Nabertherm

MORE THAN HEAT 30-3000 °C

Advanced Materials

Furnaces and Heat Treatment Plants for

Powder Metallurgy
Technical Ceramics
Bio Ceramics
MLCC, LTCC, HTCC
MIM, CIM
Lighting/LED Industry
Fuel Cell/Battery Manufacturing
Wafer Production
Photovoltaics
Crystal Growth
Polymerization
Energy Efficiency Technology

www.nabertherm.com

Made in Germany

Made in Germany

Nabertherm with 400 employees worldwide have been developing and producing industrial furnaces for many different applications for over 60 years. As a manufacturer, Nabertherm offers the widest and deepest range of furnaces worldwide. 150,000 satisfied customers in more than 100 countries offer proof of our commitment to excellent design, quality and cost efficiency. Short delivery times are ensured due to our complete inhouse production and our wide variety of standard furnaces.

Setting Standards in Quality and Reliability

Nabertherm does not only offer the widest range of standard furnaces. Professional engineering in combination with inhouse manufacturing provide for individual project planning and construction of tailor-made thermal process 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

Centralized engineering and manufacturing and decentralized sales and service define our strategy to live up to your needs. Long term sales and distribution partners in all important world markets ensure individual on-site customer service and consultation. There are various reference customers in your neighborhood who have similar furnaces or plants.

Large Customers Test Center

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

Customer Service and Spare Parts

Our professional service engineers are available for you world-wide. Due to our complete inhouse production, we can despatch most spare parts from stock over night or produce with short delivery time.

Experience in Many Fields of Thermal Processing

In addition to furnaces for Advanced Materials, 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.

Nabertherm
MORE THAN HEAT 30-3000 °C

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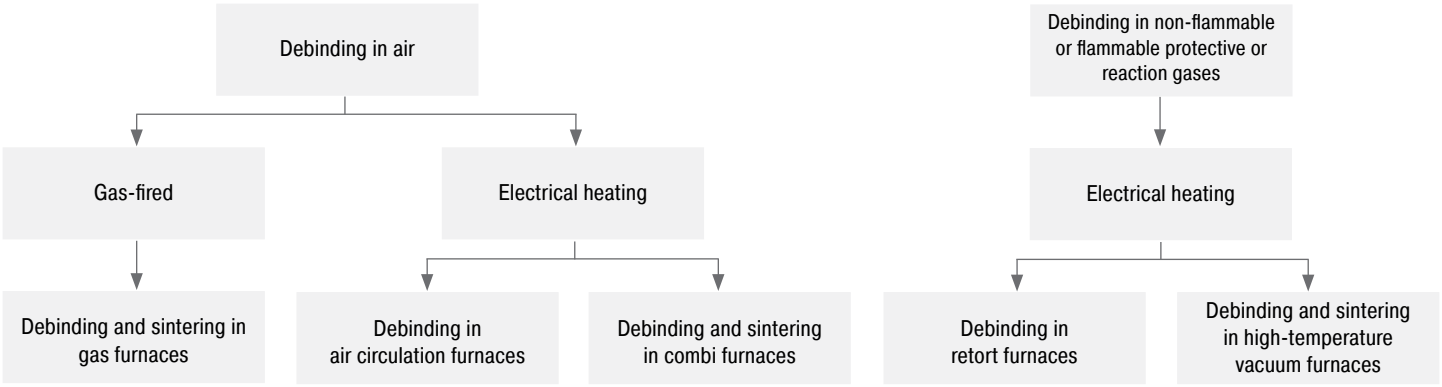
Matrix Debinding Technology

Debinding of technical ceramics is both a critical process due to the released hydrocarbons and a technical challenge due to the necessary precise temperature control. Nabertherm offers professional solutions for the different debinding methods.

Debinding Methods



I. Debinding in Air

1. Debinding (and Sintering) in Directly Gas-Fired Furnaces

Compared with electrically heated furnaces, gas-fired furnaces have the advantage that the released hydrocarbons are almost completely burned immediately during the firing process. Therefore, gas-fired furnaces are especially used when the vaporization process is difficult to manage e.g. due to high vaporization dynamics. Hence, unavoidable erratic releases of hydrocarbons do not necessitate any elaborate process control or long process times. If, on the other hand, the debinding process requires precise temperature control or a good temperature uniformity, in particular at low temperatures, this challenge can be met only with the employment of electrically heated debinding furnaces.

2. Debinding (and Sintering) in Electrically Heated Furnaces

For debinding in air with electrical heating, Nabertherm offers different debinding packages for different process requirements. All debinding packages comprise a professional, integrated safety technology. Depending on the process a passive or active safety concept can be chosen.

a) Passive Safety Concept

Basically, all Nabertherm debinding furnaces are equipped with a passive safety concept. The electrically heated furnaces operate according to the dilution principle by means of fresh air injection, in order to reduce the gas emissions from the load to a noncombustible atmosphere in the furnace. It is the customer's responsibility to ensure that the maximum permissible vaporization rate is not exceeded, i.e. that the furnace is not overloaded with organic substances and the executable thermal profiles are appropriately defined. The monitoring of all safety-related process parameters, e.g. volume flow, and a corresponding emergency program in case of failure ensures a safe operation. In practice the passive safety concept has prevailed based on the good cost/performance ratio. Subject to process requirements, there are two different debinding packages available as described below.

Debinding Package I

This package represents the basic version for safe debinding and is ideally suited for recurring processes with defined vaporization rates. The furnace is equipped with a fresh air fan and an exhaust gas fan. Both units are firmly mounted on the furnace and factory-adjusted so that the volume of fresh air required for the debinding process is injected in a controlled mode to assure a certain underpressure in the furnace chamber, so that the exhaust gases are discharged exclusively through the exhaust gas outlet and not into the production hall. The fresh air required for the process is indirectly preheated via inlet channels. Monitoring of the furnace underpressure ensures a safe operation.

In addition, an independent ramp monitor is installed, where the customer sets the maximum permissible heating gradient during the debinding process. If in case of faulty operation or a control failure this gradient is exceeded or another safety-related fault is detected, an emergency program ensures that the furnace is transferred into a safe mode. As additional equipment, debinding package I can be expanded with active fresh air preheating and/or controlled cooling.

Debinding Package II

Debinding package II is the convenient solution for the variable ceramics production, since there is ample flexibility to accommodate different or frequently changing debinding processes. The basic differences and advantages compared with debinding package I are:

- Program adjustable fresh air volume depending on the vaporization rate of the product
- Fresh air preheating with separate air preheater. The fresh air temperature (up to max. 500 °C) is controlled as additional heat source depending on the furnace temperature. This results in a very good heat transfer and improved temperature uniformity.
- Automatic control of the exhaust gas fan depending on the preselected fresh air volume provides for advantages in temperature control (temperature uniformity) and adapted discharge of the exhaust gases
- Differentiated emergency program: Depending on the fault different emergency programs are automatically executed
- Perforated injection tubes in the furnace chamber depening on furnace model for uniform distribution of the preheated fresh air through the horizontal charging layers
- Display at the furnace for underpressure and volume flow
- PLC controls with touch panel H 1700 see page 82
- Controlled cooling as standard

b) Active Safety Concept

Alternatively, an active safety concept is also available as additional equipment on request. The actually vaporized organic volume in the furnace chamber is monitored by means of the flame-thermal analysis (FTA). The fresh air and exhaust gas fans are automatically reconciled accordingly. In case of unsafe condition in the furnace e.g. from overloading, a heating gradient that is too fast or inadequate fresh air supply, the necessary emergency program is immediately initiated depending on the process step.

2.1. Debinding in Air Circulation Furnaces

Air circulation furnaces are generally the right choice when debinding is the only process. Depending on the raw materials or temperature requirements, the green compacts can also be presintered. Air circulation furnaces convince by their good temperature uniformity even with dense loads, their accelerated heat transfer and their better charge penetration. Debinding and sintering in two process steps is always advisable if a better capacity utilization of the different furnaces and a reduced overall investment volume can be achieved.

2.2. Debinding and Sintering in Combi Furnaces

Combi furnaces provide for debinding and subsequent sintering in just one furnace system. Debinding and sintering or pre-sintering in one process step offer the following advantages:

- Shortened process times: cooling, transfer, no second heating process required
- Energetic advantages
- Reduced scrap risk

The use of combi furnaces is always advisable when charging takes a longer a period of time or if the debindered green/brown compacts are sensitive to cooling and transfer due to their material properties or parts geometry. Nabertherm combi furnaces have successfully proven their reliability in the market for years. Equipped with mature system modules, these furnaces are the right choice for sophisticated processes. For example, the controlled air-preheating provides – besides the conventional furnace heating – for an optimum temperature uniformity up to 500 °C and, therefore, for excellent quality results.

II. Debinding in Non-Flammable or Flammable Protective or Reaction Gases

Besides debinding in air, debinding processes in technical ceramics or powder metallurgy are also executed under non-flammable or flammable protective or reaction gases to achieve other process or quality requirements. Also, for these applications Nabertherm offers standard as well as customized furnace solutions, explained in detail on following catalog pages. The safety technology varies subject to the specific process requirements.

Heat Recovery Systems for Energy Savings Purposes

With rising energy costs, but also for environmental reasons, the integration of heat recovery systems is paying off more and more. Depending on the furnace size and process, there is always a certain potential for energy recovery through heat exchangers from the released process exhaust gases or warm disposal air of the furnace system. Especially for large furnace plants or long process times the achieven energy savings will pay back the additional investment in just a short time. We would be glad to advise you on whether an additional heat recovery module would be a useful addition to your furnace system.

Air Circulation Chamber Furnaces for Debinding in Air up to 650 °C

Debinding line with integrated heat recovery system for utilizing the exhaust heat for fresh air preheating

N 250/65HACDB with debinding package I

Charging cart with pull-out trays

N 120/65 HACDB - N 500/65 HACDB

The air circulation chamber furnaces N 120/65 HACDB - N 500/65 HACDB are perfectly suited for debinding processes that require a good temperature uniformity due to the parts geometry or characteristics of the binder. The powerful, horizontal air circulation with high air flow rate provides for full utilization of the furnace in different charging layers. Uniform process results are ensured even for small components, such as CIM manufactured parts. On request, the furnaces can be equipped with catalytic or thermal afterburning to clean the exhaust gases. Following the debinding the components are transferred to the sintering furnace.

- Tmax 650 °C
- Powerful, horizontal air circulation provides for a temperature uniformity of ΔT 8 K according to DIN 17052 see page 79
- Debinding package I with passive safety package and monitoring of the underpressure in the furnace chamber, exhaust gas fan, fresh air fan, preset underpressure in the furnace chamber, controlled by Nabertherm controller P 300 see page 6
- Connection port for further piping behind the exhaust fan
- Welded inside housing of the furnace made of stainless steel 1.4301
- Holders for removable trays for charging in multiple layers
- 3 removable trays included with delivery
- Heating switched with low-wear semiconductor relay
- Over-temperature limiter with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load

Additional equipment

- Additional trays
- Controlled cooling including PLC control of the heating and cooling air fan
- Fresh air preheating and controlled fan cooling, including PLC control of the furnace heating as well as the fresh air preheating as a second heat source
- Debinding package II with passive safety concept see page 7
- Thermal or catalytic exhaust cleaning systems see page 41
- Heat recovery systems see page 7
- Commissioning of the furnace with test firing and temperature uniformity measurement (also with load) for the purpose of process optimization
- Process documentation and control with Controltherm MV software package, NTLog and NTGraph for the basic furnace or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 83

Air Circulation Bogie Hearth Furnaces for Debinding in Air up to 600 °C

Bogie hearth furnace system for debinding with cross sliding device

W 1000/60 HACDB - W 8100/60 HACDB

The air circulation bogie hearth furnaces W 1000/60 HACDB - W 8100/60 HACDB are designed for debinding large volumes of material. The functionality corresponds to air circulation chamber furnaces for debinding. These powerful production furnaces are equipped with a passive safety package providing for a reliable process control. On request the furnaces can be equipped with catalytic or thermal afterburning to clean the exhaust gases.

Furnace chamber with air baffle plates

- Tmax 600 °C
- Powerful, horizontal air circulation provides for a temperature uniformity of ΔT 8 K according to DIN 17052 see page 79
- Debinding package I with passive safety package and monitoring underpressure in the furnace chamber, exhaust gas fan, fresh air fan, preset underpressure in the furnace chamber, controlled by Nabertherm controller P 300 see page 6
- Connection port for further piping behind the exhaust fan
- Inside sheets of the furnace made of stainless steel 1.4301 fully cover the insulation
- Heating switched with low-wear semiconductor relay
- Over-temperature limiter with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load

Additional equipment

- Controlled cooling including PLC control of the heating and cooling air fan
- Fresh air preheating and controlled fan cooling, including PLC control of the furnace heating as well as the fresh air preheating as a second heat source
- Debinding package II with passive safety concept see page 7
- Thermal or catalytic exhaust cleaning systems see page 41
- Heat recovery systems see page 7
- Additional bogie, rail operation, cross-traversal system see page 19
- Commissioning of the furnace with test firing and temperature uniformity measurement (also with load) for the purpose of process optimization
- Process documentation and control with Controltherm MV software package, NTLog and NTGraph for the basic furnace or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 83

W 3300/85A

Air Circulation Chamber Furnaces/Ovens with Safety Technology for Solvent-Containing Charges according to EN 1539 or NFPA 68

Ship-lock type furnace N 560/26HACLS with safety technology, front charging and rear unloading

Drying oven KTR 1500 for drying of foundry cores with an alcohol-based binder

Exhaust port and powerful exhaust fan mounted on the furnace

Guide-in tracks for furnaces with bottom insulation

Safety Technology for Air Circulation Chamber Furnaces

Certain processes release and vaporize solvents or other flammable vapors. The concentration of these vapors must be kept below a certain limit to prevent ignition. European Norm EN 1539 and NFPA 68 in the USA prescribe the required safety equipment for these processes.

For these applications and processes, all air circirculation furnaces of the KTR and N ..HACLS product lines are suited with safety technology for protection of a potentional ignition in the furnace chamber.

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

- Furnace sizes between 120 and 10,000 liters
- Powerful exhaust fan capable of maintaining underpressure in the furnace
- Defined and monitored air circulation flow and exhaust air
- Visual and audible emergency signals
- Overtemperature selection limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter for the furnace and the product
- Controls description see page 80

Clean Room Solutions

KTR 8000 designed as a production furnace in the clean room with filters for air recirculation

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 air circulation 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.

Air circulation chamber furnace NAC 120/65 with clean room specs

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.

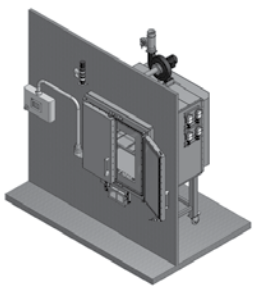
Sluice Furnace between Grey Room and Clean Room

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.

Air circulation furnace N 250/65 HAC for clean room Class 100 with charging door to the clean room

Hot-wall retort furnace NRA 1700/06 with charging frame for installation in grey room with charging door in clean room



Clean/Grey room solution with charging and operating in clean room

Ovens, also with Safety Technology According to EN 1539

Electrically Heated

TR 60 with adjustable fan speed

TR 240

Electrical rotating device as additional equipment

Extricable metal grids to load the oven in different layers

TR 60 - TR 1050

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

- Tmax 300 °C
- Working temperature range: + 5 °C above room temperature up to 300 °C
- Models TR 60 - TR 240 designed as tabletop models
- Models TR 450 and TR 1050 designed as floor standing models
- Horizontal, forced air circulation results in temperature uniformity better than ΔT 8 K see page 79
- Stainless steel chamber, alloy 304 (AISI)/(DIN material no. 1.4301), rust-resistant and easy to clean
- Large handle to open and close the door
- Charging in multiple layers possible using 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 60 - TR 450
- Double swing door with quick release for TR 1050
- TR 1050 equipped transport rollers
- Infinitely adjustable exhaust at the rear wall with operation from the front
- PID microprocessor control with self-diagnosis system
- Solid state relays provide for lownoise operation
- Controls description see page 80

Additional equipment

- Over-temperature limiter with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Infinitely adjustable fan speed of the air circulation fan
- Window for charge observing
- Further removeable grids with rails
- Side inlet

TR 450 with observation window

TR 1050 with double door

- Stainless steel collecting pan to protect the furnace chamber
- Safety Technology according to EN 1539 for charges containing liquid solvents (TRS) up to model TRS 240, achievable temperature uniformity +/- 8 °C see page 79
- Transport costors 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 with Controltherm MV software package see page 83

TR 60 with observation window

Model	Tmax	Inner dimensions in mm			Volume	Outer dimensions in mm			Heating	Electrical	Weight	Grids in-	Grids	Max.
	°C	w	d	h	in l	W	D	H	power in kW[2]	connection*	in kg	cluded	max.	total load[1]
TR 60	300	450	380	350	60	700	650	690	3.1	1-phase	90	1	4	120
TRS 60	260	450	360	350	57	700	680	690	6.3	3-phase	92	1	4	120
TR 120	300	650	380	500	120	900	650	840	3.1	1-phase	120	2	7	150
TRS 120	260	650	360	500	117	900	680	840	6.3	3-phase	122	2	7	150
TR 240	300	750	550	600	240	1000	820	940	3.1	1-phase	165	2	8	150
TRS 240	260	750	530	600	235	1000	850	940	6.3	3-phase	167	2	8	150
TR 450	300	750	550	1100	450	1000	820	1440	6.3	3-phase	235	3	15	180
TR 1050	300	1200	630	1400	1050	1470	955	1920	9.3	3-phase	450	4	14	250

[1]Max load per layer 30 kg

[2]Depending on furnace design connected load might be higher

*Please see page 80 for more information about supply voltage

Chamber Dryer
Electrically Heated or Gas-Fired

Standard models

Motor-driven rotary rack with baskets for moving the charge during heat treatment

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

- Tmax 260 °C
- Electrically heated (via a heating register with integrated chrome steel heating elements) or gas-fired (direct gas heating including injection of the hot air into the intake duct)
- Temperature uniformity up to ΔT 6 K according to DIN 17052-1 (for design wihout track cutouts) see page 79

Charging cart with pull-out trays

KTR 1500 with charging cart

KTR 21640/S with chamber lightning and drive-in tracks with insulated plugs which provide for an optimal temperature uniformity

- High-quality mineral wool insulation provides for outer temperatures of < 20 °C above room temperature
- High air exchange for fast drying processes
- Double-wing door for furnaces KTR 3100 and larger
- Over-temperature limiter with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the dryer and load
- Incl. floor insulation
- Controls description see page 80

Additional equipment

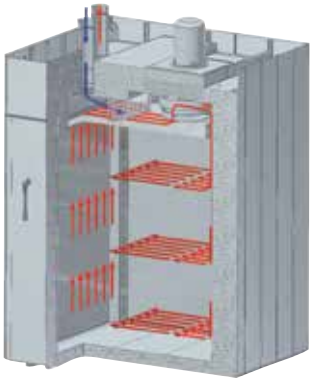
- Entry ramp for pallet trucks or track cutouts for charging cart
- Optimal air circulation for individual charges by means of adjustable air outlets
- Fan system for faster cooling with manual or motor-driven control
- Programmed opening and closing of exhaust air flaps
- Observation window and furnace chamber lighting
- Safety technology according to EN 1539 for charges containing solvents see page 10
- Charging cart with or without rack system
- Design for clean room heat treatment processes see page 11
- Process control and documentation with Controltherm MV software package see page 83

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

Model	Tmax	Inner dimensions in mm			Volume	Outer dimensions in mm			Heating	Electrical
	°C	w	d	h	in l	W	D	H	power in kW[1]	connection*
KTR 1500	260	1000	1000	1500	1500	1930	1430	2315	21.0	3-phase
KTR 3100	260	1250	1250	2000	3100	2160	1680	2880	30.0	3-phase
KTR 4500	260	1500	1500	2000	4500	2410	1930	2880	48.0	3-phase
KTR 6125	260	1750	1750	2000	6125	2660	2180	3000	50.0	3-phase
KTR 8000	260	2000	2000	2000	8000	2910	2430	3000	59.0	3-phase

[1]Depending on furnace design connected load might be higher

*Please see page 80 for more information about supply voltage



Air circulation in the chamber dryer

Dewaxing Furnaces

Electrically Heated (N../WAX) or Gas-Fired (NB../WAX)

N 150/WAX

N 660/WAX

Grid bottom

N 100/WAX - N 2200/WAX with Electrical Heating

The N and NB chamber furnaces are especially designed for dewaxing and subsequent firing of the ceramic form. The electrically heated models are operated below the ignition point of the wax during dewaxing. The furnaces have a heated stainless steel drain in the bottom of the furnace chamber, formed as a funnel with the discharge near the center of the furnace. The drainage is made of stainless steel. The stainless steel grids in the bottom can be removed for cleaning . To prevent draining wax from ignition, there is a tight stainless steel container under the furnace with a removable drawer for wax collection as a safety feature. After the dewaxing process is finished the furnace continues heating in order to sinter the molds.

