300 x 100 x 60</td>
<td>1660 x 740 x 1345</td>
<td>18</td>
<td>3-phase</td>
<td>300</td>
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</tbody>
</table>

*External dimensions vary when furnace is equipped with additional equipment. Dimensions on request
*Please see page 73 for more information about supply voltage
These gas tight retort furnaces are equipped with direct or indirect heating depending on temperature. They are perfectly suited for various heat treatment processes requiring a defined protective or a reaction gas atmosphere. These compact models can also be laid out for heat treatment under vacuum up to 600 °C. The furnace chamber consists of a gas tight retort with water cooling around the door to protect the special sealing. With the corresponding safety technology, retort furnaces are also suitable for applications under reaction gases, such as hydrogen or, in combination with the IDB package, for inert debinding or for pyrolysis processes.

Different model versions are available depending on the temperature range:

**Models NRA ../06 with Tmax 650 °C**
- Heating elements located inside the retort
- Temperature uniformity up to +/- 5 °C inside the work space see page 71
- Retort made of 1.4571
- Gas circulation fan in the back of the retort provides for optimal temperature uniformity
- Insulation made of mineral wool

**Models NRA ../09 with Tmax 950 °C**
Design like models NRA ../06 with following differences:
- Outside heating with heating elements around the retort
- Retort made of 1.4828
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2

**Models NR ../11 with Tmax 1100 °C**
Design like models NRA ../09 with following differences:
- Retort made of 1.4841
- Without gas-circulation
Basic version
- Compact housing in frame design with removable stainless steel sheets
- Controls and gas supply integrated in the furnace housing
- Welded charging supports in the retort resp. air-baffle box in the furnaces with atmosphere circulation
- Swivel door hinged on right side
- Open cooling water system
- Depending on furnace volume for 950 °C- and 1100 °C-models the control system is divided in one or more heating zones
- Furnace temperature control with measurement outside the retort
- Gas supply system for one non-flammable protective or reaction gas with flow meter and magnetic valve
- Port for vacuum pump for cold evacuation
- Operation under vacuum up to 600 °C with optional single-stage rotary vane pump
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Controls description see page 72

Additional equipment
- Upgrade for other non-flammable gases, H₂ version for flammable gases see page 60
- Automatic gas injection, including MFC flow controller for alternating volume flow, controlled with process control H3700, H1700
- Vacuum pump for evacuating of the retort up to 600 °C, attainable vacuum up to $10^{-5}$ mbar subject to selected pump
- Indirect cooling see page 69
- Direct cooling see page 69
- Heat exchanger with closed-loop cooling water circuit for door cooling
- Measuring device for residual oxygen content
- Door heating
- Temperature control as charge control with temperature measurement inside and outside the retort
- Retort, made of 2.4633 for Tmax 1150 °C
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 75
**Retort furnace NRA 300/09 H₂ for heat treatment under hydrogen**

<table>
<thead>
<tr>
<th>Model</th>
<th>Tmax °C</th>
<th>Work space dimensions in mm</th>
<th>Useful volume in l</th>
<th>Electrical connection</th>
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<tr>
<td>NRA</td>
<td>17/11</td>
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<td>1100</td>
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<td>1100</td>
<td>225</td>
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<td>325</td>
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<td>1100</td>
<td>325</td>
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<td>NRA</td>
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<td>1100</td>
<td>450</td>
</tr>
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<td>1100</td>
<td>450</td>
</tr>
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<td>300/11</td>
<td>650 or 950</td>
<td>1100</td>
<td>590</td>
</tr>
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<td>NRA</td>
<td>400/11</td>
<td>650 or 950</td>
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<td>590</td>
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<td>500/11</td>
<td>650 or 950</td>
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<td>650 or 950</td>
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<td>870</td>
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</table>

*Please see page 73 for more information about supply voltage*
With their high level of flexibility and innovation, Nabertherm offers the optimal solution for customer-specific applications.

