Nabertherm

MORE THAN HEAT 30-3000 °C

Advanced Materials

Furnaces and Heat Treatment Plants for

Powder Metallurgy
Technical Ceramics
Bio Ceramics
Additive Manufacturing, 3D-Printing
MLCC, LTCC, HTCC
MIM, CIM
Lamps/Illuminants/LED
Fuel Cell/Battery Manufacturing
Photovoltaics
Crystal Growth
Polymerization
Energy Efficiency Technology

www.nabertherm.com

Made in Germany

Made in Germany

Nabertherm with 450 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

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

Large 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 worldwide. Due to our complete inhouse production, we can despatch most spare parts from stock over night or produce with short delivery time.

Experience in Many Fields of Thermal Processing

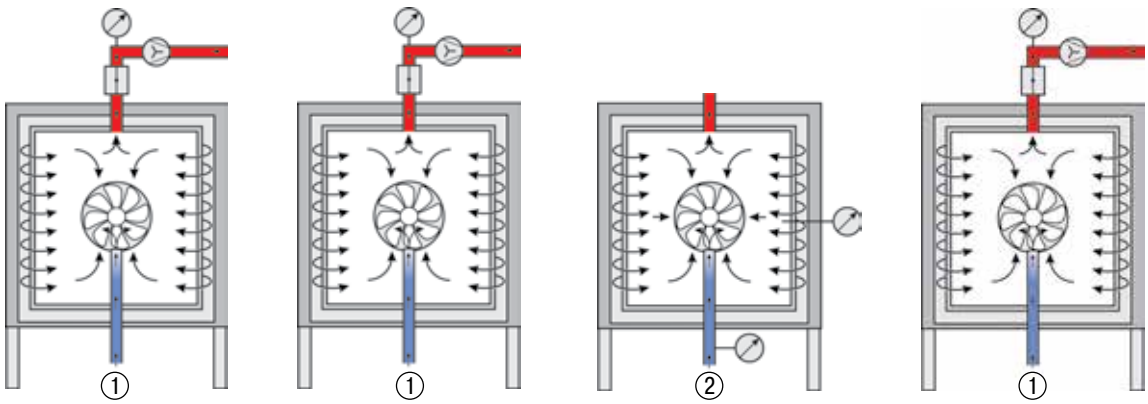
In addition to furnaces for Advanced Materials, Nabertherm offers a wide range of standard furnaces and plants for many other thermal processing applications. The modular design of our products provides for customized solutions to your individual needs without expensive modifications.

Table of Contents

Concepts for Drying, Debinding, Thermal Cleaning and Wax Burnout

Process	Drying Solvents			
Atmosphere	Air		Inert	
Maximum Temperature for Debinding	300 °C	450 °C	450 °C	450 °C
Organic Quantity	Organic quantity low	Organic quantity low	Organic quantity low	Organic quantity low
Requirement	Low requirement for temperature uniformity	Increased requirement for temperature uniformity	Increased requirement for temperature uniformity	Increased requirement for temperature uniformity
Concept	LS	LS	LSI	DB10
	Acc. to EN 1539 Type A. Monitored air exchange. Exhaust gas venting via nozzles in the on-site extraction system.	Acc. to EN 1539 Type A (NFPA 86 Class A). Monitored air exchange. Active venting of the exhaust gas via integrated exhaust gas fan.	Acc. to EN 1539 Type B. Monitored inert rendering with low volume of residual oxygen.	Monitored air exchange. Active venting of the exhaust gas via integrated exhaust gas fan. Uncontrolled furnace underpressure.
Furnace Type				
For Debinding	TR .. LS, page 20	KTR, page 22 NA .. LS, page 18 NAC, page 17	KTR .. LSI, page 22 NAC, page 17	NA .. 45 DB10, page 18
For Debinding and Sintering				
Post-Treatment of Exhaust Gases				
Furnace Heating		Gas		

1) Air
2) Protective gas



Debinding

Air

650 °C

Organic quantity low

Low requirement for temperature uniformity

DB50

Monitored air exchange. Fresh air, unheated. Furnace in overpressure.