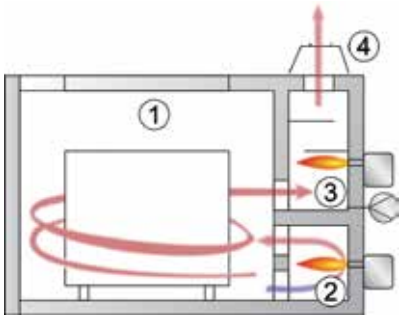
Drain pan in floor

Standard equipment N../WAX, electrically heated

- Chamber furnace with wide-opening swinging door
- Tmax 850 °C
- Four side heating with freely radiating heating elements on ceramic carrier tubes
- Heated drainage in floor, controlled by a separate controller up to a maximum of 200 °C, to reliably prevent freezing of the draining wax - Release of furnace heating only possible after drain temperature is reached, to prevent clogging
- Stainless steel floor pan with grid bottom for level loading
- Rugged self-supporting, vaulted arch construction
- Exhaust gas vent in furnace ceiling for connection with ductwork (starting with N 440 manual exhaust air flap)
- Air inlet openings for reliable air exchange
- Dual shell furnace housing for low exterior temperatures
- Removable base included in delivery (fixed base for models N 440 and larger)
- First over-temperature limiter which must be set below the ignition point of the wax and prevents the wax from igniting during dewaxing. It is customers responsibility to set the required time interwal for dewaxing. After this time has elapsed the over-temperature limiter will be deactivated to make sure that the furnace can continue with the sintering process.
- Second over-temperature limiter with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load

Chamber Furnaces for Heat Cleaning

gas-fired with integrated thermal afterburner



1 Furnace chamber
2 Gas heater of the furnace chamber
3 Thermal afterburner
4 Exhaust hood

The chamber furnaces in the model series NBCL are used for heat cleaning of components. An optimum temperature uniformity is not a priority for these processes. Examples are heat cleaning of electric motors, coated surfaces of steel components or the nozzles of plastic injection molding machines.

The furnaces are gas-fired and have an integrated thermal afterburner system which is also gas-fired. The pre-set, low-oxygen respectively reducing atmosphere in the furnace effectively prevents spontaneous combustion at the workpiece and subsequent damage as a result of over-temperature.

The generated exhaust gases are guided from the furnace chamber into the thermal afterburner where they are incinerated. Depending on the type of exhaust gas involved complete incineration is possible.

For safe operation, the furnace door locks after program start and cannot be opened again until the temperature has dropped below 180 °C at the process end. In case of a burner flame malfunction or gas shortage the process is aborted. In addition, the control system is equipped with an over-temperature limiter with manual reset that is set by the customer at a safe cut-off temperature to switch off the furnace if the limit is exceeded.

The furnaces are not suitable for components and coatings that contain solvents or a high concentration of water. These models must also not be used for charges with low flash points such as wood, paper or wax.

NBCL 2300

NBCL 1300

Gas burners for furnace heating and thermal afterburner

- Tmax 500 °C
- Standard sizes with furnace chambers up to 2500 liters
- Furnace housing with equipped for safe transport with forklift
- Furnace chamber size dimensioned to hold standard lattice boxes
- Furnace chamber insulation made of non-classified fiber material, floor and rear wall insulated with lightweight refractory bricks
- High performance, atmospheric burner fueled by liquified gas or natural gas
- Completely automated temperature controls
- Integrated thermal afterburner for exhaust gas cleaning

Model	Tmax	Inner dimensions in mm			Outer dimensions in mm			Burner rating furnace chamber	Burner ratingTNV
	°C	w	d	h	W	D	H	in kW	in kW
NBCL 1300	500	1200	900	1000	2160	2310	2450	50	100
NBCL 2300	500	1200	1200	1600	2160	2605	3050	100	100
NBCL 2500	500	1200	1600	1300	2160	3000	2750	100	100

Bogie Hearth Furnaces with Wire Heating up to 1400 °C also as Combi Furnaces for Debinding and Sintering in one Process or with Gas-Supply Box for Inert Debinding

W 1500/H

Bogie hearth furnace W 2060/S without bogie heating for preheating fusion molds

Meander shaped heating elements for short process times

Bogie hearth furnace W 3300 for glazing melting crucibles for the solar industry

W 1000 - W 10000/14, W 1000/DB - W 10000/14DB

Bogie hearth furnaces offer a whole series of advantages in firing, sintering and tempering in production. The bogie can be loaded outside the furnace. If multiple bogies are used, one bogie can be loaded while the other is in use in the furnace. Useful accessories like multi-zone control to optimize the temperature uniformity, controlled cooling systems to shorten process times to the fully automatic system with motorized bogies and bogie exchange provide for the perfect adaptation of these furnaces to production process. A combi furnace version with debinding package for debinding and sintering in a single process is also possible.

- Tmax 1280 °C, 1340 °C or 1400 °C
- Dual shell housing with rear ventilation, provides for low shell temperatures
- Swing door hinged on the right side
- Heating from five sides (four sides and bogie) provides for an optimum temperature uniformity
- Bogie heating receives power via blade contacts when driven in
- Heating elements mounted on support tubes provide for free radiation and long service life
- Bottom heating protected by SiC tiles on the bogie providing level stacking surface
- Multi-layer insulation consisting of lightweight refractory bricks backed by microporus silica insulation
- Self-supporting and long-life ceiling construction with bricks laid in arched construction, for models up to 1340 °C or as fiber insulation
- Roof made of high-quality fiber material for models with Tmax 1400 °C
- Freely moveable bogie with rubber wheels up to model W 3300
- Adjustable air inlet damper
- Manual exhaust air flap on the furnace roof
- Over-temperature limiter with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load

Additional equipment

- Fiber insulation also in combination with meander shaped heating for short heating times
- Bogies with flanged wheels running on rails for easy and precise movement of high loads or complex kiln furniture
- Electric chain-driven bogie in combination with rail operation for smooth movement of heavy loads
- Bogie running on steel wheels with gear rack drive, no rails in front of the furnace necessary

W 2200/14 DB with debinding package and catalytical afterburning system

W 8250/S for tempering quartz glass

- Different possibilities for an extension to a bogie hearth furnace system:
  - Additional bogies
  - Bogie transfer system with parking rails to exchange bogies running on rails or to connect multiples furnaces
  - Motor-driven bogies and cross-traversal system
  - Fully automatic control of the bogie exchange
- Electro-hydraulic lift door
- Kiln furniture
- Motor-driven exhaust air flap, switchable via the program
- Uncontrolled or controlled cooling system with frequency-controlled cooling fan and motor-driven exhaust air flap
- Multi-zone control adapted to the particular furnace provides model for optimal the temperature uniformity
- IDB design with gas supply system and safety technology for debinding in non-flammable protective gases
- Commissioning of the furnace with test firing and temperature uniformity measurement (also with load) for the purpose of process optimization
- Debinding packages with passive safety concept see page 6
- Thermal or catalytic exhaust cleaning systems see page 41
- Process documentation and control with Controltherm MV software package, NTLog and NTGraph for the basic furnace or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 83

W 7500 with bogie, separated in three parts

Bogie Hearth Furnaces with Wire Heating up to 1400 °C
also as Combi Furnaces for Debinding and Sintering in one Process or with Gas-Supply Box for Inert Debinding

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

Bogie hearth furnace in IDB-version with gas box for debinding and sintering under non-flammable protective or reaction gases

Model	Tmax	Inner dimensions in mm			Volume	Outer dimensions in mm			Heating power in	Electrical	Weight
	°C	w	d	h	in l	W	D	H	kW[1]	connection*	in kg
W 1000	1280	800	1600	800	1000	1470	2410	1915	57	3-phase	3000
W 1500	1280	900	1900	900	1500	1570	2710	2030	75	3-phase	3500
W 2200	1280	1000	2200	1000	2200	1670	3010	2140	110	3-phase	4500
W 3300	1280	1000	2800	1200	3300	1670	3610	2355	140	3-phase	5300
W 5000	1280	1000	3600	1400	5000	1670	4410	2555	185	3-phase	7300
W 7500	1280	1000	5400	1400	7500	1670	6210	2555	235	3-phase	10300
W 10000	1280	1000	7100	1400	10000	1670	7910	2555	300	3-phase	12500
W 1000/H	1340	800	1600	800	1000	1470	2410	1915	75	3-phase	3500
W 1500/H	1340	900	1900	900	1500	1570	2710	2030	110	3-phase	4000
W 2200/H	1340	1000	2200	1000	2200	1670	3010	2140	140	3-phase	5000
W 3300/H	1340	1000	2800	1200	3300	1670	3610	2355	185	3-phase	6000
W 5000/H	1340	1000	3600	1400	5000	1670	4410	2555	235	3-phase	8000
W 7500/H	1340	1000	5400	1400	7500	1670	6210	2555	370	3-phase	11300
W 10000/H	1340	1000	7100	1400	10000	1670	7910	2555	440	3-phase	13800
W 1000/14	1400	800	1600	800	1000	1470	2410	1915	75	3-phase	3300
W 1500/14	1400	900	1900	900	1500	1570	2710	2030	110	3-phase	3800
W 2200/14	1400	1000	2200	1000	2200	1670	3010	2140	140	3-phase	4800
W 3300/14	1400	1000	2800	1200	3300	1670	3610	2355	185	3-phase	5700
W 5000/14	1400	1000	3600	1400	5000	1670	4410	2555	235	3-phase	7700
W 7500/14	1400	1000	5400	1400	7500	1670	6210	2555	370	3-phase	10900
W 10000/14	1400	1000	7100	1400	10000	1670	7910	2555	440	3-phase	13300

[1]Depending on furnace design connected load might be higher

*Please see page 80 for more information about supply voltage

Pit-Type and Top-Loading Furnaces with or without Air Circulation

Electrically Heated or Gas-Fired

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

S 5120/GS1, furnace chamber divided in two sections, split cover

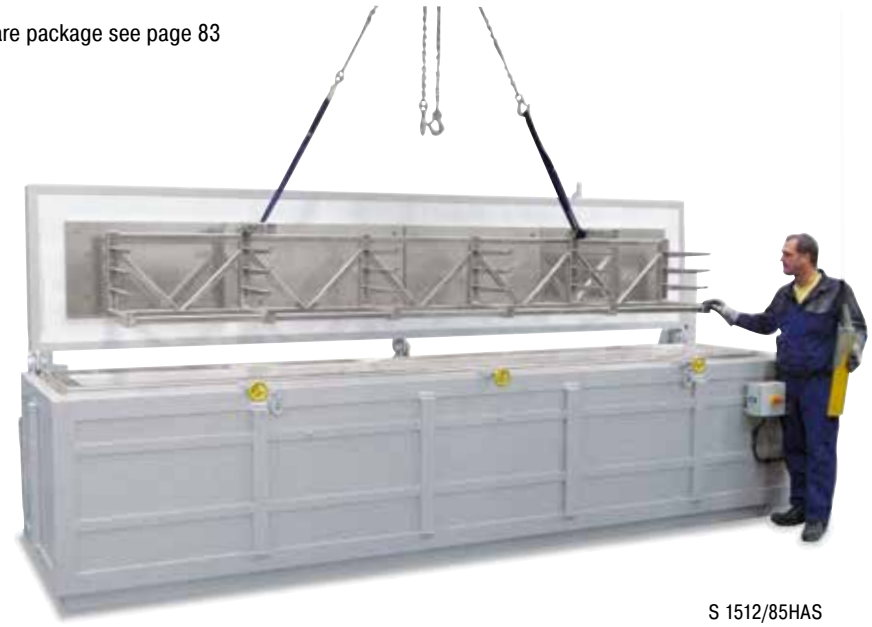
- Tmax 260 °C, 450 °C, 600 °C or 850 °C for furnaces with air recirculation
- Tmax 900 °C or 1280 °C for furnaces with radiant heating
- Electrically heated or gas-fired
- Heating from both long sides for furnaces with air recirculation
- Heating from all four sides and the floor with SiC plates in the floor as level stacking support for models to 900 °C or 1280 °C
- Hight-quality insulation, adapted to the specific maximum temperature
- Electrohydraulic opening system of the lid with two-hand operation
- Closable air supply vents in the lower area of the furnace chamber
- Closable exhaust air vents in the lid
- Over-temperature limiter with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load

Furnace chamber S 5120/GS with receptacle for an insulating plate in order to devide the furnace chamber

Additional equipment

- Automatic exhaust air flaps for faster cooling
- Controlled fan cooling with electrically driven exhaust air flaps
- Multi-zone control of the heating provides for optimum temperature uniformity
- Furnace chamber can be devided in length for short workparts, partitions can be controlled separately
- Designed for Tmax 950 °C, fan blade driven indirectly via a belt to protect the air recirculation motor against over-heating
- Process control and documentation with Controltherm MV software package see page 83

S 4100/S for sintering of high parts



S 1512/85HAS

Lift-Top or Lift-Bottom Furnaces with Wire Heating up to 1400 °C also as Combi Furnaces for Debinding and Sintering in One Process

H 1600/14DB

H 1000/LB

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

In production lift-top and lift-bottom furnaces have the advantage in comparison with chamber furnaces that even complex charge loads can be clearly arranged. The basic furnace is equipped with a table fixed in place under the hood. The system can be expanded to include one or more changeable tables, either manually or motor driven. Depending on process conditions, a lift-top- or lift-bottom version is advisable. Further additional equipment like a multi-zone control to optimize the temperature uniformity or controlled cooling systems for shorter processes provide for customized solution with respect to the process requirements. A combi furnace version with debinding package I or II for debinding and sintering in a single process is also available. The furnaces are moreover perfectly suited for special applications like sintering fuel cells, in which auxiliary fittings must be introduced in the furnace from below or above.

- Tmax 1280 °C
- Dual shell housing with rear ventilation for low shell temperatures
- Electrohydraulically driven hood with fixed table
- Five-sided heating from all four sides and from the table provides for a good temperature uniformity

- Heating elements mounted on support tubes provide for free radiation and long service life of the heating wire
- Bottom heating protected by SiC tiles which provide for a level stacking surface
- Multi-layer insulation consisting of lightweight refractory bricks backed by special insulation
- Long-life ceiling design with fiber insulation
- Manual exhaust air flap on the furnace roof
- Over-temperature limiter with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load

Lift-top furnace H 3630/LTHDB for debinding and sintering

Lift-top system H 245/LTS with cooling station and table changing system

Lift-top furnace with alternating table system and protective gas boxes for sintering in non-flammable protective and reaction gas

Additional equipment

- Tmax to 1400 °C
- Lift-bottom furnace version with driven table and fixed hood
- Uncontrolled or controlled cooling system with frequency-controlled cooling fan and motor-driven exhaust air flap
- Protective gas connection for purging the furnace with non-flammable protective or reaction gases
- Manual or automatic gas supply systems
- Multi-zone control adapted to the particular furnace provides model for optimal the temperature uniformity
- Commissioning of the furnace with test firing and temperature uniformity measurement (also with load) for the purpose of process optimization
- Additional tables, table changing system, also motor-driven
- Motor-driven exhaust air flap, switchable via the program
- Debinding package I with passive safety package and monitoring of the underpressure in the furnace chamber, exhaust gas fan, fresh air fan, preset underpressure in the furnace chamber, controlled by Nabertherm controller P 300 see page 6
- Debinding package II with passive safety concept see page 7
- Exhaust air and exhaust gas piping
- Thermal or catalytic exhaust cleaning systems see page 41
- Heat recovery systems see page 7
- Process documentation and control with Controltherm MV software package, NTLog and NTGraph for the basic furnace or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 83

Kiln furniture for small ceramics components

Model	Tmax	Inner dimensions in mm			Volume	Outer dimensions in mm			Heating power in kW[1]	Electrical connection*	Weight
	°C	w	d	h	in l	W	D	H			in kg
H 125/LB, LT	1280	800	400	400	125	1570	1280	2000	12	3-phase	1250
H 250/LB, LT	1280	1000	500	500	250	1770	1380	2200	18	3-phase	1400
H 500/LB, LT	1280	1200	600	600	500	2050	1780	2500	36	3-phase	1800
H 1000/LB, LT	1280	1600	800	800	1000	2250	2000	2900	48	3-phase	2800
H 1350/LB, LT	1280	2800	620	780	1360	3750	2050	3050	75	3-phase	3500
H 3000/LB, LT	1280	3000	1000	1000	3000	4000	2100	3200	140	3-phase	6200

[1]Depending on furnace design connected load might be higher

*Please see page 80 for more information about supply voltage

Combi Chamber Furnaces up to 1400 °C for Debinding and Sintering in one Process

N 200/HDB

N 650/HDBS

Injection of preheated air through perforated ceramic tubes

Pressure and flow rate displayed as part of debinding package II

N 200/DB - N 1000/14DB

The combi chamber furnaces N 200/DB - N 1000/14DB are specially developed for debinding and sintering in one process. The furnaces have a fresh air supply providing for dilution of the exhaust gases produced during debinding, for safe prevention of an inflammable atmosphere in the furnace chamber. The standard version of the furnaces includes debinding package I, with fresh air injected at room temperature in the furnace and with a factory pre-set volume flow with respect to the organic volume to be vaporized. In addition, the furnaces have an exhaust gas fan that is also factory pre-set and provides for a safe underpressure in the furnace. This system prevents exhaust gases from escaping into the production area. The passive safety package immediately intervenes when the underpressure in the furnace chamber drops. This system is recommended for reproducible processes in which the load does not change.

If the furnace is to be used flexibly with changing loads, we recommend debinding package II. The furnace then includes fresh air preheating with variable fan speed and injection of the warm fresh air through air distribution tubes. The exhaust gas fan also operates at variable speed. The PLC control system automatically adjusts the underpressure in the furnace chamber.

- Tmax 1280 °C, 1340 °C or 1400 °C
- Five-sided heating from all four sides and from the floor for a good temperature uniformity
- Heating elements mounted on support tubes provide for free radiation and long service life of the heating wire
- Bottom heating protected by SiC tiles on the table to provide a level stacking surface
- Multi-layer insulation consisting of lightweight refractory bricks backed by special insulation
- Self-supporting and long-life ceiling construction, with bricks laid in arched construction
- Motor-driven exhaust air flap on the furnace roof

Production system consisting of five combi chamber furnaces N 300/HDB with debinding package II with catalytic afterburning

- Debinding package I with passive safety package and monitoring of the underpressure in the furnace chamber, exhaust gas fan, fresh air fan, preset underpressure in the furnace chamber, controlled by Nabertherm controller P 300 see page 6
- Over-temperature limiter with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load

Additional equipment

- Multi-zone control adapted to the particular furnace model for optimizing the temperature uniformity
- Commissioning of the furnace with test firing and temperature uniformity measurement (also with load) for the purpose of process optimization see page 23
- Debinding package II with passive safety concept see page 7
- Exhaust air and exhaust gas tubing
- Thermal or catalytic exhaust cleaning systems see page 41
- Process documentation and control with Controltherm MV software package, NTLog and NTGraph for the basic furnace or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 83

N 697/HDS with debinding package II for debinding and sintering of standing filter products

Model	Tmax	Inner dimensions in mm			Volume	Outer dimensions in mm			Electrical	Weight
	°C	w	d	h	in l	W	D	H	connection*	in kg
N 200/DB	1280	430	530	720	140	760	1045	1690	3-phase	370
N 300/DB	1280	420	700	780	230	810	1215	1750	3-phase	410
N 450/DB	1280	470	750	1000	350	1010	1440	1815	3-phase	815
N 650/DB	1280	650	850	1100	610	1600	1750	2650	3-phase	1350
N 1000/DB	1280	750	1000	1250	940	1900	2250	2400	3-phase	2100
N 200/HDB	1340	430	530	720	140	760	1045	1690	3-phase	420
N 300/HDB	1340	420	700	780	230	810	1215	1750	3-phase	500
N 450/HDB	1340	470	750	1000	350	1010	1440	1815	3-phase	1040
N 650/HDB	1340	650	850	1100	610	1600	1750	2650	3-phase	1550
N 1000/HDB	1340	750	1000	1250	940	1900	2250	2400	3-phase	2500
N 200/14DB	1400	430	530	720	140	760	1045	1690	3-phase	450
N 300/14DB	1400	420	700	780	230	810	1215	1750	3-phase	550
N 450/14DB	1400	470	750	1000	350	1010	1440	1815	3-phase	1320
N 650/14DB	1400	650	850	1100	610	1600	1750	2650	3-phase	1750
N 1000/14DB	1400	750	1000	1250	940	1900	2250	2400	3-phase	2700

*Please see page 80 for more information about supply voltage

Chamber Furnaces with Wire Heating up to 1400 °C

N 2900

N 12900/S in customized dimensions

N 100 - N 2200/14

These high-quality chamber furnaces for firing, sintering and tempering have qualified themselves with the reliability for many years in daily use. Thanks to their five-side heating, the furnaces provide for a very good temperature uniformity. A wide range of additional equipment perfectly adapt these models to the process requirements.