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

Hot-wall retort furnace NRA 1700/06 for steel annealing under nitrogen

Hot-wall retort furnace NRA 3300/06 with automatic door opening for the integration in a fully automatic quench & temper plant
Bottom Loading Retort Furnaces up to 1100 °C

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

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

Additional equipment, H₂ version and IDB version see models NR and NRA
Cold-Wall Retort Furnaces up to 2400 °C or up to 3000 °C

Compared with the VHT models (page 64 ff), the retort furnaces of the SVHT product line offer improved performance data with regard to achievable vacuum and maximum temperature. Due to the design as pit-type furnace with tungsten heating, processes up to max. 2400 °C even in high vacuum can be implemented with retort furnaces of the SVHT...-W product line. Retort furnaces of the SVHT...-GR product line with graphite heating, also in pit-type design, can be operated in an inert gas atmosphere even up to max. 3000 °C.

- Standard sizes with a furnace chamber of 2 or 9 liters
- Designed as pit-type furnace, charged from above
- Frame construction with inserted sheets of textured stainless steel
- Dual shell water-cooled stainless steel container
- Manual operation of process gas and vacuum functions
- Manual gas supply for non-combustible process gas
- A step in front of the retort furnace for an ergonomic charging height
- Retort lid with gas-charged shock absorbers
- Controls and switchgear as well as gas supply integrated in furnace housing
- Defined application within the constraints of the operating instructions
- Further standard product characteristics see description for standard design of VHT models page 64

Heating Options

**SVHT ...-GR**

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

**SVHT ...-W**

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

Additional equipment such as automatic process gas control or design for the operation with flammable gases incl. safety system see VHT models page 64.
Cold-Wall Retort Furnaces up to 2400 °C

The compact retort furnaces of the VHT product line are available as electrically heated chamber furnaces with graphite, molybdenum, tungsten or MoSi2 heating. A wide variety of heating designs as well as a complete range of accessories provide for optimal retort furnace configurations even for sophisticated applications.

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

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

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

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

VHT ../..-KE with Fiber Insulation and Heating through Molybdenum Disilicide Heating Elements
- Suitable for processes under protective and reaction gases, in air or under vacuum
- Tₘₐₓ 1800 °C
- Max. vacuum up to 10⁻² mbar (up to 1300 °C) depending on pump type
- Insulation made of high purity aluminum oxide fiber
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2
Basic version
- Standard furnace sizes 8 - 500 liters
- Water-cooled retort made of stainless steel
- Frame made of stable steel profiles, easy to service due to easily removable stainless steel panels
- Housing of the VHT 8 model on castors for easy repositioning of furnace
- Cooling water manifold with manual tap, automatic flow monitoring, open-loop cooling water system
- Adjustable cooling water circuits with flowmeter and temperature indicator and overtemperature protection
- Switchgear and controller integrated in furnace housing
- Process control with controller P470
- Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2
- Manual operation of the process gas and vacuum functions
- Manual gas supply for one process gas (N₂, Ar or non-flammable forming gas) with adjustable flow
- Bypass with manual valve for rapid filling or flooding of furnace chamber
- Manual gas outlet with overflow valve (20 mbar relative) for over-pressure operation
- Single-stage rotary vane pump with ball valve for pre-evacuating and heat treatment in a rough vacuum to 5 mbar
- Pressure gauge for visual pressure monitoring
- Defined application within the constraints of the operating instructions

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

1 Retort
2 Heating
3 Insulation
4 Gas management system
5 Vacuum pump
6 Cooling water distribution
7 Controls
8 Integrated switchgear
9 Heating transformer
10 Charging frame inside the inner process chamber

Retort furnace VHT 8/16-MO with automation package

Retort furnace VHT 100/16-MO with automation package
Additional equipment housing/heater
- Housing, optionally divisible, for passing through narrow door frames (VHT 8)
- Lift door
- Individual heating concepts

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

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

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

Additional equipment vacuum
- Two-stage rotary vane pump with ball valve for pre-evacuating and heat-treating in a fine vacuum (up to 10⁻³ mbar) incl. electronic pressure sensor
- Turbo molecular pump with slide valve for pre-evacuation and for heat treatment in a high vacuum (up to 10⁻² mbar) including electronic pressure sensor and booster pump
- Other vacuum pumps on request
- Partial pressure operation: protective gas flushing at controlled underpressure (only with automation package)

Additional equipment cooling
- Heat exchanger with closed-loop cooling water circuit
- Direct cooling see page 69