- Tmax 1300 °C, 1340 °C or 1400 °C
- Five-side heating provide for good temperature uniformity
- Heating elements on support tubes provide for free heat radiation and long service life
- Vapour vent in the middle of the roof (excellent ventilation)
- Smoothly adjustable and easy-to-operate air inlet flap or sliding damper
- Self-supporting and long-life ceiling construction, with bricks laid in arched construction
- Special door lock for easy handling
- Multi-layer insulation consisting of lightweight refractory bricks and backed by special fiber insulation
- Models up to N 300/.. with removable stand
- Bottom heating elements protected by SiC tiles for level stacking surface
- Controls description see page 80

Chamber furnaces N 200/14 for sintering semiconductors

Additional equipment

- Motor-driven exhaust air flap
- Fan system for faster cooling with manual or automatic control
- Protective gas connection for purging the furnace with non-flammable protective or reaction gases
- Manual or automatic gas supply systems

- Fiber-insulation for shorter cycle times, especially cooling periods
- Multi-zone control for optimal temperature uniformity in the useful chamber
- Over-temperature limiter with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load

Model	Tmax	Inner dimensions in mm			Volume	Outer dimensions in mm			Heating power in	Electrical	Weight
	°C	w	d	h	in l	W	D	H	kW[1]	connection*	in kg
N 100	1300	400	530	460	100	710	1150	1430	9	3-phase	270
N 150	1300	450	530	590	150	760	1150	1560	11	3-phase	305
N 200	1300	500	530	720	200	810	1150	1690	15	3-phase	345
N 300	1300	550	700	780	300	860	1340	1750	20	3-phase	430
N 440	1300	600	750	1000	450	1000	1450	1820	30	3-phase	700
N 660	1300	600	1100	1000	660	1000	1800	1820	40	3-phase	850
N 1000	1300	800	1000	1250	1000	1450	1850	2000	57	3-phase	1800
N 1500	1300	900	1200	1400	1500	1550	2050	2160	75	3-phase	2500
N 2200	1300	1000	1400	1600	2200	1650	2250	2360	110	3-phase	3100
N 100/H	1340	400	530	460	100	710	1150	1430	11	3-phase	315
N 150/H	1340	450	530	590	150	760	1150	1560	15	3-phase	350
N 200/H	1340	500	530	720	200	810	1150	1690	20	3-phase	420
N 300/H	1340	550	700	780	300	860	1340	1750	27	3-phase	500
N 440/H	1340	600	750	1000	450	1000	1450	1820	40	3-phase	1040
N 660/H	1340	600	1100	1000	660	1000	1800	1820	57	3-phase	1260
N 1000/H	1340	800	1000	1250	1000	1450	1850	2000	75	3-phase	2320
N 1500/H	1340	900	1200	1400	1500	1550	2050	2160	110	3-phase	2700
N 2200/H	1340	1000	1400	1600	2200	1650	2250	2360	140	3-phase	3600
N 100/14	1400	400	530	460	100	710	1150	1430	15	3-phase	345
N 150/14	1400	450	530	590	150	760	1150	1560	20	3-phase	400
N 200/14	1400	500	530	720	200	810	1150	1690	22	3-phase	450
N 300/14	1400	550	700	780	300	860	1340	1750	30	3-phase	550
N 440/14	1400	600	750	1000	450	1000	1450	1820	40	3-phase	1320
N 660/14	1400	600	1100	1000	660	1000	1800	1820	57	3-phase	1560
N 1000/14	1400	800	1000	1250	1000	1450	1850	2000	75	3-phase	2500
N 1500/14	1400	900	1200	1400	1500	1550	2050	2160	110	3-phase	3000
N 2200/14	1400	1000	1400	1600	2200	1650	2250	2360	140	3-phase	3900

[1]Depending on furnace design connected load might be higher

*Please see page 80 for more information about supply voltage

N 1680/S for long parts

Chamber furnace with fiber insulation for shorter cycle times

Charging trolley for N 2200

Gas-Fired Chamber Furnaces up to 1300 °C also as Combi Furnaces for Debinding and Sintering in one Process

NB 660

NB 4330/S

NB 2880/S

Certain firing or sintering processes require a gas-fired chamber furnace. Short heating times due to the high power are a convincing argument. The chamber furnaces with powerful gas burners cover a wide variety of these processes. In the basic version the burners are manually ignited once at the start of the process. The automatic control system then takes over control of the temperature curve. At program end, the burners are automatically switched off. Depending on the process, the furnaces can be equipped with automatically controlled fan burners and safety technology for debinding. Especially in case of larger binder concentrations, gas furnaces have the advantage that the exhaust quantity can be significantly reduced as the binders are burnt off in the furnace, providing for downsizing of the exhaust cleaning.

- Tmax 1300 °C
- Powerful, atmospheric burners for operation with liquified gas or natural gas
- Special positioning of the gas burners with flame guide top-down provides for good temperature uniformity
- Fully automatic temperature control
- Gas fittings with flame control and safety valve in accordance with DVGW (German Technical and Scientific Association for Gas and Water)
- Multi-layer, reduction-proof insulation with light-weight refractory bricks and special back-up insulation result in low gas consumption
- Self-supporting and rugged ceiling, bricks laid in arched construction or as fiber insulation
- Dual shell housing, side panels made of stainless steel (NB 300), for low outside temperatures
- Solid, dual shell door
- Exhaust hood with 150 mm (NB 300) and 00 mm (NB 400, NB 600) diameter connection
- Over-temperature limiter with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load

Compact burners for standard models up to NB 600

Additional equipment

- Fan burner with fully automatic control and ignition
- Debinding technology see page 7
- Exhaust air and exhaust gas piping
- Thermal or catalytic exhaust cleaning systems see page 41
- Recuperator technology for heat recovery
- Process documentation and control with Controltherm MV software package, NTLog and NTGraph for the basic furnace or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 83

Gas-Fired Bogie Hearth Furnaces up to 1400 °C for Firing or Sintering in Air or under Reducing Atmosphere

Combi furnace system consisting of one gas-fired furnace WB 11000HS and two additional bogies incl. bogie transfer system and incl. necessary park rails

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

- Tmax up to 1400 °C, depending on furnace design
- Powerful, sturdy high-speed burner with pulse control and special flame control in the furnace chamber provide for optimum temperature uniformity
- Operation with city gas, natural gas or liquified gas
- Fully automatic PLC control of the temperature as well as monitoring of the burner function
- Reduction-resistant fiber insulation with low heat storage provides for short heating and cooling times
- Dual shell housing provides for low outside temperatures
- Exhaust hood with fittings for further discharge of the exhaust gases
- Over-temperature limiter with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load

WB 3360/14 for reducing firing of porcelain

Additional equipment

- Automatic lambda control to set the furnace atmosphere
- Debinding package for debinding and sintering with corresponding safety technology see page 6
- Exhaust air and exhaust gas piping
- Recuperator burners utilizing part of the waste heat in the exhaust tract to preheat the combustion air and considerably contribute to energy saving
- Thermal or catalytic exhaust cleaning systems
- Process documentation and control with Controltherm MV software package, NTLog and NTGraph or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 80
- Other additional equipment for bogie hearth furnaces see page 19

Furnace chamber with eight high-speed burners

High-Temperature Bogie Hearth Furnaces with SiC Rod Heating up to 1550 °C

WHTC 3300/15

WHTC 4000/15 with bogie on rails and fan cooling

SiC rod elements on both sides of the furnace

Bogie hearth furnaces equipped with SiC rod heating can be used in the production of technical ceramics, especially for sintering at working temperatures up to 1550 °C. The WHTC product line with especially robust design can hold heavy charges including kiln furniture. The furnace chamber is equipped with a high-quality insulation made of high-temperature fiber blocks. The bogie insulation is structured in multi-layer lightweight refractory bricks on the heating chamber side.

The furnace is heated along both sides by vertically installed SiC heating rods. This heating technology permits processes requiring working temperatures above 1350 °C which cannot achieved with wire heating elements. The SiC rods are controlled by thyristor controller which counteract the aging of the heating elements by means of automatic power compensation.

- Tmax 1550 °C
- Dual shell housing with rear ventilation, provides for low shell temperatures
- Swing door hinged on the right side

- Heating from both sides via vertically mounted SiC rods
- Thyristor controllers with automatic output compensation counteract the aging of SiC rods
- Multi-layer insulation with high-quality fiber modules on the heating chamber side
- Bogie for heavy loads lined with lightweight refractory bricks
- Bogie hand driven on rubber tires
- Motor-driven exhaust air flap on the furnace roof
- Over-temperature limiter with manual reset for thermal protection class 2, as defined in EN 60519-2, to protect the furnace and charge

Additional equipment

The WHTC bogie hearth furnaces can be equipped with extensive additional equipment to be optimally adapted to individual processes. For additional equipment see page 19.

Design with two doors and two bogies, on rails, allows for rapid bogie changes

High-Temperature Chamber Furnaces with SiC Rod Heating up to 1550 °C

HTC 276/16

HTC 160/16

HTC 16/16 - HTC 450/16

The high-temperature chamber 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. 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
- Chain-guided parallel swivel door for defined opening and closing of the door
- Labyrinth sealing ensures the least possible temperature loss in the door area
- Specially reinforced furnace floor for accommodating high charge weights for model HTC 16 and above
- Exhaust air opening in the furnace roof
- Heating elements switched via SCR's
- Over-temperature limiter with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Controls description see page 80

For additional equipment see models HT 04/16 - HT 450/18

Vertically mounted SiC rods

Exhaust-air flap and charge thermocouple including a stand as additional equipment

Model	Tmax	Inner dimensions in mm			Volume	Outer dimensions in mm			Heating	Electrical	Weight
	°C	w	d	h	in l	W	D	H	power in kW[2]	connection*	in kg
HTC 16/16	1550	200	300	260	16	810	700	1500	12,0	3-phase[1]	270
HTC 40/16	1550	300	350	350	40	1000	800	1620	12,0	3-phase	380
HTC 64/16	1550	400	400	400	64	1130	900	1670	18,0	3-phase	550
HTC 128/16	1550	400	800	400	128	1130	1290	1670	26,0	3-phase	750
HTC 160/16	1550	500	550	550	160	1245	1040	1900	21,0	3-phase	800
HTC 276/16	1550	500	1000	550	276	1140	1470	1900	36,0	3-phase	1100
HTC 450/16	1550	500	1150	780	450	1200	1620	2060	64,0	3-phase	1500

[1]Heating only between two phases

[2]Depending on furnace design connected load might be higher

*Please see page 80 for more information about supply voltage

High-Temperature Chamber Furnaces with Molybdenum Disilicide Heating Elements with Fiber Insulation up to 1800 °C

HT 16/17

HT 160/17DB2 with catalytic afterburning system

HT 04/16 - HT 450/18

The high-temperature chamber furnaces HT 04/16 - HT 450/18 have proven reliable over many years in the lab and in the production of technical ceramics. Whether for bioceramics, for sintering CIM components or for other processes up to a maximum temperature of 1800 °C, these furnaces afford the optimal solution for the sintering process.

Protection of heating elements against mechanical damage

High-temperature chamber furnaces can either be insulated with fiber material or lightweight refractory bricks. Furnaces with fiber insulation achieve significantly shorter heating up times because of the low thermal mass. An insulation made of lightweight refractory bricks (see HFL models on page 35), on the other hand, has the advantage of better chemical stability.

These furnaces can also be tailored to specific processes by means of a wide range of additional equipment. The addition of a debinding package, for example, allows the use of these models as combi furnaces for debinding and sintering in one process. Thermal or catalytic exhaust cleaning equipment round up the system.

- Tmax 1600 °C, 1750 °C or 1800 °C
- 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
- Chain-guided parallel swivel door for defined opening and closing of the door
- Labyrinth sealing ensures the least possible temperature loss in the door area
- Specially reinforced furnace floor for accommodating high charge weights for model HT 40 and above
- Exhaust air opening in the furnace roof
- Heating elements switched via SCR‘s
- Over-temperature limiter with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load

HT 160/17 with gas supply system and inner process hood

HT 276/17 with pneumatically driven and parallel lift door

Additional equipment

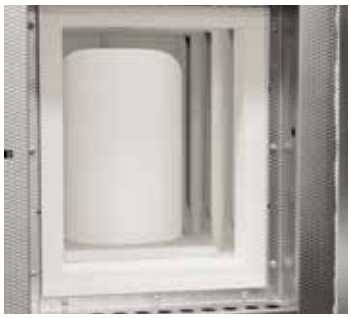
- Uncontrolled or controlled cooling system with frequency-controlled cooling fan and motor-driven exhaust air flap
- Commissioning of the furnace with test firing and temperature uniformity measurement (also with load) for the purpose of process optimization
- Temperature measurement with thermocouples, types B and type S with automatic pull-out device for precise control results in the low temperature range
- Protection grid in front of the heating elements to prevent mechanical damages see page 35
- Special heating elements for zirconia sintering provide for longer service life with respect to chemical interaction between charge and heating elements
- Protective gas connection for purging the furnace with non-flammable protective or reaction gases
- Manual or automatic gas supply system
- Gas supply system in the furnace chamber with ceramic bell jar, protective gas inlet and outlet from below for better sealing when operating with protective gases and/or to prevent from chemical interactions between the load and the insulation or the heating elements
- Parallel swivel door opening upwards, also motor driven
- Bottom insulation made of durable lightweight refractory bricks for heavy charge weights
- Motorized exhaust air flap, switchable via the program
- Debinding package I with passive safety package and monitoring of the underpressure in the furnace chamber, exhaust gas fan, fresh air fan, preset underpressure in the furnace chamber, controlled by Nabertherm controller P 300 see page 6
- Debinding package II with safety concept see page 7
- Exhaust air and exhaust gas piping
- Thermal or catalytic exhaust cleaning systems see page 41
- Process documentation, display and control via HiproSystems control system see page 81

Fresh air injection through perforated injection tubes with debinding package II

Display of pressure and volume flow with debinding package II

High-Temperature Chamber Furnaces with Molybdenum Disilicide Heating Elements with Fiber Insulation up to 1800 °C

HT 1000/17 with two movable door segments and fourside heating for sintering hanging ceramic tubes up to 1700 °C



Inner process hood with gas injection through the furnace bottom protects the furnace chamber against contamination and/or prevents chemical interaction between the charge and heating elements

Gas supply system for non-flammable protective or reaction gases

Model	Tmax	Inner dimensions in mm			Volume	Outer dimensions in mm			Heating power in	Electrical	Weight
	°C	w	d	h	in l	W	D	H	kW[2]	connection*	in kg
HT 04/16	1600	150	150	150	4	610	470	1400	5.2	3-phase[1]	150
HT 08/16	1600	150	300	150	8	730	640	1400	8.0	3-phase[1]	200
HT 16/16	1600	200	300	260	16	810	700	1500	12.0	3-phase[1]	270
HT 40/16	1600	300	350	350	40	1000	800	1620	12.0	3-phase	380
HT 64/16	1600	400	400	400	64	1130	900	1670	18.0	3-phase	550
HT 128/16	1600	400	800	400	128	1130	1290	1670	26.0	3-phase	750
HT 160/16	1600	500	550	550	160	1245	1040	1900	21.0	3-phase	800
HT 276/16	1600	500	1000	550	276	1140	1470	1900	36.0	3-phase	1100
HT 450/16	1600	500	1150	780	450	1200	1620	2060	64.0	3-phase	1500
HT 04/17	1750	150	150	150	4	610	470	1400	5.2	3-phase[1]	150
HT 08/17	1750	150	300	150	8	730	640	1400	8.0	3-phase[1]	200
HT 16/17	1750	200	300	260	16	810	700	1500	12.0	3-phase[1]	270
HT 40/17	1750	300	350	350	40	1000	800	1620	12.0	3-phase	380
HT 64/17	1750	400	400	400	64	1130	900	1670	18.0	3-phase	550
HT 128/17	1750	400	800	400	128	1130	1290	1670	26.0	3-phase	750
HT 160/17	1750	500	550	550	160	1245	1040	1900	21.0	3-phase	800
HT 276/17	1750	500	1000	550	276	1140	1470	1900	36.0	3-phase	1100
HT 450/17	1750	500	1150	780	450	1200	1620	2060	64.0	3-phase	1500
HT 04/18	1800	150	150	150	4	610	470	1400	5.2	3-phase[1]	150
HT 08/18	1800	150	300	150	8	730	640	1400	9.0	3-phase[1]	200
HT 16/18	1800	200	300	260	16	810	700	1500	12.0	3-phase[1]	270
HT 40/18	1800	300	350	350	40	1000	800	1620	12.0	3-phase	380
HT 64/18	1800	400	400	400	64	1130	900	1670	18.0	3-phase	550
HT 128/18	1800	400	800	400	128	1130	1290	1670	26.0	3-phase	750
HT 160/18	1800	500	550	550	160	1245	1040	1900	21.0	3-phase	800
HT 276/18	1800	500	1000	550	276	1140	1470	1900	36.0	3-phase	1100
HT 450/18	1800	500	1150	780	450	1200	1620	2060	64.0	3-phase	1500

[1]Heating only between two phases

[2]Depending on furnace design connected load might be higher

*Please see page 80 for more information about supply voltage

Chamber Furnaces with Molybdenum Disilicide Heating Elements with Refractory Insulation up to 1700 °C

HFL 160/17 with gas supply system

HFL 295/13 with lift door and transformer in stand

HFL 16/16 - HFL 160/17

The HFL 16/16 HFL 160/17 product line is characterized by its lining with robust light weight refractory bricks. Compared with the fiber-insulated models of the HT product line, these furnaces are recommended when high charge weights have to be sintered. In most cases lightweight refractory brick insulation is also significantly more resistant to gas emissions occurring during heat treatment.

Standard equipment like HT models, except:

- Tmax 1600 °C or 1700 °C
- Sturdy lightweight refractory bricks and special backing insulation
- Furnace floor made of lightweight refractory bricks accommodates high charge weights

Additional equipment like HT models

Protection grid in front of heating elements prevent against mechanical damages

Model	Tmax	Inner dimensions in mm			Volume	Outer dimensions in mm			Heating power in	Electrical	Weight
	°C	w	d	h	in l	W	D	H	kW[2]	connection*	in kg
HFL 16/16	1600	200	300	260	16	770	830	1550	12	3-phase[1]	500
HFL 40/16	1600	300	350	350	40	880	880	1710	12	3-phase	660
HFL 64/16	1600	400	400	400	64	980	930	1830	18	3-phase	880
HFL 160/16	1600	500	550	550	160	1090	1080	2030	21	3-phase	1140
HFL 16/17	1700	200	300	260	16	770	830	1550	12	3-phase[1]	530
HFL 40/17	1700	300	350	350	40	880	880	1710	12	3-phase	690
HFL 64/17	1700	400	400	400	64	980	930	1830	18	3-phase	920
HFL 160/17	1700	500	550	550	160	1090	1080	2030	21	3-phase	1190

[1]Heating only between two phases

[2]Depending on furnace design connected load might be higher

*Please see page 80 for more information about supply voltage

Gas supply system for non-flammable protective or reaction gases

Lift-Top and Lift-Bottom Furnaces with Molybdenum Disilicide Heating Elements up to 1800 °C

HT 680/17 LTS2 with table exchange system

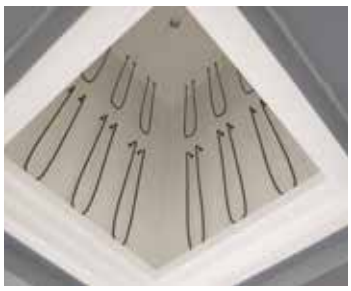
HT 64/17 LT

Heat from all sides and between the stack to optimize temperature uniformity

HT 64/14 LB or LT - HT 1440/17 LB or LT

For charging complex settings we recommend lift-top or lift-bottom furnaces. Also small workparts can be conveniently loaded on different layers. Up to an application temperature of 1500 °C the furnaces are heated by SiC rods (HTC models). For sintering temperatures above 1500 °C these furnaces with molybdenum disilicide heating elements (HT models). Possible potential chemical interaction between the charge and the heating method can also affect the selection of heating system.

The basic furnace comes with one table. Depending on the technical requirements are equipped, a lift-top or lift-bottom version will be the choice. The system can be expanded with one or more changeable tables, either manually or electrically driven. Other additional equipment, like controlled cooling systems to short process cycles or the addition of a debinding package for debinding and sintering in one process provide for tailored solution for individual needs.



Heating elements arranged one above the other for tall structures

- Tmax 1400 °C or 1500 °C (HTC models with SiC rod heating)
- Tmax 1600 °C, 1750 °C or 1800 °C (HT models with molybdenum disilicide heating elements)
- Dual shell housing with fan cooling provides for low shell temperatures
- Designed as lift-top furnace with driven hood (LT) or lift-bottom furnace
- Gently running, low-vibration spindle drive or electrohydraulic drive for larger models
- Safe and tight closing of the furnace due to labyrinth seal and sand cup
- Heating from all four sides provides for good temperature uniformity
- High-quality fiber insulation backed by special insulation
- Side insulation constructed with tongue and groove blocks provides for low heat dissipation to the outside
- Long-life roof insulation with special suspension
- Furnace table with special bottom reinforcement to accommodate high charge weights
- Motor-driven exhaust air flap in the furnace roof, switchable at the program
- PLC controls with state-of-the-art touch panel as user interface see page 81
- Over-temperature limiter with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load

Additional equipment

- Uncontrolled or controlled cooling system with frequency-controlled cooling fan and motor-driven exhaust air flap
- Commissioning of the furnace with test firing and temperature uniformity measurement (also with load) for the purpose of process optimization
- Temperature measurement with thermocouples, types B and type S with automatic pull-out device for precise control results in the low temperature range
- Heat from all sides and between the stack or with heating elements, positioned above each other to optimize temperature uniformity
- Protective gas connection for purging the furnace with non-flammable protective or reaction gases
- Manual or automatic gas supply systems
- Gas supply system in the furnace chamber with ceramic bell jar, protective gas inlet and outlet from below for better sealing when operating with protective gases and/or to prevent from chemical interactions between the load and the insulation or the heating elements
- Alternative table changing systems
- Debinding package I with passive safety package and monitoring of the underpressure in the furnace chamber, exhaust gas fan, fresh air fan, preset underpressure in the furnace chamber, controlled by Nabertherm controller P 300 see page 6
- Debinding package II with passive safety concept see page 7
- Exhaust air and exhaust gas piping
- Automatic changing system for thermocouple type S/B for precise measurement and control quality at lowes temperatures, e.g. in combination with a debinding package
- Thermal or catalytic exhaust cleaning systems see page 41
- Process documentation, display and control via HiproSystems control system see page 81

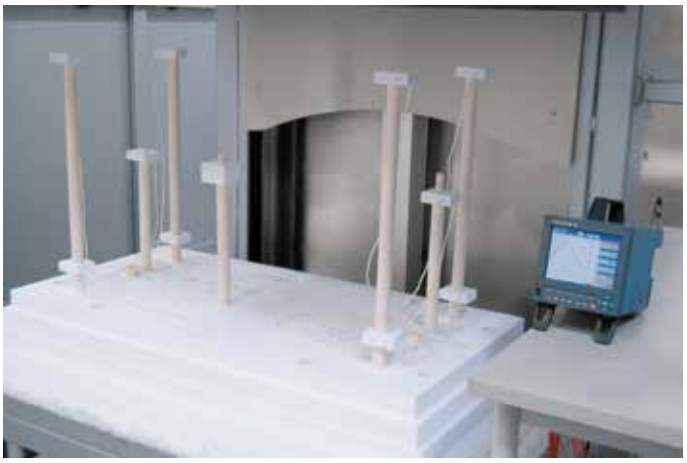
HT 276/18 LTS with two inner process hoods for sintering under non-flammable protective or reaction gases

Gas supply system for non-flammable protective or reaction gas

HT 276/17 LT HDB with manual table changing system and debinding package II

Lift-Top and Lift-Bottom Furnaces with Molybdenum Disilicide Heating Elements up to 1800 °C

Combi high-temperature plant HT 1440/17 LBS with catalytic afterburning system for debinding and sintering in one process



Measurement setup to determine the temperature uniformity in a high-temperature lift-bottom furnace

Production system consisting of a bogie hearth furnace for debinding and a high-temperature furnace for residual debinding and sintering with shared catalytic afterburning system

High-temperature furnace HT 273/17S with table by transportable fork lift

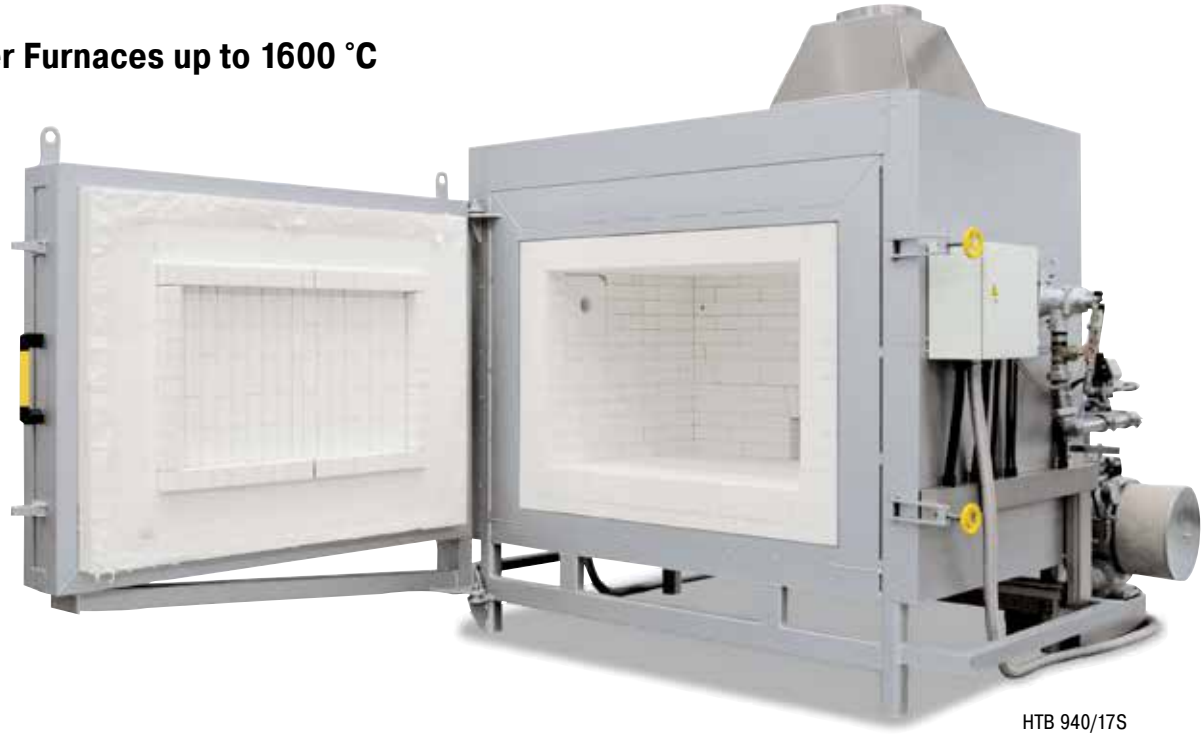
Model	Tmax	Inner dimensions in mm			Volume	Outer dimensions in mm			Heating power in	Electrical	Weight
	°C	w	d	h	in l	W	D	H	kW[1]	connection*	in kg
HT 64/16 LB, LT	1600	400	400	400	64	950	1750	2350	36	3-phase	1000
HT 166/16 LB, LT	1600	550	550	550	166	1095	2060	2450	42	3-phase	1600
HT 276/16 LB, LT	1600	1000	500	550	276	1550	2090	2600	50	3-phase	2000
HT 400/16 LB, LT	1600	1200	600	550	400	1750	2200	2600	72	3-phase	2200
HT 1000/16 LB, LT	1600	1000	1000	1000	1000	1550	2600	3200	146	3-phase	3000
HT 1030/16 LB, LT	1600	2200	600	780	1030	2800	2500	3000	163	3-phase	3000
HT 1440/16 LB, LT	1600	1800	800	1000	1440	3000	2800	3700	330	3-phase	4000
HT 64/17 LB, LT	1750	400	400	400	64	950	1750	2350	36	3-phase	1000
HT 166/17 LB, LT	1750	550	550	550	166	1095	2060	2450	42	3-phase	1600
HT 276/17 LB, LT	1750	1000	500	550	276	1550	2090	2600	50	3-phase	2000
HT 400/17 LB, LT	1750	1200	600	550	400	1750	2200	2600	72	3-phase	2200
HT 1000/17 LB, LT	1750	1000	1000	1000	1000	1550	2600	3200	146	3-phase	3000
HT 1030/17 LB, LT	1750	2200	600	780	1030	2800	2500	3000	163	3-phase	3000
HT 1440/17 LB, LT	1750	1800	800	1000	1440	3000	2800	3700	330	3-phase	4000
HT 64/18 LB, LT	1800	400	400	400	64	950	1750	2350	on request	3-phase	1000
HT 166/18 LB, LT	1800	550	550	550	166	1095	2060	2450	on request	3-phase	1600
HT 276/18 LB, LT	1800	1000	500	550	276	1550	2090	2600	on request	3-phase	2000
HT 400/18 LB, LT	1800	1200	600	550	400	1750	2200	2600	on request	3-phase	2200
HT 1000/18 LB, LT	1800	1000	1000	1000	1000	1550	2600	3200	on request	3-phase	3000
HT 1030/18 LB, LT	1800	2200	600	780	1030	2800	2500	3000	on request	3-phase	3000
HT 1440/18 LB, LT	1800	1800	800	1000	1440	3000	2800	3700	on request	3-phase	4000

[1]Depending on furnace design connected load might be higher

*Please see page 80 for more information about supply voltage

HT 750/18 LTS

Gas-Fired Chamber Furnaces up to 1600 °C



HTB 940/17S

Gas line for natural gas

The gas-fired high-temperature furnaces of the HTB product line are specially developed for applications requiring fast heating up ramps. Gas-fired furnaces are preferred also if inflammable gases are produced in large amounts during the process. A large content of the gas emissions are already burned in the furnace chamber, so that downstream equipment like thermal and catalytic exhaust cleaners can accordingly be downsized. The furnaces are insulated with highly heat-resistant and long-life lightweight refractory brick insulation or fiber materials.

- Tmax 1600 °C
- Powerful, sturdy high-speed burners with pulse control and special flame guidance in the furnace chamber provide for good temperature uniformity
- Operation with natural gas, propane or liquified gas
- Fully automatic PLC control of the temperature, including monitoring of the burner function
- Gas fittings according to DVGW (German Technical and Scientific Association for Gas and Water) with flame monitoring and safety valve
- Reduction-resistant fiber insulation with low heat storage provides for short heating and cooling times
- Dual shell housing provides for low outside temperatures
- Exhaust hood with fittings for further discharge of the exhaust gases
- PLC control with touch panel as user interface see page 81

HTB 645/17

Additional equipment

- Automatic lambda control to set the furnace atmosphere
- Debinding package for debinding and sintering with corresponding safety technology see page 6
- Exhaust air and exhaust gas piping
- Recuperator burners
- Thermal or catalytic exhaust cleaning systems see page 41
- Process display and documentation via Nabertherm Control Center (NCC) see page 81

Catalytic and Thermal Afterburning Systems, Exhaust Gas Washer

Catalytic afterburning system independent from furnace model for refitting on existing plants

Catalytic and Thermal Afterburning Systems (KNV and TNV), 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.

Exhaust gas washer to clean generated process gases by washing out

Catalytic exhaust cleaning is especially recommended due to energetic reasons when only pure hydrocarbon compounds must be cleaned during the debinding process in air. Thermal afterburning systems are used if large volumes of exhaust gas from the debinding process in air must be cleaned and/or if there is a risk that the exhaust gases might damage the catalyst. Thermal afterburning is also used for debinding applications under non-flammable or flammable protective or reaction gases.

An exhaust gas washer is often used if large amounts of exhaust gases are generated respectively, if the gases cannot be treated with a thermal afterburner system or with a torch. The gases will be lead through a water shower and fall out as condensate.

Chamber furnace N 150/14 with catalytic afterburning system

Catalytic afterburning systems (KNV)

- Perfectly suited for debinding processes in air with only organic exhaust gases
- Catalytic conversion of the unburned hydrocarbons to their nontoxic, natural components
- Integrated in a compact stainless steel housing
- Electric heating provides for preheating of the exhaust gas to the optimal reaction temperature for catalytic treatment
- Cleaning in different layers of catalytic honeycombs within the system
- Thermocouples for measuring the temperatures of raw gas, reaction honeycombs and discharge
- Over-temperature limiter with adjustable cutout temperature protects the catalyst
- Tight connection between the exhaust gas outlet of the debinding furnace and the exhaust gas fan with corresponding integration into the overall system with respect to control and safety technology
- Catalyst dimensioned in reletion to the exhaust gas flow
- Measuring port for clean gas measurements (FID)

Thermal afterburning systems (TNV)

- 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
- 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 afterburning
- Design depending on the exhaust gas flow
- Measuring port for clean gas measurements (FID)

Thermal afterburning system

Continuous Furnaces
Electrically Heated
or Gas-Fired

Continuous furnace D 700/10000/300/45S
with chain conveyor for 950 °C, gas-fired

Service window

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

Alternative furnace design subject to process specifications:

Conveyor concepts
- Conveyor belt
- Metal conveyor belt with adjusted mesh gauges
- Drive chain
- Roller conveyors
- Pusher-type furnace

Discharge of D 650/S

Continuous belt furnace for bulk
materials in baskets

Roller conveyor furnace N 650/45 AS for
heat treatment of heavy workparts

Conveyor plant D 1600/3100/1200/55, consisting of annealing furnace, cooling station and conveyor system

Visualization of process data on the PC

Drop bottom for quenching within 5 seconds

Heating systems
- Electric heating, radiant or convection
- Direct or indirect gas-firing
- Infrared heating
- Heating with the use of external heat sources

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

Process atmosphere
- In air
- In non-flammable protective or reactive gases such as nitrogen, argon or forming gas
- In flammable protective or reactive gases such as hydrogen incl. the necessary safety technology

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

Continuous belt furnace for bulk charges incl. water bath for quenching

Hot-Wall Retort Furnaces up to 1100 °C

NR 75/06 with automatic gas injection and touch panel H 3700

NR 17/06 with gas supply system

Inside heating in models NRA ../06

NRA 17/06 - NRA 1000/11

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. Equipped with the corresponding safety technology, retort furnaces are also suitable for applications under reaction gases, such as hydrogen or, in combination with the IDB package, for inert debinding or for pyrolysis processes.

Different model versions are available depending on the temperature range required for the process:

Models NRA ../06 with Tmax 650 °C

- Heating elements located inside the retort
- Temperature uniformity up to ΔT 6 K inside the work space from 100 °C - 600 °C see page 79
- Retort made of 1.4571
- Gas circulation fan in the back of the retort provides for optimal temperature uniformity

Models NRA ../09 with Tmax 950 °C

- Outside heating with heating elements surrounding the retort as well as an additional door heater
- Temperature uniformity up to ΔT 6 K inside the work space from 200 °C - 900 °C see page 79
- Retort made of 1.4841
- Fan in the back of the retort provides for optimal temperature uniformity

Models NR ../11 with Tmax 1100 °C

- Outside heating with heating elements surrounding the retort as well as an additional door heater
- Temperature uniformity up to ΔT 10 K inside the work space from 200 °C - 1050 °C see page 79
- Retort made of 1.4841

NRA 480/04S

NRA 50/09 H_2

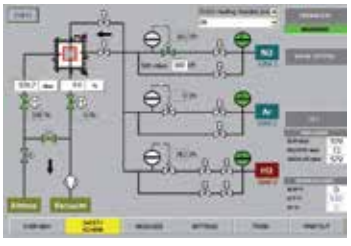
Basic version

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

Additional equipment

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

Vacuum pump for cold evacuation of the retort



Touchpanel H 3700 for automatic version

NR 200/11 H_2 for heat treatment under hydrogen

Charging of the NR 300/06 furnace with a pallet truck

H_2 Version for Operation under Hydrogen

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

- H_2 supply at controlled overpressure of 50 mbar relative
- Certified safety concept
- PLC controls with graphic touch panel H 3700 for data input
- Redundant gas inlet valves for hydrogen
- Monitored pre-pressures of all process gases
- Bypass for safe flushing of furnace chamber with inert gas
- Torch for thermal afterburning of exhaust gases
- Emergency flood container for purging the furnace in case of failore

Bayonet quick-lock for the retort, also with electric drive as additional equipment

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

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

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

Parallel guided door to open the hot furnace as additional equipment

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

Model	Tmax °C	Model	Tmax °C	Work space dimensions in mm w	d	h	Useful volume in l	Electrical connection*
NRA 17/..	650 or 950	NR 17/11	1100	225	350	225	17	3-phase
NRA 25/..	650 or 950	NR 25/11	1100	225	500	225	25	3-phase
NRA 50/..	650 or 950	NR 50/11	1100	325	475	325	50	3-phase
NRA 75/..	650 or 950	NR 75/11	1100	325	700	325	75	3-phase
NRA 150/..	650 or 950	NR 150/11	1100	450	750	450	150	3-phase
NRA 200/..	650 or 950	NR 200/11	1100	450	1000	450	200	3-phase
NRA 300/..	650 or 950	NR 300/11	1100	570	900	570	300	3-phase
NRA 400/..	650 or 950	NR 400/11	1100	570	1250	570	400	3-phase
NRA 500/..	650 or 950	NR 500/11	1100	720	1000	720	500	3-phase
NRA 700/..	650 or 950	NR 700/11	1100	720	1350	720	700	3-phase
NRA 1000/..	650 or 950	NR 1000/11	1100	870	1350	870	1000	3-phase

*Please see page 80 for more information about supply voltage

SRA 300/06 with charging basket

SR(A) 17/.. - SR(A) 1500

The retort furnaces SR and SRA (with gas circulation) are designed for operation with non-flammable or flammable protective or reaction gases. The furnace is loaded from above by crane or other lifting equipment provided by the customer. In this way, even large charge weights can be loaded into the furnace chamber.