Additional equipment for controls and documentation
- Charge thermocouple with display
- Temperature measurement at 2200 °C models with pyrometer in the upper temperature range and thermocouple, type C with automatic pull-out device for precise control results in the low temperature range (VHT 40/...-GR and larger)
- Automation package with process control H3700
  - 12" graphic touch panel
  - Input of all process data like temperatures, heating rates, gas injection, vacuum at the touch panel
  - Display of all process-relevant data on a process control diagram
  - Automatic gas supply for one process gas (N₂, argon or non-flammable forming gas) with adjustable flow
  - Bypass for flooding and filling the chamber with process gas controlled by the program
  - Automatic pre- and post programs, including leak test for safe furnace operation
  - Automatic gas outlet with bellows valve and overflow valve (20 mbar relative) for over-pressure operation
  - Transducer for absolute and relative pressure
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 75
Process Box for Debinding in Inert Gas

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

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

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

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

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

<table>
<thead>
<tr>
<th>Model</th>
<th>Inner dimensions of process box in mm</th>
<th>Volume in l</th>
<th>Max. charge weight/kg</th>
<th>Outer dimensions in mm</th>
<th>Heating power in kW*</th>
</tr>
</thead>
<tbody>
<tr>
<td>W x D x H</td>
<td></td>
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</tr>
<tr>
<td>VHT 8/..</td>
<td>170 x 240 x 200</td>
<td>1250 (800) x 1100 x 2700</td>
<td>19/34</td>
<td>12</td>
<td>1000</td>
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<tr>
<td>VHT 25/..</td>
<td>250 x 400 x 250</td>
<td>1500 x 2500 x 2200</td>
<td>45/65</td>
<td>25</td>
<td>50</td>
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<tr>
<td>VHT 40/..</td>
<td>300 x 500 x 400</td>
<td>1600 x 2600 x 2000</td>
<td>54/90</td>
<td>30</td>
<td>85</td>
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<tr>
<td>VHT 70/..</td>
<td>350 x 700 x 500</td>
<td>1800 x 3000 x 2400</td>
<td>70/110</td>
<td>30</td>
<td>110</td>
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<tr>
<td>VHT 100/..</td>
<td>450 x 900 x 600</td>
<td>1900 x 3500 x 2500</td>
<td>130/190</td>
<td>55</td>
<td>55</td>
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<tr>
<td>VHT 250/..</td>
<td>575 x 1100 x 750</td>
<td>3000 x 4300 x 3100</td>
<td>180/210</td>
<td>on request</td>
<td>on request</td>
</tr>
<tr>
<td>VHT 500/..</td>
<td>725 x 1200 x 900</td>
<td>3200 x 4500 x 3300</td>
<td>220/260</td>
<td>on request</td>
<td>on request</td>
</tr>
</tbody>
</table>

*1With separated switching system unit
*2Depending on furnace design connected load might be higher
*31800 °C/2200 °C
*41200 °C/1600 °C
*5Dimensions may be smaller depending on the heater type
*6External dimensions vary when furnace is equipped with additional equipment. Dimensions on request
**H₂ Version for Operation with Hydrogen or other Reaction Gases**

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

- Certified safety concept
- Automation package (additional equipment see page 66)
- 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
- Electrically heated or gas-fired exhaust gas torch for H₂ post combustion
- Atmospheric operation: H₂-purging of retort starting from room temperature at controlled over pressure (50 mbar relative)

**Additional equipment**

- Partial pressure operation: H₂ flushing at underpressure in the retort starting from 750 °C furnace chamber temperature
- Inner process hood in the retort for debinding under hydrogen
- Process control and documentation via Nabertherm Control Center (NCC) for monitoring, documentation and control see page 75
Retort Furnace Cooling Systems

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

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

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

<table>
<thead>
<tr>
<th>Time [min]</th>
<th>Temperature [°C]</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>500</td>
</tr>
<tr>
<td>15</td>
<td>450</td>
</tr>
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<td>30</td>
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<td>350</td>
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<tr>
<td>120</td>
<td>300</td>
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<tr>
<td>150</td>
<td>250</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Time [min]</th>
<th>Temperature [°C]</th>
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<td>0</td>
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</tr>
<tr>
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<td>20</td>
<td>200</td>
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<tr>
<td>22</td>
<td>100</td>
</tr>
</tbody>
</table>