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

Models SR .../11 with Tmax 1100 °C

- Heating from all sides outside the retort
- Temperature uniformity up to ΔT 14 K according to DIN 17052-1 within the working chamber of 500 °C - 1100 °C see page 79
- Retort made of 1.4841
- Top down multi-zone control of the furnace heating

Models SRA ../09 with Tmax 950 °C

Design like models SR.../11 with following differences:

- Atmosphere circulation with powerful fan in the furnace lid provides for temperature uniformity of up to ΔT 8 K according to DIN 17052-1 within the working chamber of 200 °C - 900 °C see page 79

SR 170/1000/11 with changeable retort and cooling station

Models SRA ../06 with Tmax 600 °C

Design like models SRA.../09 with following differences:

- Heating inside the retort
- Temperature uniformity up to ΔT 14 K according to DIN 17052-1 within the working chamber of 100 °C - 600 °C see page 79
- Single-zone control
- Retort made of 1.4571

Standard Equipment (all models)

Design like standard equipment of models NR and NRA with following differences:

- Charging from above with crane or other lifting equipment from customer
- Hinged lid with opening to the side

Additional equipment, H_2 version or IDB version see models NR and NRA

Model	Tmax	Inner dimensions of alloy retort		Volume	Outer dimensions in mm			Electrical	Weight
	°C	ø in mm	h in mm	in l	W	D	H	connection*	in kg
SR(A) 17/..		250	350	17	1300	1700	1800	3-phase	600
SR(A) 25/..		250	500	25	1300	1900	1800	3-phase	800
SR(A) 50/..		400	450	50	1400	2000	1800	3-phase	1300
SR(A) 100/..	600,	400	800	100	1400	2000	2100	3-phase	1500
SR(A) 200/..	950	600	700	200	1600	2200	2200	3-phase	2100
SR(A) 300/..	or	600	1000	300	1600	2200	2500	3-phase	2400
SR(A) 500/..	1100	800	1000	500	1800	2400	2700	3-phase	2800
SR(A) 600/..		800	1200	600	1800	2400	2900	3-phase	3000
SR(A) 800/..		1000	1000	800	2000	2600	2800	3-phase	3100
SR(A) 1000/..		1000	1300	1000	2000	2600	3100	3-phase	3300
SR(A) 1500/..		1200	1300	1500	2200	2800	3300	3-phase	3500

[1]Depending on furnace design connected load might be higher

*Please see page 80 for more information about supply voltage

SRA 200/09

Cold-Wall Retort Furnaces up to 2400 °C

VHT 500/22-GR H_2 with CFC-process box and extension package for operation under hydrogen

VHT 8/18-KE with fiber insulation and molybdenum disilicide heating elements

Heat treatment of copper bars under hydrogen in VHT 08/16 MO

VHT 8/18-GR - VHT 500/18-KE

The compact furnaces of the VHT product line are available as electrically heated chamber furnaces with graphite, molybdenum, tungsten or $MoSi_2$ heating. A wide variety of heating designs as well as a complete range of accessories provide for optimal furnace configurations even for sophisticated applications.

The vacuum-tight retort allows heat treatment processes either in protective and reaction gas atmospheres or in a vacuum, subject to the individual furnace specs to 10^{-5} mbar. The basic furnace is suited for operation with non-flammable protective or reactive gases or under vacuum. The H_2 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

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

VHT ../GR with Graphite Insulation and Heating

- Suitable for processes under protective and reaction gases or under vacuum
- Tmax 1800 °C or 2200 °C (2400 °C as additional equipment)
- Max. vacuum up to 10^{-4} mbar depending on pump type used
- Graphite felt insulation

VHT ../MO or ../W with Molybdenum or Tungsten Heating

- Suitable for high-purity processes under protective and reaction gases or under high vacuum
- Tmax 1200 °C, 1600 °C or 1800 °C (see table)
- Max. vacuum up to 5 x 10^{-5} mbar depending on pump type used
- Insulation made of molybdenum 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

Standard Equipment for all Models

Basic version

- Standard furnace sizes 8 - 500 liters
- A water-cooled stainless steel process reactor sealed with temperature-resistant o-rings
- Frame made of stable steel profiles, easy to service due to easily removable stainless steel panels
- Housing of the VHT 8 model on castors for easy repositioning of furnace
- Cooling water manifold with manual stopcocks in supply and return lines, automatic flowmeter monitoring, openloop cooling water system
- Adjustable cooling water circuits with flowmeter and temperature indicator and overtemperature fuses
- Switchgear and controller integrated in furnace housing
- H 700 PLC control with clearly laid out 5.7“ touchpanel control for program entry and display, 10 programs each with 20 segments
- Over-temperature limiter with manual reset for thermal protection class in accordance with EN 60519-2
- Manual operation of the process gas and vacuum functions
- Manual gas supply for one process gas (N_2 or Ar) with adjustable flow
- Bypass with manual valve for rapid filling or flooding of furnace chamber
- Manual gas outlet with overflow valve (20 mbar relative)
- Single-stage rotary vane pump with ball valve for pre-evacuating and heat treatment in a rough vacuum to 5 mbar
- Pressure gauge for visual pressure monitoring

Additional equipment

- Tmax 2400 °C
- Housing, optionally divisible, for passing through narrow door frames (VHT 08)
- Manual gas supply for second process gas (N_2 or Ar) with adjustable flow and bypass
- Inner process box made of molybdenum, tungsten or CFC, especially recommended for debinding processes. The box is installed in the furnace with direct gas inlet and outlet and provides for better temperature uniformity. Due to a change in gas supply direction after debinding a clean process atmosphere for sintering is achieved.
- Charge thermocouple with display
- Temperature measurement at 2200 °C models with pyrometer and thermocouple, type S with automatic pull-out device for precise control results in the low temperature range (VHT 40 and larger)
- Two-stage rotary vane pump with ball valve for pre-evacuating and heat-treating in a vacuum to 10^{-2} mbar
- Turbo molecular pump with slide valve for pre-evacuation and for heat treatment in a vacuum to 10^{-5} mbar including electric pressure transducer and booster pump (only VHT.../MO)
- Other pumps on request
- Heat exchanger with closed-loop cooling water circuit
- Automation package with graphic touch panel H 3700
  - 12" graphic touch panel H 3700
  - Input of all process data like temperatures, heating rates, gas injection, vacuum at the touch panel
  - Display of all process-relevant data on a process control diagram
  - Automatic gas supply for one process gas (N_2, argon or forming gas) with adjustable flow
  - Bypass for flooding and filling the chamber with process gas controlled by the program
  - Automatic pre- and post programs, including leak test for safe furnace operation
  - Automatic gas outlet with bellows valve and overflow valve (20 mbar)
  - Transducer for absolute and relative pressure
- MFC flow controller for alternating volume flow and generation of gas mixtures with second process gas (only with automation package)
- Partial pressure operation: protective gas flushing at controlled underpressure (only with automation package)
- PC control via NCC with corresponding optional documentation and connection to customer PC networks

Graphite heating chamber

Molybdenum heating chamber

Tungsten heating chamber

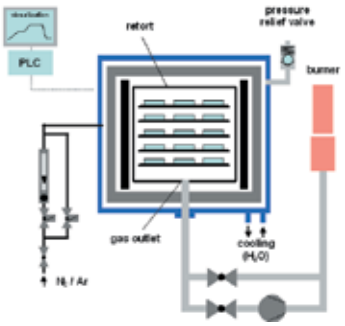
Ceramic fiber insulation

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

VHT 40/16MO H_2

VHT 40/22 GR with motor-driven lift door and front frame for connection to a glove box

Turbo-molecular pump



VHT gas supply diagram, debinding and sintering

H_2 Version for Operation with Hydrogen or other Reaction Gases

In the H_2 version the 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 furnaces are controlled by a fail-safe PLC control system (S7-300F/safety controller).

- Certified safety concept
- Automation package (see additional equipment above)
- Redundant gas inlet valves for hydrogen
- Monitored pre-pressures of all process gases
- Bypass for safe purging of furnace chamber with inert gas
- Pressure-monitored emergency flooding with automated solenoid valve opening
- Electric or gas-heated exhaust gas torch for H_2 post-combustion
- Atmospheric operation: H_2-purging of process reactor starting from room temperature at controlled over pressure (50 mbar relative)

Additional equipment

- Partial pressure operation: H_2 flushing at underpressure in the process reactor starting from 750 °C furnace chamber temperature
- Retort in the process chamber for debinding under hydrogen

Single-stage rotary vane pump for heat treatment in a rough vacuum to 20 mbar

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

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

Process Box for Debinding in Inert Gas

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

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

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

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

VHT 8/16 MO with hydrogen extension package and process box

	VHT ...-../GR	VHT ...-../MO	VHT ...-18/W	VHT ...-18/KE
Tmax	1800 °C or 2200 °C	1200 °C or 1600 °C	1800 °C	1800 °C
Inert gas	✓	✓	✓	✓
Air/Oxygen	up to 350 °C	-	-	✓
Hydrogen	✓[3]	✓[3]	✓[3]	✓[1,3]
Rough vacuum and fine vacuum (>10^{-3} mbar)	✓	✓	✓	✓[2]
High vacuum (<10^{-3} mbar)	-	✓	✓	✓[2]
Material of heater	Graphite	Molybdenum	Tungsten	$MoSi_2$
Material of insulation	Graphite felt	Molybdenum	Tungsten/Molybdenum	Ceramic fiber

[1]Up to 1400 °C
[2]Depending on Tmax
[3]Only with safety package for flammable gases

Model	Inner dimensions of process box in mm			Volume
	w	d	h	in l
VHT 8/..	120	210	150	3,5
VHT 40/..	250	430	250	25,0
VHT 70/..	325	475	325	50,0
VHT 100/..	425	500	425	90,0
VHT 250/..	575	700	575	230,0
VHT 500/..	725	850	725	445,0

Model	Inner dimensions in mm			Volume	Max. charge	Outer dimensions in mm			Heating power in kW[4]			
	w	d	h	in l	weight/kg	W	D	H	Graphite	Molybdenum	Tungsten	Ceramic fiber
VHT 8/..	170	240	200	8	5	1250 (800)[1]	1100	2000	27	19/34[3]	50	12
VHT 40/..	300	450	300	40	30	1600	2100	2300	83/103[2]	54/100[3]	134	30
VHT 70/..	375	500	375	70	50	1700	2500	2400	105/125[2]	70/130[3]	160	55
VHT 100/..	450	550	450	100	75	1900	2600	2500	131/155[2]	90/165[3]	210	85
VHT 250/..	600	750	600	250	175	2300	2800	2800	180/210[2]	125/220[3]	on request	on request
VHT 500/..	750	900	750	500	350	2500	3200	3000	220/260[2]	on request	on request	on request

[1]With the switching system unit removed
[2]1800 °C/2200 °C
[3]1200 °C/1600 °C
[4]Depending on furnace design connected load might be higher

Pit-Type Cold-Wall Retort Furnaces up to 2400 °C or up to 3000 °C

SVHT 9/24-W with tungsten heating

SVHT 2/24-W - SVHT 9/30-GR

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

- Standard sizes with a furnace chamber of 2 or 9 liters
- Designed as pit-type furnace, charged from above
- Frame construction with inserted sheets of textured stainless steel
- 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 furnace for an ergonomic charging height
- Retort lid with gas-charged shock absorbers
- Controls and switchgear as well as gas supply integrated in furnace housing
- Further standard product characteristics see description for standard design of VHT models page 48

Cylindrical retort with tungsten heating

Graphite heating module

Water-cooling controls

Heating Options

SVHT ..-GR

- Applicable for processes:
  - under protective or reaction gases or in the vacuum up to 2200 °C
  - under inert gases (argon, helium) up to 3000 °C
- Max. vacuum up to 10^{-3} mbar depending on the type of pump used
- Heating: graphite heating elements in cylindrical arrangement
- Insulation: graphite felt insulation
- Temperature measurement by means of an optical pyrometer

SVHT ..-W

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

Additional equipment such as automatic process gas control or design for the operation with flammable gases incl. safety system see VHT models page 48.

Model	Tmax	Work space dimensions	Useful volume	Outer dimensions in mm			Heating power	Electrical
	°C	Ø x h in mm	in l	W	D	H	in kW[1]	connection*
SVHT 2/24-W	2400	150 x 150	2,5	1400	2500	2100	55	3-phase
SVHT 9/24-W	2400	230 x 230	9,5	1500	2750	2100	95	3-phase
SVHT 2/30-GR	3000	150 x 150	2,5	1400	2500	2100	55	3-phase
SVHT 9/30-GR	3000	230 x 230	9,5	1500	2750	2100	95	3-phase

[1]Depending on furnace design connected load might be higher

*Please see page 80 for more information about supply voltage

Lift-Bottom-Retort Furnace up to 2400 °C for Production

LBVHT 250/20-W with tungsten heating chamber

LBVHT 600/24-GR

LBVHT 100/16 - LBVHT 600/24

The LBVHT model series with lift-bottom specification are especially suitable for production processes which require either protective or reaction gase atmosphere or a vacuum. The basic performance specifications of these models are similar to the VHT models. Their size and design with electro-hydraulically driven table facilitate charging during production. The furnaces are available in various sizes and designs. Similar like the VHT models, these furnaces can be equipped with different heating concepts.

- Standard furnace sizes between 100 and 600 liters
- Designed as lift-bottom retort furnace with electro-hydraulically driven table for easy and well-arranged charging
- Prepared to carry heavy charge weights
- Different heating concepts using
  - Graphite heating chamber up to Tmax 2400 °C
  - Molybdenum heating chamber up to Tmax 1600 °C
  - Tungsten heating chamber up to Tmax 2000 °C
- Frame structure filled with textured stainless steel sheets
- Standard design with gassing system for non-flammable protective or reaction gases
- Automatic gas supply system which also allows for operation with several process gases as additional equipment
- Gas supply systems for operating with hydrogen or other combustible reaction gases incl. safety package as additional equipment
- Switchgear and control box as well as gassing system integrated into the furnace housing
- Further product characteristics of the standard furnace as well as possible additional equipment can be found in the description of the VHT furnaces from Page 48

LBVHT with graphite heating chamber

Model	Tmax °C	Model	Tmax °C	Model	Tmax °C	Inner dimensions in mm Ø	h	Volume in l	Electrical connection*
LBVHT 100/16-MO	1600	LBVHT 100/20-W	2000	LBVHT 100/24-GR	2400	450	700	100	3-phase
LBVHT 250/16-MO	1600	LBVHT 250/20-W	2000	LBVHT 250/24-GR	2400	600	900	250	3-phase
LBVHT 600/16-MO	1600	LBVHT 600/20-W	2000	LBVHT 600/24-GR	2400	800	1200	600	3-phase

*Please see page 80 for more information about supply voltage

Chamber Retort Furnaces for Catalytic Debinding also as Combi Furnaces for Catalytic or Thermal Debinding

NRA 40/02 with cupboard for the acid pump

NRA 40/02 CDB and NRA 150/02 CDB

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

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

- Process retort made of acid-resistant stainless steel 1.4571 with large swiveling door
- Four-side heating inside the retort through chromium steel tube heating elements for good temperature uniformity
- Horizontal gas circulation for uniform distribution of the process atmosphere
- Acid pump and acid vessel (to be provided by the customer) accommodated in the furnace frame
- Gas-fired exhaust gas torch with flame monitoring
- Extensive safety package with redundantly operating safety PLC for safe operation with nitric acid
- Large, graphic touch panel H 3700 for entering data and for process visualization

Acid pump for nitric acid

Version NRA 40/02 CDB
- Tmax 200 °C
- Gas supply system with fixed values

Additional version NRA 150/02 CDB
- Automatic gas supply system for nitrogen with mass flow controller
- Adjustable acid volume and correspondingly adjusted gas spply volumes

Version NRS .. CTDB
- Safety package for thermal, inert debinding see page 46
- Availabel for 600 °C and 900 °C with atmosphere circulation

Process chamber with internal heating

Additional equipment
- Scale for the nitric acid vessel, connected to the PLC monitors the acid consumption and visualizes the fill level of the acid vessel (NRA 150/02 CDB)
- NCC software package for visualization, control and charge documentation of the process
- Automatic gas supply system for nitrogen with mass flow controller (NRA 40/02 CDB)
- Adjustable acid volume and correspondingly adjusted gas spply volumes (NRA 40/02 CDB)
- Lift truck for easy loading of the furnace
- Cupboard for acid pump
- Emergency tank for flushing in case of a failure

Model	Tmax	Inner dimensions in mm			Volume	Outer dimensions in mm			Heating power in	Electrical	Weight	Acidic quantity	Nitrogen
	°C	w	d	h	in l	W	D	H	kW[2]	connection*	in kg	(HNO_3)	(N_2)
NRA 40/02 CDB	200	300	450	300	40	1100	1250	2450	5	3-phase[1]	800	max. 70 ml/h	1000 l/h
NRA 150/02 CDB	200	450	700	450	150	1650	1960	2850	23	3-phase[1]	1650	max. 180 ml/h	max. 4000 l/h

[1]Heating only between two phases

[2]Depending on furnace design connected load might be higher

*Please see page 80 for more information about supply voltage

Fast-Firing Furnaces

LS 12/13 and LS 25/13

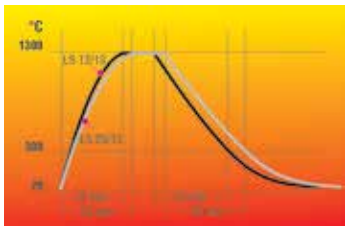
These models are ideal for simulation of typical fast-firing processes up to a maximum firing temperature of 1300 °C. The combination of high performance, low thermal mass and powerful cooling fans provides for cycle times from cold to cold of under 35 minutes.

- 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 20 mm for faster cooling without activating the fan
- Thermocouple PtRh-Pt, type S for top and bottom zone
- Castors for easy furnace moving
- Controls description see page 80

LS 12/13

Model	Tmax	Inner dimensions in mm			Volume	Outer dimensions in mm			Heating power in	Electrical	Weight
	°C	w	d	h	in l	W	D	H	kW[1]	connection*	in kg
LS 12/13	1300	350	350	40	12	600	800	985	15	3-phase	130
LS 25/13	1300	500	500	100	25	750	985	1150	22	3-phase	160

[1]Depending on furnace design connected load might be higher *Please see page 80 for more information about supply voltage



Firing curves LS 12/13 and LS 25/13

Gradient or Lab Strand Annealing Furnaces

GR 1300/13

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 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 strand furnace with a second door on the opposite side. Other available additional equipment consists of fiber chamber separators dividing the furnace chamber into six equally sized chambers. Charging then occurs from above by opening the large lid.

GR 1300/13

- 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
- Controls description see page 80

Additional equipment

- Up to ten control zones
- Fiber separators dividing the chamber in six equally sized chambers
- Second parallel swivel door for use as strand furnace
- Vertical instead of horizontal strand furnace

Furnace chamber of the GR 1300/13 with second door as additional equipment

Model	Tmax	Inner dimensions in mm			Outer dimensions in mm			Heating power in	Electrical	Weight
	°C	w	d	h	W	D	H	kW[1]	connection*	in kg
GR 1300/13	1300	1300	100	60	1660	740	1345	18	3-phase	300

[1]Depending on furnace design connected load might be higher *Please see page 80 for more information about supply voltage

Professional Chamber Furnaces with Brick Insulation or Fiber Insulation

LH 15/12 with brick insulation

LH 120/12SW with scale to measure weight reduction during annealing

Cooling fan in combination with motor-driven exhaust air flap to reduce cooling time

LH 15/12 - LF 120/14

The LH 15/12 - LF 120/14 laboratory furnaces 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 models can be optimally adapted to your processes.

- Tmax 1200 °C, 1300 °C, or 1400 °C
- Five-sided heating for very good temperature uniformity
- Heating elements on support tubes ensure free heat radiation and a long service life
- Protection of bottom heating and flat stacking surface provided by embedded SiC plate in the floor
- LH models: multi-layered, fiber-free insulation of light refractory bricks and special backup insulation
- LF models: high-quality fiber insulation with corner bricks for shorter heating and cooling times
- Door with brick-on-brick seal, hand fitted
- Short heating times due to high installed power
- Side vent with bypass connection for exhaust pipe
- Self-supporting arch for high stability and greatest possible protection against dust
- Quick lock on door
- Freely adjustable air slide intake in furnace floor
- Stand included
- Controls description see page 80

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

LH 120/12S process box made of quartz glass

LH 216/12SW with scale to measure weight reduction during annealing

- Motor driven exhaust air flap
- Cooling fan for shorter cycle times
- Protective gas connection for purging the furnace with non-flammable protective or reaction gases
- Process box made of quartz glass for very clean atmosphere, quartz glass covered door with lid function
- Manual or automatic gas supply system
- Scale to measure weight reduction during annealing

LH 60/12 with manual lift door and gas supply box for non-flammable protective or reactive gases

Model	Tmax	Inner dimensions in mm			Volume	Outer dimensions in mm			Heating power in	Electrical	Weight
	°C	w	d	h	in l	W	D	H	kW[2]	connection*	in kg
LH 15/12	1200	250	250	250	15	570	790	1170	5.0	3-phase[1]	150
LH 30/12	1200	320	320	320	30	640	860	1240	7.0	3-phase[1]	170
LH 60/12	1200	400	400	400	60	720	1010	1320	8.0	3-phase	260
LH 120/12	1200	500	500	500	120	820	1110	1420	12.0	3-phase	340
LH 216/12	1200	600	600	600	216	900	1210	1530	20.0	3-phase	400
LH 15/13	1300	250	250	250	15	570	790	1170	7.0	3-phase[1]	150
LH 30/13	1300	320	320	320	30	640	860	1240	8.0	3-phase[1]	170
LH 60/13	1300	400	400	400	60	720	1010	1320	11.0	3-phase	260
LH 120/13	1300	500	500	500	120	820	1110	1420	15.0	3-phase	340
LH 216/13	1300	600	600	600	216	900	1210	1530	22.0	3-phase	400
LH 15/14	1400	250	250	250	15	570	790	1170	8.0	3-phase[1]	150
LH 30/14	1400	320	320	320	30	640	860	1240	10.0	3-phase[1]	170
LH 60/14	1400	400	400	400	60	720	1010	1320	12.0	3-phase	260
LH 120/14	1400	500	500	500	120	820	1110	1420	18.0	3-phase	340
LH 216/14	1400	600	600	600	216	900	1210	1530	26.0	3-phase	400
LF 15/13	1300	250	250	250	15	570	790	1170	7.0	3-phase[1]	130
LF 30/13	1300	320	320	320	30	640	860	1240	8.0	3-phase[1]	150
LF 60/13	1300	400	400	400	60	720	1010	1320	11.0	3-phase	230
LF 120/13	1300	500	500	500	120	820	1110	1420	15.0	3-phase	300
LF 15/14	1400	250	250	250	15	570	790	1170	8.0	3-phase[1]	130
LF 30/14	1400	320	320	320	30	640	860	1240	10.0	3-phase[1]	150
LF 60/14	1400	400	400	400	60	720	1010	1320	12.0	3-phase	230
LF 120/14	1400	500	500	500	120	820	1110	1420	18.0	3-phase	300

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

*Please see page 80 for more information about supply voltage

Parallel swinging door for opening when hot

Gas supply system

High-Temperature Chamber Furnaces with SiC Rod Heating

HTC 08/15

HTCT 01/16

HTCT 03/14 - HTCT 08/16

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 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.