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

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

Rapid gas cooling, cold-wall retort furnace VHT 8/16-MO
Catalytic and Thermal Post Combustion Systems, Exhaust Gas Washer

For exhaust gas cleaning, in particular in debinding, Nabertherm offers exhaust gas cleaning systems tailored to the process. The afterburning system is permanently connected to the exhaust gas fitting of the furnace and accordingly integral part of the control system and the safety matrix of the furnace. For existing furnaces, independent exhaust gas cleaning systems are also available that can be separately controlled and operated.

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

- Perfectly suited for debinding processes in air with only organic exhaust gases
- Decomposition of gases in carbon dioxide and water

**Thermal post combustion systems (TNV)**
Thermal post combustion systems are used if large volumes of exhaust gas from the debinding process in air must be cleaned and/or if there is a risk that the exhaust gases might damage the catalyst. Thermal post combustion is also used for debinding applications under non-flammable or flammable protective or reaction gases.

- Optimally suited for debinding processes in air with large exhaust gas flow, erratic large exhaust gas volumes, large volume flow or for debinding processes under non-flammable or flammable protective or reaction gases
- Gas-fired to burn the exhaust gases
- Burn-off at temperatures up to 850 °C provides for thermal decomposition of the exhaust gases
- Heating with compact gas burner with automatic firing device
- Thermocouples in the combustion chamber and in the raw gas inlet
- Over-temperature limiter for protecting the thermal post combustion
- Design depending on the exhaust gas flow
- Measuring port for clean gas measurements (FID)

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

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

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

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

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

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

**System Accuracy**

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

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

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

In standard furnaces a temperature uniformity is guaranteed as +/- K without measurement of temperature uniformity. However, as additional feature, a temperature uniformity measurement at a reference temperature in the work space compliant with DIN 17052-1 can be ordered. Depending on the furnace model, a holding frame which is equivalent in size to the work 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.
Nabertherm has many years of experience in the design and construction of both standard and custom control alternatives. All controls are remarkable for their ease of use and even in the basic version have a wide variety of functions.

**Standard Controllers**

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

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

**HiProSystems Control and Documentation**

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

**Alternative User Interfaces for HiProSystems**

**Process control H500/H700**

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

**Process control H1700**

Customized versions can be realized in addition to the scope of services of the H500/H700.

**Process control H3700**

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

**Control, Visualisation and Documentation with Nabertherm Control Center NCC**

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

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

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

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

The connecting rates in the catalog refer to the standard furnace with 400 V (3/N/PE) respectively 230 V (1/N/PE).

### Functionality of the Standard Controllers

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<thead>
<tr>
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<th>R7</th>
<th>C6</th>
<th>C6/3208</th>
<th>3216</th>
<th>3504</th>
<th>3508</th>
<th>B400</th>
<th>B410</th>
<th>C440</th>
<th>C450</th>
<th>P470</th>
<th>P480</th>
<th>H500/PLC</th>
<th>H700/PLC</th>
<th>H1700/PLC</th>
<th>H3700/PLC</th>
<th>NCC</th>
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<td>NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive</td>
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1. Not for melt bath control
2. Control of additional separate slave regulators possible
3. Depending on the design
Data storing of Nabertherm controllers with NTLog Basic

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

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

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

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

Data storing of HiProSystems with NTLog Comfort

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

Visualization with NTGraph for Single-Furnace Control

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

Software NTEdit for Entering Programs on the PC

By using the software NTEdit (Freeware) the input of the programs becomes clearer and thus easier. The program can be entered on customers PC and then be imported into the controller with a USB stick. The display of the set curve is tabular or graphical. The program import in NTEdit is also possible. With NTEdit Nabertherm provides a user-friendly free tool. A prerequisite for the use is the client installation of MS-Excel for Windows (2007/2010/2013). NTEdit is available in eight languages (DE/EN/FR/SP/IT/CH/RU/PT).
**VCD-Software for Visualization, Control and Documentation**

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

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

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

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

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

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

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- Dental
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