Furnace chamber with high-quality fiber materials and SiC heating rods on both sides of the furnace

- Tmax 1400 °C, 1500 °C, 1550 °C or 1600 °C
- Working Temperature 1500 °C (for models HTC ../16), increased wear and tear of heating elements must be expected in case of working at higher temperatures
- Model HTCT 01/16 with single phase connection
- High-quality fiber material, selected for the working temperature
- Housing made of sheets of textured stainless steel
- Dual shell housing for low external temperatures and high stability
- Optional flap door (HTC) which can be used as work platform or lift door (HTCT) with hot surface facing away from the operator (HTCT 01/16 only with lift door)
- Switching system with solid-state-relays, power tuned to the SiC rods
- Easy replacement of heating rods
- Controls description see page 80

Additional equipment

- Over-temperature limit controller with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the oven and load
- Square saggar for charging of up to three layers
- Lid for top saggar
- Manual or automatic gas supply system
- Adjustable air intake opening in the furnace door, exhaust air opening in the roof

Saggars with top lid

Over-temperature limit controller

Model	Tmax	Inner dimensions in mm			Volume	Outer dimensions in mm			Heating power in	Electrical	Weight	Minutes
	°C	w	d	h	in l	W	D	H[2]	kW[4]	connection*	in kg	to Tmax[3]
HTC, HTCT 03/14	1400	120	210	120	3.0	400	535	530	9.0	3-phase[1]	30	40
HTC, HTCT 08/14	1400	170	290	170	8.0	450	620	570	13.0	3-phase	40	40
HTC, HTCT 03/15	1500	120	210	120	3.0	400	535	530	9.0	3-phase[1]	30	50
HTC, HTCT 08/15	1500	170	290	170	8.0	450	620	570	13.0	3-phase	40	50
HTCT 01/16	1550	110	120	120	1.5	340	300	460	3.5	single-phase	18	40
HTC, HTCT 03/16	1600	120	210	120	3.0	400	535	530	9.0	3-phase[1]	30	60
HTC, HTCT 08/16	1600	170	290	170	8.0	450	620	570	13.0	3-phase	40	60

[1]Heating only between two phases
[2]Plus maximum 270 mm for models HTCT when open
[4]Depending on furnace design connected load might be higher

*Please see page 80 for more information about supply voltage
[3]If connected at 230 V 1/N/PE rsp. 400 V 3/N/PE

High-Temperature Chamber Furnaces with $MoSi_2$ Heating Elements as Table-Top Model

LHT 08/17

LHT 02/18 with gas supply system for four gases

LHT 02/16 - LHT 08/18

Designed as tabletop models, these compact high-temperature chamber 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 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
- Furnace chamber lined with first-class, durable fiber material
- Housing made of sheets of textured stainless steel
- Dual shell housing with additional fan cooling for low surface temperature
- Furnace sizes of 2, 4, or 8 liters
- Compact design with lift-door, opening upwards
- Adjustable air inlet
- Exhaust air opening in the roof
- Type B thermocouple
- Switching system with phase-angle firing thyristors (SCRs)
- Controls description see page 80

Additional equipment

- Over-temperature limit controller with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the oven and load
- Square saggar for charging of up to three layers
- Process control and documentation with Controltherm MV software package see page 83
- Protective gas connection for purging the furnace with non-flammable protective or reaction gases
- Manual or automatic gas supply system

Model	Tmax	Inner dimensions in mm			Volume	Outer dimensions in mm			Heating power in	Electrical	Weight	Minutes
	°C	w	d	h	in l	W	D	H[3]	kW[4]	connection*	in kg	to Tmax[2]
LHT 02/16	1600	90	150	150	2	470	700	750+350	3.0	single-phase	75	30
LHT 04/16	1600	150	150	150	4	470	700	750+350	5.2	3-phase[1]	85	25
LHT 08/16	1600	150	300	150	8	470	850	750+350	8.0	3-phase[1]	100	25
LHT 02/17	1750	90	150	150	2	470	700	750+350	3.0	single-phase	75	60
LHT 04/17	1750	150	150	150	4	470	700	750+350	5.2	3-phase[1]	85	40
LHT 08/17	1750	150	300	150	8	470	850	750+350	8.0	3-phase[1]	100	40
LHT 02/18	1800	90	150	150	2	470	700	750+350	3.6	single-phase	75	75
LHT 04/18	1800	150	150	150	4	470	700	750+350	5.2	3-phase[1]	85	60
LHT 08/18	1800	150	300	150	8	470	850	750+350	9.0	3-phase[1]	100	60

[1]Heating only between two phases
[2]If connected at 230 V 1/N/PE rsp. 400 V 3/N/PE
[4]Depending on furnace design connected load might be higher
*Please see page 80 for more information about supply voltage
[3]Including opened lift door

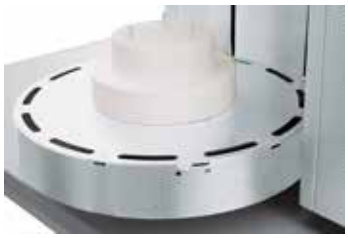
Saggars with top lid

Over-temperature limit controller

High-Temperature Lift-Bottom Furnaces

LHT 02/17 LB with a set of saggars

LHT 16/17 LB



Electrically driven lift-bottom

Saggar

LHT/LB

The electrically driven lift-bottom considerably allows for proper charging of the LHT/LB furnaces. The heating all around the cylindrical furnace chamber provides for an opitimal temperature uniformity. For model 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 model LHT 16/17 LB can also be used for applications in production.

- Tmax 1700 °C
- High-quality molybdenum disilicide heating elements
- Furnace chamber lined with first-class, durable fiber materials
- Outstanding temperature uniformity due to all-round furnace chamber heating
- Furnace chamber with a volume of 2 or 16 liters, table with large footprint
- Spacers to lift-up the saggars already installed in the table
- Precise, electric spindle drive with push button operation
- Housing made of sheets of textured stainless steel
- Exhaust air vent in the roof
- Type S thermocouple
- Switchgear with thyristor
- Controls description see page 80

Additional equipment

- Over-temperature limiter with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Saggar for charging of up to three layers
- Protective gas connection for purging the furnace with non-flammable protective or reaction gases
- Manual or automatic gas supply system
- Adjustable air inlet through the floor
- Process control and documentation with Controltherm MV software package see page 83

Model	Tmax	Inner dimensions in mm		Volume	Outer dimensions in mm			Heating power in	Electrical	Weight
	°C	Ø	h	in l	W	D	H	kW[1]	connection*	in kg
LHT 02/17 LB	1700	Ø 120	130	2	540	610	740	3.3	single-phase	85
LHT 16/17 LB	1700	Ø 260	260	16	650	1250	1980	12.0	3-phase	410

[1]Depending on furnace design connected load might be higher

*Please see page 80 for more information about supply voltage

High-Temperature Furnaces with Scale for Determination of Combustion Loss and Thermogravimetric Analyses (TGA)

LHT 04/16 SW with scale for measuring weight reduction during annealing and with gas supply system

LHT 04/16 SW and LHT 04/17 SW

These 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.

- Technical description of the furnaces: see models LHT 04/16 and LHT 04/17 see page 59

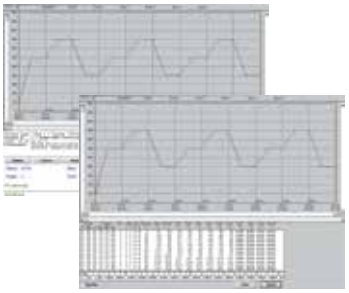
Model	Tmax	Inner dimensions in mm			Volume	Outer dimensions in mm			Heating power in	Electrical	Weight	Minutes
	°C	w	d	h	in l	W	D	H	kW[3]	connection*	in kg	to Tmax[2]
LHT 04/16 SW	1600	150	150	150	4	655	370	890	5.0	3-phase[1]	85	25
LHT 04/17 SW	1750	150	150	150	4	655	370	890	5.0	3-phase[1]	85	40

[1]Heating only between two phases

[2]If connected at 230 V 1/N/PE rsp. 400 V 3/N/PE

*Please see page 80 for more information about supply voltage

[3]Depending on furnace design connected load might be higher



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

Compact Tube Furnaces

RD 30/200/11

RD 30/200/11 - RD 30/200/13

The RD product line 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 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.

Over-temperature limiter

- Tmax 1100 °C or 1300 °C
- Housing made of sheets of textured stainless steel
- 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
- Controls description see page 80

Additional equipment

- Over-temperature limiter with adjustable shut-off temperature for thermal protection class 2 according to EN 60519-2 as over-temperature protection for furnace and load
- Gas supply system for non-flammable protective or reactive gas

Model	Tmax °C [1]	Outer dimensions in mm B	T	H	Inner tube Ø mm	Heated length/mm	Length constant temperature ΔT 10 K in mm	Connected load kW	Minutes to Tmax[2]	Electrical connection*	Weight in kg
RD 30/200/11	1100	350	200	350	30	200	65	1.5	20	1-phase	12
RD 30/200/13	1300	350	200	350	30	200	65	1.5	25	1-phase	12

[1]Tmax. is reached outside the tube. Realistic working temperature inside the tube is approx. 50 °C lower.

[2]If connected at 230 V 1/N/PE rsp. 400 V 3/N/PE

*Please see page 80 for more information about supply voltage

R 50/250/12

R 100/750/13

R 50/250/12 - R 120/1000/13

These compact tabletop 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 furnaces have an unbeatable price/performance ratio.

R 50/250/13 with gas supply system 2

- Tmax 1200 °C or 1300 °C
- Housing made of sheets of textured stainless steel
- Outer tube diameter of 50 to 120 mm, heated length from 250 to 1000 mm
- Working tube of C 530 ceramic including two fiber plugs as standard equipment
- Type S thermocouple
- Solid state relays provide for lownoise operation
- Controls description see page 80

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 75
- Three-zoned design with HiProSystem control (heated length from 750 mm, for 1300 °C models)
- Please see page 75 for additional equipment
- Alternative gas supply systems for protective gas or vacuum operation see page 76
- Process control and documentation with Controltherm MV software package see page 83

Model	Tmax °C[3]	Outer dimensions in mm W	D	H	Outer tube Ø /mm	Heated length mm	Length constant temperature ΔT 10 K in mm	Tube length in mm	Connected load kW	Electrical connection*	Weight in kg
R 50/250/12	1200	400	240	490	50	250	80	450	1.2	1-phase	20
R 50/500/12	1200	650	240	490	50	500	170	700	1.8	1-phase	25
R 100/750/12	1200	1000	360	640	90	750	250	1070	3.6	1-phase	80
R 120/1000/12	1200	1300	420	730	120	1000	330	1400	6.0	3-phase[2]	170
R 50/250/13	1300	400	240	490	50	250	80	450	1.3	1-phase	35
R 50/500/13	1300	650	240	490	50	500	170	700	2.4	1-phase	48
R 100/750/13[1]	1300	1000	360	640	90	750	250	1070	4.4	3-phase[2]	120
R 120/1000/13[1]	1300	1300	420	730	120	1000	330	1400	6.5	3-phase[2]	230

[1]These models also available with three-zones
[2]Heating only between two phases
*Please see page 80 for more information about supply voltage
[3]Tmax. is reached outside the tube. Realistic working temperature inside the tube is approx. 50 °C lower.

Universal Tube Furnaces with Stand for Horizontal or Vertical Operation

RT 50-250/11 with gas supply system for nitrogen

RT 50-250/13

RT 50-250/11 - RT 30-200/15

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 furnaces suitable for integration into existing process systems.

- Tmax 1100 °C, 1300 °C, or 1500 °C
- Compact design
- 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 75 for additional equipment
- Controls description see page 80

Model	Tmax °C	Outer dimensions in mm W	D	H	Inner tube Ø /mm	Heated length mm	Length constant temperature ΔT 10 K in mm	Tube length in mm	Connected load kW	Electrical connection*	Weight in kg
RT 50-250/11	1100	350	380	740	50	250	80	360	1.8	1-phase	25
RT 50-250/13	1300	350	380	740	50	250	80	360	1.8	1-phase	25
RT 30-200/15	1500	445	475	740	30	200	70	360	1.8	1-phase	45

*Please see page 80 for more information about supply voltage

Universal High-Temperature Tube Furnaces with Silicon Carbide Rod Heating Gas Atmosphere or Vacuum

RHTC 80-230/15

RHTC 80-450/15 with manual gas supply system

RHTC 80-230/15 - RHTC 80-710/15

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
- Housing made of sheets of textured stainless steel
- High-quality fiber insulation
- 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
- Controls description see page 80

SiC rod heating

Additional equipment

- Over-temperature limiter with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect furnace and load
- Charge control with temperature measurement in the working tube and in the furnace chamber outside the tube see page 75
- 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 75

Model	Tmax °C[3]	Outer dimensions in mm W	D	H	Outer tube Ø /mm	Heated length/mm	Length constant temperature ΔT 10 K in mm	Tube length in mm	Connected load kW	Electrical connection*	Weight in kg
RHTC 80-230/15	1500	600	430	580	80	230	80	600	7.5	3-phase[2]	50
RHTC 80-450/15	1500	820	430	580	80	450	150	830	11.3	3-phase[1]	70
RHTC 80-710/15	1500	1070	430	580	80	710	235	1080	13.8	3-phase[1]	90

[1]Heating only between two phases
[2]Heating only between phase 1 and neutral
*Please see page 80 for more information about supply voltage
[3]Tmax. is reached outside the tube. Realistic working temperature inside the tube is approx. 50 °C lower.

High-Temperature Tube Furnaces for Horizontal and Vertical Operation up to 1800 °C Gas Atmosphere or Vacuum

RHTH 120/600/17

RHTH 120/150/.. - RHTH 120/600/.., RHTV 120/150/.. - RHTV 120/600/..

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.

Over-temperature limiter

- Tmax 1600 °C, 1700 °C, or 1800 °C
- $MoSi_2$ heating elements, mounted vertically for easy replacement
- Insulation with vacuum-formed ceramic fiber plates
- Rectangular outer housing with slots for convection cooling
- Models RHTV with hinges for wall mounting
- Housing made of sheets of textured stainless steel
- Ceramic working tube made of material C 799 incl. fiber plugs operation under air
- Type B thermocouple
- Power unit with low-voltage transformer and thyristor
- Over-temperature limiter with manual reset for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the oven and load and with selectable maximum temperature gradient as tube protection
- Switchgear and control unit separate from furnace in separate floor standing cabinet
- Controls description see page 80

RHTV 120/150/17 vertical tube furnace with stand and gas supply system 2 as additional equipment

Additional equipment

- Charge control with temperature measurement in the working tube and in the furnace chamber outside the tube see page 75
- 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 RHTH)
- Check valve at gas outlet avoids intrusion of false air
- Stand for vertical operation
- Please see page 75 for more additional equipment

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

RHTH 120/600/16 with upstream furnace RT 50-250/11 to preheat the process gas

Model	Tmax	Outer dimensions in mm			Max. outer tube Ø	Heated	Length constant temperature ΔT 10 K	Tube length	Connected	Electrical	Weight
Horizontal design	°C[3]	W[2]	D	H	/mm	length mm	in mm	in mm	load kW	connection*	in kg
RHTH 120/150/..	1600 or	470	550	640	50	150	50	380	5.4	3-phase[1]	70
RHTH 120/300/..	1700 or	620	550	640	80	300	100	530	9.0	3-phase[1]	90
RHTH 120/600/..	1800	920	550	640	120	600	200	830	14.4	3-phase[1]	110

Model	Tmax	Outer dimensions in mm			Max. outer tube Ø	Heated	Length constant temperature ΔT 10 K	Tube length	Connected	Electrical	Weight
Vertical design	°C[3]	W	D	H[2]	/mm	length mm	in mm	in mm	load kW	connection*	in kg
RHTV 120/150/..	1600 or	570	650	510	50	150	30	380	5.4	3-phase[1]	70
RHTV 120/300/..	1700 or	570	650	660	80	300	80	530	10.3	3-phase[1]	90
RHTV 120/600/..	1800	570	650	960	120	600	170	830	19.0	3-phase[1]	110

[1]Heating only between two phases
[2]Without tube
*Please see page 80 for more information about supply voltage
[3]Tmax. is reached outside the tube. Realistic working temperature inside the tube is approx. 50 °C lower.

Hinged Tube Furnaces for Horizontal or Vertical Operation up to 1300 °C
Gas Atmosphere or Vacuum

RS 80/500/11 with gas supply system 1

RS 80/750/13 with stand as additional equipment for vertical operation

Gas supply system for non-flammable protective or reactive gas with shutoff valve and flow meter with regulator valve, piped and ready to connect

RS 80/300/11 - RS 170/1000/13

The tube furnaces of the product line RS can be used for horizontal as well as for vertical operation. The hinged design makes it easy to change the working tube. It allows the different working tubes (e.g. working tubes made of different materials) to be comfortably taken out and put in.

Using the wide range of accessories these profi tube furnaces can be optimally configured for 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
- Housing made of sheets of textured stainless steel
- Tmax 1100 °C: Type K thermocouple
- Tmax 1300 °C: Type S thermocouple
- Frame for vertical operation, which can also be retrofitted as additional equipment
- Hinged design for simple insertion of the working tube

Model	Tmax	Outer dimensions[3] in mm			Max. outer tube Ø	Heated	Length constant temperature ΔT 10 K	Tube length	Connected	Electrical	Weight
	°C[5]	W[2]	D	H	/mm	length mm	in mm	in mm	load kW	connection*	in kg
RS 80/300/11	1100	555	475	390	80	300	100	650	1.8	1-phase	80
RS 80/500/11	1100	755	475	390	80	500	170	850	3.4	1-phase	90
RS 80/750/11	1100	1005	475	390	80	750	250	1100	4.6	3-phase[4]	105
RS 120/500/11	1100	755	525	440	120	500	170	850	4.8	3-phase[4]	95
RS 120/750/11	1100	1005	525	440	120	750	250	1100	6.3	3-phase[1]	110
RS 120/1000/11	1100	1255	525	440	120	1000	330	1350	9.0	3-phase[1]	125
RS 170/750/11	1100	1005	575	490	170	750	250	1100	7.0 [7]	3-phase[1]	115
RS 170/1000/11	1100	1255	575	490	170	1000	330	1350	9.0 [7]	3-phase[1]	130
RS 80/300/13	1300	555	475	390	80	300	100	650	3.6	1-phase	80
RS 80/500/13	1300	755	475	390	80	500	170	850	6.0	3-phase[1]	90
RS 80/750/13	1300	1005	475	390	80	750	250	1100	9.3	3-phase[1]	105
RS 120/500/13	1300	755	525	440	120	500	170	850	7.8	3-phase[1]	95
RS 120/750/13	1300	1005	525	440	120	750	250	1100	12.6	3-phase[1]	110
RS 120/1000/13	1300	1255	525	440	120	1000	330	1350	12.6	3-phase[1]	125
RS 170/750/13	1300	1005	575	490	170	750	250	1100	12.6	3-phase[1]	115
RS 170/1000/13	1300	1255	575	490	170	1000	330	1350	12.6	3-phase[1]	130

[1]Heating only between two phases
[2]Without tube
[3]Outer dimensions for vertical operation upon request
[4]Heating only between phase 1 and neutral
[5]Tmax. is reached outside the tube. Realistic working temperature inside the tube is approx. 50 °C lower.
[7]Only valid for single-zone version
*Please see page 80 for more information about supply voltage

RS 120/1000/13S with gas tight tube, charge control and check valve at gas outlet

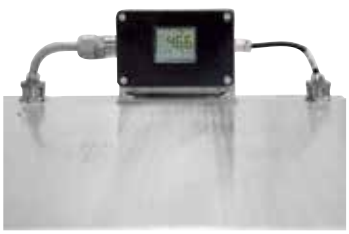
- Working tube made of ceramic C 530 for operation in air included in scope of delivery
- Switchgear and control unit separate from furnace in own wall or standing cabinet
- Controls description see page 80

Additional equipment

- Charge control with temperature measurement in the working tube and in the furnace chamber outside the tube see page 75
- Display of inner tube temperature with additional thermocouple
- Different gas supply systems (page 76) for non-flammable or flammable protective or reactive gases and vacuum operation
- Three-zone control for optimization of temperature uniformity
- Check valve at gas outlet avoids intrusion of false air
- Ceramic half pipe for heating elements and/or as support surface for the load
- Optical temperature measurement for the use as contiuously working furnace
- Stand for vertical operation
- Base frame with integrated switchgear and controller
- Please see page 75 for more additional equipment

Quartz glass and flanges for protective gas operation as optional equipment

RS 120/750/13 with gas supply system 4, hydrogen applications



Optical temperature measurement for the use as contiuously working furnace

Rotary Tube Furnaces for Continuous Processes and/or Batch Operation

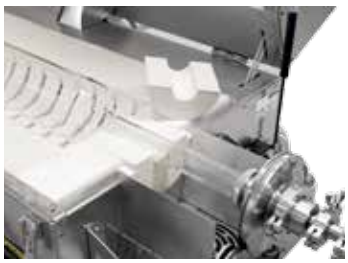
RSR 120/1000/13 for continuous operation

RSR-B 120/750/11 as tabletop version for batch operation

RSR 80-500/11 - RSR 120-1000/13, RSR-B 80-500/11 - RSR-B 120-1000/11

If, for example, the focus lies on maintaining the individual grain characteristics of the material such as in drying or calcination, rotary tube furnaces of the RSR product line are the optimal solution. The permanently rotating working tube allows for the continuous movement of the charge.

In general, these models can be used for continuous processing and/or batch operation. While during a continuous process the charge is transported uniformly from one end to the other of the working tube, during batch operation, it can be heated-treated over a longer period in the furnace chamber thanks to the special shape of the quartz glass reactor (tapered tube ends).



Adapters for alternative operation with working tube or process reactor

The compact furnaces of the RSR-B product line are perfectly suited for batch operation. The versatile RSR furnaces can be equipped both with working tubes for continuous operation as well as with reactors for batch operation.

Depending on the process, charge and the required maximum temperature, various working tubes made of quartz glass, ceramic or metal can be used (see page 42). Depending on the application these models can be upgraded by adding suitable accessories such as filling funnels, electric feed screw for feeding material or gas supply systems for small production furnaces. Operation can take place in air, in non-flammable protective or reactive gases, or in a vacuum. The necessary equipment is available as additional equipment.

Standard design of all models

- Housing made of sheets of textured stainless steel
- Beltless drive and hinged furnace housing provide for very easy removal of working tube or reactor
- Adjustable drive of approx. 2-45 rpm
- Controls description see page 60

Connection set for vacuum operation

RSR 80/750/13 with charging funnel and collection bottle at the outlet

Additional equipment for all models

- Different tube diameters or heated lengths
- Manual or automatic gas supply systems
- Gas tight rotary device for the connection to gas supply systems
- Check valve at gas outlet avoids intrusion of false air
- 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

Standard design for batch operation

- Tmax 1100 °C
- Thermocouple type K
- Furnace designed as table-top model with quartz glass reactor which opens on both sides, tapered ends
- Reactor is removed from the furnace for discharging
- Switchgear and control unit separate from furnace in own wall or standing cabinet

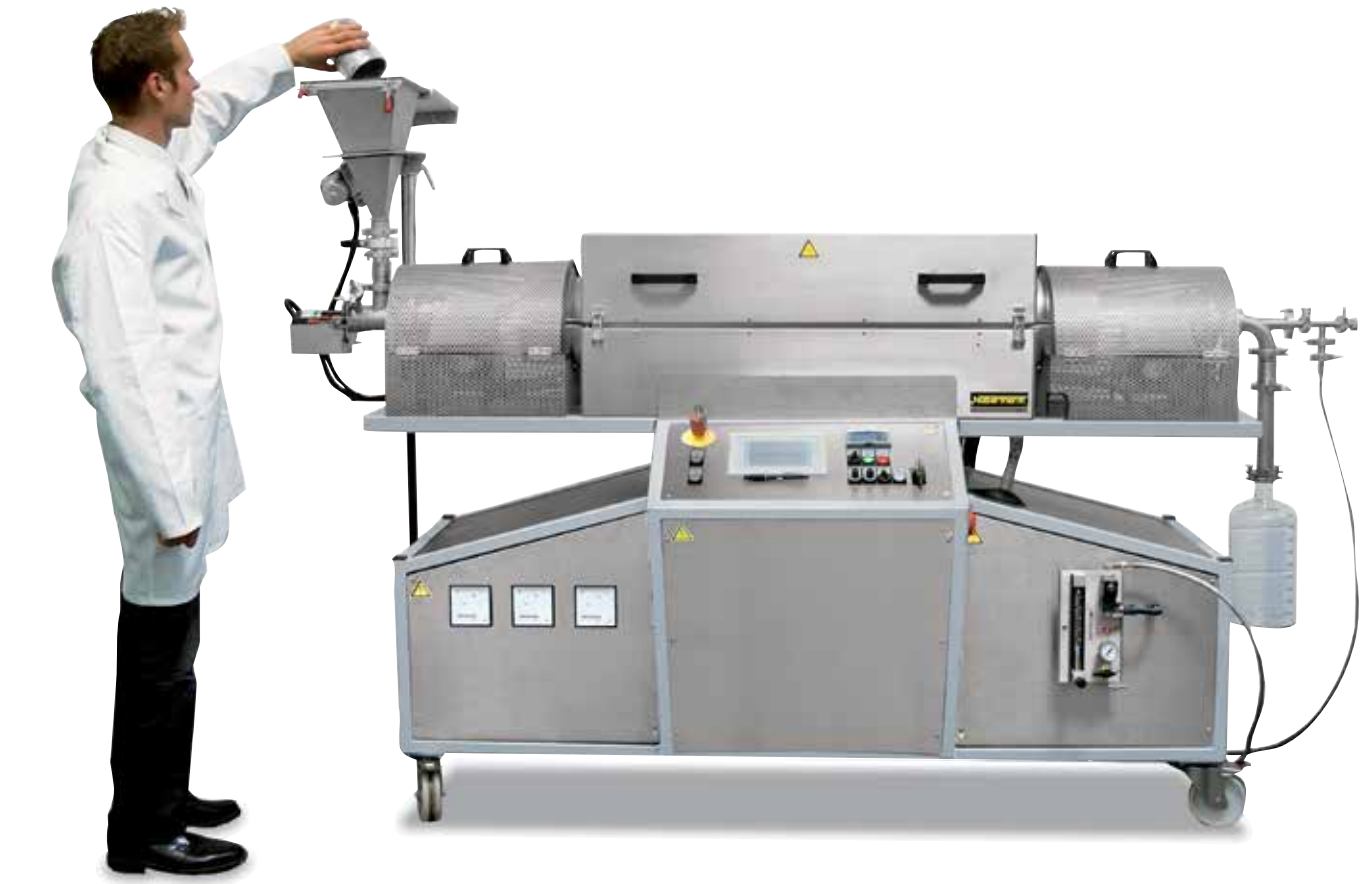
Additional equipment for batch operation

- Different gas supply systems
- Vacuum design, up to 10^{-2} mbar depending on the applied pump
- Reactor made of quartz glass, open at both sides, with burling for better conveyance of the charge in the tube
- Information on the different working tubes see page 39
- Package for improved charging and discharging of the working tube in the following design:
  - Single-side closed mixing reactor made of quartz glass with an integrated blade for improved blending of the charge
  - 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 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.
  - Furnace assembled on base with integrated switchgear and controller, incl. transport casters
- Digital display for the tilting angle of the furnace

Screw-conveyor with adjustable speed

Screw-conveyors with different pitches for the adaption to the charge

Vibration generator at the charging funnel for improved powder supply



RSR 120/750/11 S with electrically adjustable tilting angle for continuous processes or batch operation

Standard design for continuous processes

- Tmax 1100 °C
  - Thermocouple type K
  - Working tube made of quartz glass open at both sides
- Tmax 1300 °C
  - Thermocouple type S
  - Working tube made of C530 ceramics, open at both sides, not gas tight
- Compact design with switchgear and controller, mounted in the base, including transport casters
- Furnace mounted on base, including manual spindle drive with crank for pre-adjustment of the tilting angle

RSR 120/500/11 S with reactor closed at one side for batch operation

Additional equipment for continuous processes

- Working tube made of quartz glass with burling for optimized mixing of the charge up to Tmax 1100 °C
- Gas tight working tube made of C610 ceramics up to Tmax 1300 °C
- Information on the different working tubes see page 39
- Higher temperatures up to 1600 °C available on request
- Different gas supply systems with good process gas circulation around the charge thanks to an inlet on one tube side and outlet on the other side (only together with the charging system, see below)
- Charging system for continuous material transport, consisting of:
  - Charging funnel made of stainless steel with lockable powder outlet
  - Electric vibration generator at the charging funnel for the optimization of material supply into the working tube as additional option
  - 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 a gas atmosphere or in a vacuum
- Digital display unit for the tilting angle of the furnace
- Electric linear drive for the adjustment of the tilting angle
- Alternating design for continuous processes or batch operation. The furnace can be tilted on the frame towards both sides. The customer can mount a working tube open at both sides for flow processes as well as a process reactor (Tmax 1100 °C) closed at one side for batch operation.
- 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.

Gas tight closing plug for tubes made of silica glass closed at one side

Model Rotary tube furnace	Tmax °C[3]	Outer dimensions in mm W	D	H	Length constant Temperature ΔT 10 K in mm	Tube dimensions in mm Total length	Length working zone[5]	Ø Outer	Ø Terminal end[5]	Connected load kW	Electrical connection*	Weight in kg
Batch operation												
RSR-B 80-500/11	1100	1145[4]	475	390	170	1140	500	76	34	3.7	1-phase	555
RSR-B 80-750/11	1100	1395[4]	475	390	250	1390	750	76	34	4.9	3-phase[2]	570
RSR-B 120-500/11	1100	1145[4]	525	440	170	1140	500	106	34	5.1	3-phase[2]	585
RSR-B 120-750/11	1100	1395[4]	525	440	250	1390	750	106	34	6.6	3-phase[1]	600
RSR-B 120-1000/11	1100	1645[4]	525	440	330	1640	1000	106	34	9.3	3-phase[1]	605
Continuous operation												
RSR 80-500/11	1100	2505	1045	1655	170	1540	500	76	34	3.7	1-phase	555
RSR 80-750/11	1100	2755	1045	1655	250	1790	750	76	34	4.9	3-phase[2]	570
RSR 120-500/11	1100	2505	1045	1715	170	1540	500	106	34	5.1	3-phase[2]	585
RSR 120-750/11	1100	2755	1045	1715	250	1790	750	106	34	6.6	3-phase[1]	600
RSR 120-1000/11	1100	3005	1045	1715	330	2040	1000	106	34	9.3	3-phase[1]	605
RSR 80-500/13	1300	2505	1045	1655	170	1540	500	76	34	6.3	3-phase[1]	555
RSR 80-750/13	1300	2755	1045	1655	250	1790	750	76	34	9.6	3-phase[1]	570
RSR 120-500/13	1300	2505	1045	1715	170	1540	500	106	34	8.1	3-phase[1]	585
RSR 120-750/13	1300	2755	1045	1715	250	1790	750	106	34	12.9	3-phase[1]	600
RSR 120-1000/13	1300	3005	1045	1715	330	2040	1000	106	34	12.9	3-phase[1]	605

[1]Heating only between two phases
[2]Heating only between phase 1 and neutral
[3]Tmax is reached outside the tube. Realistic working temperature inside the tube is approx. 50 °C lower.
*Please see page 60 for more information about supply voltage
[4]Without tube
[5]Only for reactors

Tube Furnaces for Integration into Customized Systems

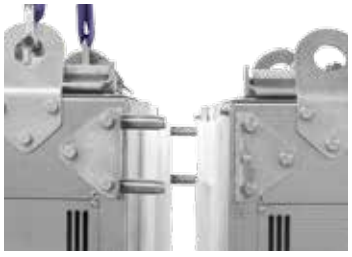
RS 120/1000/11S in divided version. Both half furnaces are manufactured identically and will be integrated in an extisting gas-heating system with space-saving design

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

Tube furnace with five-zone control for optimal temperature uniformity

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 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, lenghts and other properties of tube furnace systems – we will find the appropriate solution for a suitable process optimization.



Bolts for connection of two separated half furnaces

Working Tubes

Working tube closed at one end with gas tight flanges as additional equipment

Various working tubes as option

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:

Material	Tube outside Ø mm	Max. heat-up ramp K/h	Tmax in air* °C	Tmax in vacuum operation °C	Gas tight
C 530 (Sillimantin)	< 120	unlimited	1300	not possible	no
	from 120	200			
C 610 (Pytagoras)	< 120	300	1400	1200	yes
	from 120	200			
C 799 (99.7 % Al_2O_3)	< 120	300	1800	1400	yes
	from 120	200			
Quartz glass	all	unlimited	1100	950	yes
CrFeAl-Alloy	all	unlimited	1300	1100	yes

*The max. allowed temperature might be reduced operating under aggressive atmospheres

Working Tubes for Rotary Tube Furnaces: Standard (●) and Options (○)

Measurements outer Ø x inner Ø x length	Article No.[1] work tube	Article No.[1] spare tube	Rotary tube furnace, continuous operation RSR 1100 °C 80-500	80-750	120-500	120-750	120-1000	RSR 1300 °C 80-500	80-750	120-500	120-750	120-1000	Batch operation RSR-B 1100 °C 80-500	80-750	120-500	120-750	120-1000
Ceramic tube C 530																	
80 x 65 x1540 mm	601404699	691404536	○					●									
80 x 65 x 1790 mm	601404700	691404537		○		○			●		○						
80 x 65 x 2040 mm	601404701	691404538					○					○					
110 x 95 x 1540 mm	601404702	691404539			○					●							
110 x 95 x 1790 mm	601404703	691403376				○					●						
110 x 95 x 2040 mm	601404704	691404540					○					●					
Ceramic tube C 610																	
80 x 65 x1540 mm	601404705	691404541	○					○									
80 x 65 x 1790 mm	601404706	691404542		○		○			○		○						
80 x 65 x 2040 mm	601404707	691404543					○					○					
110 x 95 x 1540 mm	601404708	691404544			○					○							
110 x 95 x 1790 mm	601404709	691404561				○					○						
110 x 95 x 2040 mm	601404710	691403437					○					○					
Quartz glass tube																	
76 x 70 x 1540 mm	601404711	691404545	●					○		○							
76 x 70 x 1790 mm	601404712	691404546		●		○			○		○						
76 x 70 x 2040 mm	601404713	691404547					○					○					
106 x 100 x 1540 mm	601404714	691403519			●					○							
106 x 100 x 1790 mm	601404715	691403305				●					○						
106 x 100 x 2040 mm	601404716	691404548					●					○					
Quarz glass tube with pimple																	
76 x 70 x 1540 mm	601404717	691404549	○					○									
76 x 70 x 1790 mm	601404718	691404550		○		○			○		○						
76 x 70 x 2040 mm	601404719	691404551					○					○					
106 x 100 x 1540 mm	601404720	691404552			○					○							
106 x 100 x 1790 mm	601404721	691403442				○					○						
106 x 100 x 2040 mm	601404722	691404553					○					○					
Quartz glas reactor																	
76 x 70 x 1140 mm	601402746	691402548											●		○		
76 x 70 x 1390 mm	601402747	691402272												●		○	
106 x 100 x 1140 mm	601402748	691402629													●		
106 x 100 x 1390 mm	601402749	691402638														●	
Quartz glass reactor with pimples																	
76 x 70 x 1140 mm	601404723	691402804											○		○		
76 x 70 x 1390 mm	601404724	691403429												○		○	
106 x 100 x 1140 mm	601404725	691403355													○		
106 x 100 x 1390 mm	601404726	691403296														○	
Quarz glass mixing reactor																	
76 x 70 x 1140 mm	601404727	691403407											○				
76 x 70 x 1390 mm	601404728	691404554												○		○	
106 x 100 x 1140 mm	601404732	691404557													○		
106 x 100 x 1390 mm	601404733	691404558														○	

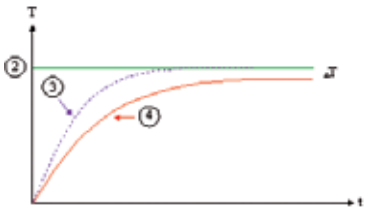
● Standard working tube
○ Working tube available as an option

[1]Tubes/reactors incl. mounted sleeves for connection to the rotary drive. Spare tubes come without sleeves.

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 ($\Delta T \leq 10$ K).

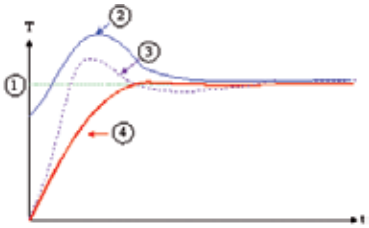
Furnace Chamber Control
with temperature measurement in furnace chamber outside the working tube.
- Advantages: Thermocouple protected against damage and aggressive load, very even control, attractive price
- Disadvantage: Process-dependent temperature difference between displayed temperature on the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



Furnace control

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



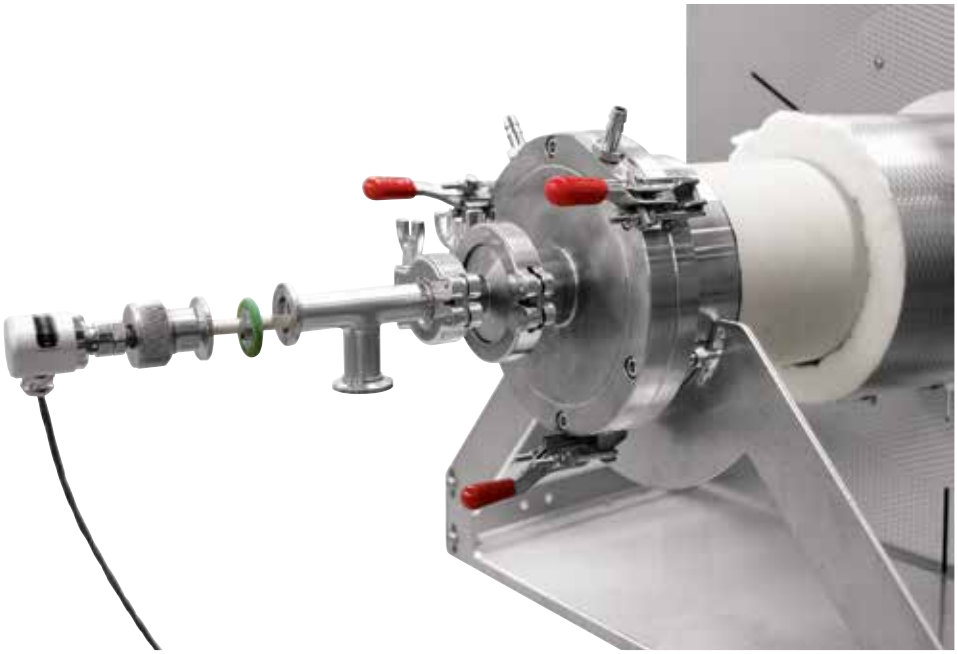
Charge control

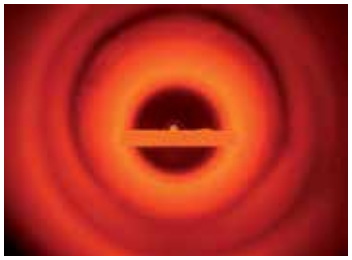
1. Charge setpoint value
2. Furnace setpoint value
3. Actual value furnace chamber
4. Actual value load/bath/muffle/retort

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.


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


Sintering under hydrogen in a tube furnace of RHTH product line

Gas Supply Systems/Vacuum Operation for Tube Furnaces RD, R, RT, RHTC, RHTH, RHTV, RS and RSR

Gas supply system 1:
Fiber plugs with protective gas connection, suitable for many laboratory applications

When equipped with various equipment packages, the tube furnace product lines RS, RHTC, RHTH, and RHTV 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 (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.

- Standard working tube can be used
- 2 plugs of ceramic fiber with protective gas connections
- Gas supply system for nonflammable protective gas (Ar, N_2, forming gas) with shutoff valve and flow meter with control valve (volume 50-500 l/hr), piped and ready to connect (gas intake pressure at 300 mbar to be provided by customer)

Water-cooled stainless steel flange

Additional equipment

- Extension of gas supply system with a second or third nonflammable type of gas
- Bottle pressure regulator for use with bottled gas
- Automatically controlled gas supply with solenoid valves on the gas supply system, which can be switched on and off through a controller with programmable extra functions (e.g. P 330)

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 standard working tube is replaced by a dense working tube of ceramic C 610 or C 799 in a gas tight design. Besides the longer working tube, the scope of delivery also includes gas tight flanges and a corresponding bracket system in the furnace. The system can also be equipped for vacuum operation.

Gas supply system for non-flammable protective or reactive gas with shutoff valve and flow meter with regulator valve, piped and ready to connect

- 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
- Gas supply system for nonflammable protective gas (Ar, N_2, forming gas) with shutoff valve and flow meter with control valve (volume 50-500 l/hr), gas outlet valve, piped and ready to connect (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
- Automatically controlled gas supply with solenoid valves on the gas supply system, which can be switched on and off through a controller with programmable extra functions (e.g. P 330)
- Water-cooled end flange with quick connectors
- Cooling unit for closed loop water circuit
- Window for charge observation in combination with gas tight flanges

Observation window as additional equipment for gas tight flanges

Vacuum Operation

- Vacuum package for evacuation of the working tube, consisting of connector for the gas outlet, 1 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 about 10^{-2} mbar
- Alternative pumps for max. final pressure of up to 10^{-5} mbar on request see page 77

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.

RHTH 120-600/18 with gas supply system 4 for hydrogen operation

- 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
- Longer, gas tight working tube
- 2 vacuum-tight, water-cooled stainless steel flanges (cooling water supply to be provided by customer via hose connector)
- 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)

Water-cooled end flange with quick connectors as additional equipment

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 50:

- 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^{-3} mbar or 10^{-9} mbar as additional equipment

Vacuum pump stand for operation up to 10^{-5} mbar

Independent pressure gauge for a pressure range of 10^{-3} mbar or 10^{-9} mbar

Information:

For protection of the vacuum pump only cold stage evacuation is allowed. The reduction of working tube strengthness limits the max. possible working temperature under vacuum see page 74.

Thermocouple Calibration Set

Thermocouple calibration set, consisting of calibrated temperature display, calibrated reference thermocouple and tube furnace

For heat treatment processes, continuous quality can only be ensured by the regular calibration of control or charge thermocouples. The calibration set can be used with every tube furnace which is equipped with heating transformer (models R../13, RS../13, RHTH, RHTV) for professional calibration of thermocouples.

The thermocouple calibration set is mounted in a compact housing and consists of a temperature display unit for two thermocouples, a reference thermocouple with compensation wire and a plug connection for different types of thermocouples. Both the display unit and the whole measuring circuit to the reference thermocouple are calibrated ex works and are supplied with a calibration certificate.

Calibrated thermocouples in various designs

The set is used with a tube furnace, e.g. model R 50/250/13. For calibration, the furnace is set for one temperature. From one side, the reference thermocouple is inserted into the working tube. From the other side, the thermocouple to be tested is positioned in the tube. The measuring points of both thermocouples must face as close as possible to each another. Depending on the furnace model, a ceramic temperature compensation block can be offered for the positioning of both thermocouples. After a defined period of time, the temperature of both thermocouples can be read off from the display unit of the thermocouple calibration set and be compared.

- Compact housing
- 1-phase connection see page 80
- Digital display unit for the test thermocouple and the reference thermocouple, with calibration certificate in steps of 100 °C
- Reference thermocouple, type N, with calibration certificate (for 3 temperatures)
- Thermocouple inputs type K, S, N for test thermocouples. Only one input per measurement is possible.
- Furnace has to be ordered separately

Additional equipment

- Reference thermocouple type K or type S
- Further thermocouple inputs for specimen, e.g. type B, type J or type R
- Fiber plug with passages and ceramic temperature compensation block for the support of the thermocouples in the test furnace

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 as the relative, maximum deviation from a defined reference temperature within the work space in the empty furnace at dwell time. Temperature uniformity is defined as ΔT in K. If, for example, a standard temperature uniformity of ΔT 10 K at 750 °C is specified, it means that the actual temperature in the furnace can vary between 740 °C and 750 °C or between 750 °C and 760 °C.

Specification of the Temperature Uniformity in +/- °C as Additional Feature

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

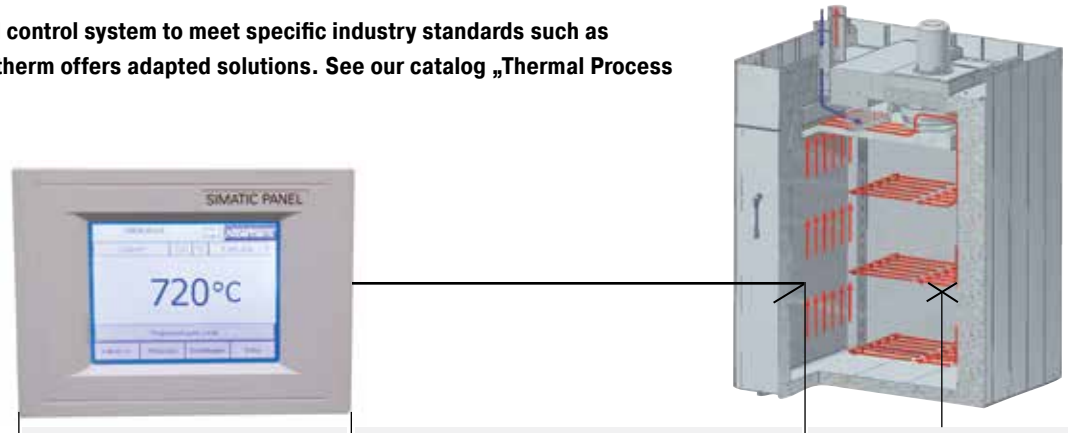
- Measurement of total temperature deviation of the measurement line from the controls to the thermocouple
- Measurement of temperature uniformity within the work space at the reference temperature or within the reference temperature range
- If necessary, an offset is set at the controls to adjust the 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 ΔT without measurement of temperature uniformity. However, as additional feature, a temperature uniformity measurement at a reference temperature in the work space compliant with DIN 17052-1 can be ordered. Depending on the furnace model, a holding frame which is equivalent in size to the charge space is inserted into the furnace. This frame holds thermocouples at 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.

Holding frame for measurement of temperature uniformity

For the configuration of furnace and control system to meet specific industry standards such as AMS 2750 E, CQI-9, or FDA, Nabertherm offers adapted solutions. See our catalog „Thermal Process Technology“



The system accuracy is defined by adding the tolerances of the controls, the thermocouple and the work space

Precision of the controls, e.g. +/- 2 °C

Deviation of thermocouple, e.g. +/- 1.5 °C

Deviation from measuring point to the average temperature in the work space +/-3 °C

Process Control and Documentation

Nabertherm has many years of experience in the design and construction of both standard and custom control system. All controls are remarkable for their ease of use and even in the basic version have a wide variety of functions.

Standard Controllers

Our extensive line of standard controllers satisfies most customer requirements. Based on the specific furnace model, the controller regulates the furnace temperature reliably. The standard controllers are developed and fabricated within the Nabertherm group. When developing controllers, our focus is on ease of use. From a technical standpoint, these devices are custom-fit for each furnace model or the associated application. From the simple controller with an adjustable temperature to the control unit with freely configurable control parameters, stored programs, PID microprocessor control with self-diagnosis system and a computer interface, we have a solution to meet your requirements.

Assignment of Standard Controllers to Furnace Families	N ../65 HACDB	W ../60 HACDB	TR	KTR	N 100/WAX - N 2200/WAX	NB 660/WAX - NB 1000/WAX	W .. + W .../DB	H ../LB or LT	N 200/DB - N 1000/HDB	N 100 - N 2200/14	NB 300 - NB 600	WB	WHTC	HTC 16/16 - HTC 450/16	HT	HFL	HT ../LB or LT	HTB	NRA 17/06 - NRA 1000/11	NRA .. H_2 version	NRA .. IDB version	SRA 17 - SR 1500	VHT	SVHT	LBVHT	NRA ..CDB	LS	GR	LH	HTC(T)	LHT	LHT/LB	RD	R	RT	RHTC	RHTH/RHTV	RS	RSR
Catalog page	8	9	12	14	16	17	18	22	24	26	28	29	30	31	32	35	36	40	44	46	46	47	48	52	53	54	55	55	56	58	59	60	62	63	64	65	66	68	70
Controller																																							
C 280										○	○																												
P 300	●[4]	●[4]		○	●	●	●[4]	●	●[4]	○	○								●			●							○								○	○
P 310										○			●[4]	●[4]	●[4]	●[4]	●[4]														●	●				●		
C 6/3208				○																																			
R 6			●																														●						
B 130										●	●																												
B 150				●																									●									●	●
B 180			○																											●				●	●	●			
P 330			○																											○				○	○	○			
3216																																	○						
3504			○	○		○												●	○			○												○		○	○	○	○
H 500/PLC							○			○		●[4]	●[4]	●[4]	●[4]	●[4]	●[4]										●		○								○		
H 700/PLC												●[4]	●[4]	●[4]	●[4]	●[4]	●[4]					●	●	●	●[4]												○		○
H 1700/PLC	●[4]	●[4]		○	○	○	●[4]	○	●[4]			●[4]						○	○		●	○				●[4]		●											
H 3700/PLC	○	○		○			○	○	○			○	○				○	○	○	●		○	○	○	○			○									○	○	○
NCC	○	○		○		○	○	○	○			○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		○									○	○	○

Functionality of the Standard Controllers	R 6	C6	3216	3208	B 130	B 150	B 180	C 280	P 300	P 310	P 330	3504	H 700	H 1700	H 3700	NCC
Number of programs	1	1	1		2	1	1	9	9	9	9	25	1/10[4]	10	10	50
Segments	1	2	8		3	2	2	3	40	40	40	500[4]	20	20	20	20
Extra functions (e.g. fan or autom. flaps)								2	2[1]	2[1]	2	2-8[4]	○[4]	6/2[4]	8/2[4]	16/4[4]
Maximum number of control zones	1	1	1	1	1	1	1	1	1	1	1	2[1,2]	○[4]	8	8	8
Drive of manual zone regulation										●						
Charge control/bath control												○	○	○	○	○
Auto tune			●	●	●	●	●	●	●	●	●	●				
Graphic color display													5,7"	5,7"	12"	19"
Status messages in clear text				●	●	●	●	●	●	●	●	●	●	●	●	●
Data input via number pad							●		●	●	●					
Data entry via touchpanel													●	●	●	
Keypad lock					●	●		●				●				
Skip-button for segment jump									●	●	●		○	●	●	●
Program entry in steps of 1 °C or 1 min.	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●
Start time configurable (e.g. to use night power rates)					●	●	●	●	●	●	●		●	●	●	●
Switch-over °C/°F	○		○	○	●	●	●	●	●	●	●	○	●[4]	●[4]	●[4]	●[4]
kWh meter					●	●	●	●	●	●	●					
Operating hour counter					●	●	●	●	●	●	●		●	●	●	●
Programmable power outlet											●[5]					
Real-time clock											●		●	●	●	●
NTLog Comfort for HiProSystems: Recording of process data on an external storage medium														○	○	
NTLog Basic for Nabertherm Controller: Recording of process data with USB-flash drive					○	○	○	○	○	○	○					
Interface for MV software					○	○	○	○	○	○	●					

● Standard
○ Option

[1] Not for melt bath control
[2] Control of additional separate slave regulators possible
[3] As an extra feature in air circulation furnaces
[4] Depending on the design
[5] Not for model L(T)15..

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).

HiProSystems Control and Documentation

This professional control system for single and multi-zone furnaces is based on Siemens hardware and can be adapted and upgraded extensively. HiProSystems control is used when more than two process-dependent functions, such as exhaust 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 telediagnostic service is required. It is flexible and is easily tailored to your process or documentation needs.

Alternative User Interfaces

Touch panel H 500/H 700

This basic panel accommodates most basic needs and is very easy to use.

Touch panel H 1700

Firing cycle data and the extra functions activated are clearly displayed in a table. Messages appear as text.

Touch panel H 3700

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

For Control, Visualisation and Documentation

Nabertherm Control Center NCC

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

- Recommended for heat treatment processes with extensive requirements in respect to documentation e.g. for metals, technical ceramics or in the medicine field
- Software can be used also in accordance with the AMS 2750 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 existing Enterprise Database systems (e.g. SAP, Oracle)
- Connection to mobile phone network for alarm message transmission via SMS
- Control from various locations over the network
- Calibration of each measuring point for a specific temperature possible
- Extendable for calibration of a polygonal line with up to 18 temperatures per measuring point for use at different temperatures e.g for AMS 2750 E applications

For Documentation

Nabertherm Documentation Center NDC and Data Recording via NTLog

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

Temperature Recorder

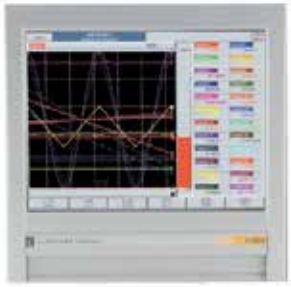
Besides the documentation via the software which is connected to the controls, Nabertherm offers different temperature recorders which can be used with respect to the application.

	Model 6100e	Model 6100a	Model 6180a
Data input using touch panel	x	x	x
Size of colour display in inch	5,5	5,5	12,1
Number of thermocouple inputs	3	18	48
Data read-out via USB-stick	x	x	x
Input of charge data		x	x
Evaluation software included	x	x	x
Applicable for TUS-measurements acc. to AMS 2750 E			x

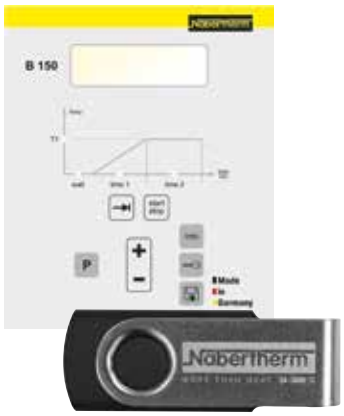
PC for HiProSystems control in a separate cabinet

H 1700 with colored, tabular depiction of the data

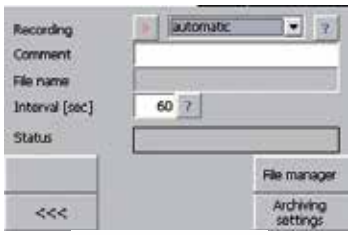
H 3700 with colored graphic presentation of data



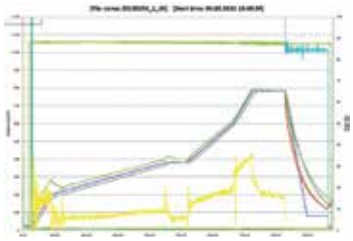
Temperature recorder



NTLog Basic for data recording of Nabertherm Controllers



NTLog Comfort for data recording of a Siemens PLC



NTGraph, a freeware for the easy-to-read analysis of recorded data using MS Excel

Documentation of Nabertherm Controller – Extension Module NTLog/NTGraph Basic

The extension module NTLog Basic is an economical way to record process data using the respective Nabertherm Controllers (P 300/310/330, B 130/150/180, C 280, all from version 3.0) on a USB stick. For this purpose the controller is enhanced with an intelligent interface adapter to accommodate a USB stick.

The process documentation with NTLog Basic requires no additional thermocouples or sensors. Only data recorded which are available in the controller via the control thermocouple (difference instead of real-time, program segment no., temperature setpoint, temperature actual value, control function 1, control function 2) is recorded.

The data stored on the USB stick (up to 16,000 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). Process data is stored with a differential time and not with an absolute time stamp. Charge data, start time and start date are assigned later (e.g. in the spreadsheet software or with the file name) by the operator at the PC.

For protection against accidental data manipulation the generated data records contain checksums. A retrofit of NTLog Basic on existing controllers can be done with a retrofit kit including a manual.

Documentation of PLC Controls with Touch Panel H 1700 or H 3700 - Extension Module NTLog/NTGraph Comfort

The extension module NTLog Comfort offers the same functionality of NTLog Basic module. Process data from a Siemens PLC Controller is read out from Touch Panel H 1700 or H 3700 and stored in real time on a USB stick. 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.

Process Data from NTLog

The process data from NTLog can be presented either using the customer‘s own spreadsheet program (e.g. MS Excel) or NTGraph. With NTGraph Nabertherm provides for a 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 (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 eight 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.

Controltherm MV Software for Control, Visualisation and Documentation

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

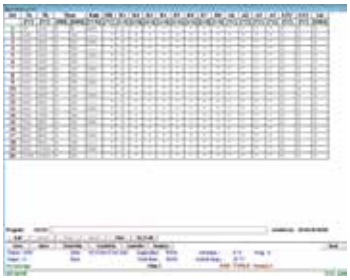
In the basic version one furnace can be connected to the MV-software. The system can be extended to four, eight or even 16 multi-zone controlled furnaces. Up to 400 different heat treatment programs can be stored. The process will be documented and filed. Process data can be read-out graphically or in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

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

Controltherm MV Software for Control, Visualisation and Documentation

Features

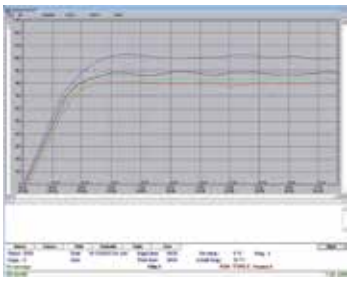
- Simple installation without specific knowledge
- Suitable for PC with operating system Microsoft Windows 7 (32 Bit), Vista (32 Bit), XP with SP3, 2000, NT4.0, Me, 98
- All Nabertherm controllers with interface connectable
- Manipulation protected storage of temperature curves of up to one, four, eight or 16 furnaces (also multizone-controlled), depending on the version of MV-software
- Redundant storage on a network server possible
- Programming, archiving and printing of programs and graphics
- Free input of descriptive charge data text with comfortable search function
- Data exportable into Excel format for further evaluation
- Start/stop of the controller from the local PC (only with Nabertherm controllers mit interface)
- Selectable languages: German, English, French, Italian or Spanish
- 400 additional programs storable (only with Nabertherm controllers with interface)



Data input in table format if used together with Nabertherm controllers

Extension Package II for Connection of one Additional Temperature Measuring Point, Independent of the Controller

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



Graphical display of set and actual temperature curve

Extension Package II for Connection Three, Six or Nine Temperature Measuring Points, Independent of the Controller

- Connection of three thermocouples, type K, S, N or B to the supplied connection box
- Extendable to two or three connection boxes for up to nine temperature measuring points
- Conversion and transmission of measured data to the MV-software
- For data evaluation, please see MV-software features

Extendable for connection of up to 16 furnaces

Nabertherm
MORE THAN HEAT 30-3000 °C

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

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

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