LH .. DB50, page 70
HT .. DB50, page 46
N .. DB50, page 38

Separate catalytic afterburning system
Separate thermal afterburning system

Organic quantity low to high

Increased requirement for temperature uniformity

DB100

Monitored air exchange. Pre heated fresh air. Furnace in overpressure.

H .. DB100, page 34
HT .. DB100, page 46/50
N .. DB100, page 36
W .. DB100, page 30

Separate catalytic afterburning system
Separate thermal afterburning system

High requirement for temperature uniformity

DB200

Monitored air exchange. Pre heated fresh air. Active venting with the exhaust gas integrated exhaust gas fan. Controlled furnace underpressure.

NA .. DB200, page 18
N .. HA DB200, page 18

H .. DB200, page 34
HT .. DB200, page 46/50
N .. DB200, page 36
W .. DB200, page 30

Catalytic afterburning
Thermal afterburning

850 °C

Organic quantity high

Low requirement for temperature uniformity

BO

Debinding process with control difficulties of heating ramp (exothermic reaction). Safe ignition of ignitable mixtures.

N .. BO, page 29
NB .. BO, page 29
W .. BO, page 30
WB .. BO, page 42

Thermal afterburning

Inert

650 °C

Organic quantity low to high

Low residual oxygen concentration

IDB

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

NA .. IDB, page 18
N .. HA IDB, page 18

Thermal afterburning

600 °C

Organic quantity low to high

No residual oxygen concentration

IDB

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

NRA .. IDB, page 58
SRA .. IDB, page 61

NR .. IDB, page 58
SR .. IDB, page 61
VHT .. IDB, page 62

Flare
Thermal afterburning

Reaction gas

600 °C

Organic quantity low

High requirement for temperature uniformity

H_2

Thermal debinding in hydrogen atmosphere. Safe monitored air exchange.

NRA .. H_2, page 58
SRA .. H_2, page 61

NR H_2, page 58
SR .. H_2, page 61
VHT .. H_2, page 62

Flare

Catalytic

120 °C

Organic quantity low to high

High requirement for temperature uniformity

CDB

Catalytic debinding in nitrogen/nitric acid atmosphere. Monitored safe Nitrogen purging to displace the oxygen.

NRA .. CDB, page 68

Flare

Thermal Cleaning, Ashing

Air

850 °C

Organic quantity high

Low requirement for temperature uniformity

BO

Safe ignition of ignitable mixtures.

N .. BO, page 29
NB .. BO, page 29
W .. BO, page 30
WB .. BO, page 42

Thermal afterburning

Reducing

500 °C

Organic quantity high

Low requirement for temperature uniformity

CL

Low oxygen concentration. Pyrolysis of the organic components. Prevention of open incineration.

NB .. CL, page 28

Thermal afterburning

Dewaxing Furnaces

Air

< Flashpoint of wax

Organic quantity high

Low requirement for temperature uniformity

WAX

Safe dewaxing below the melting point of wax. Subsequent sintering possible.

N .. WAX, page 26

> Flashpoint of wax

Organic quantity high

Low requirement for temperature uniformity

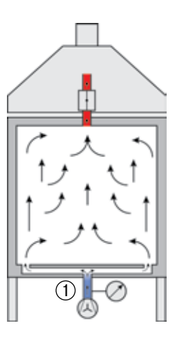
BOWAX

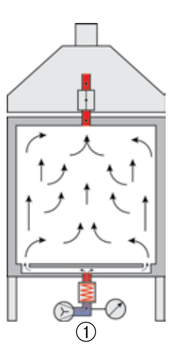
Flashfire processes. Dewaxing/incineration and sintering. Dewaxing/ incineration above the flashpoint. Filling the hot furnace.

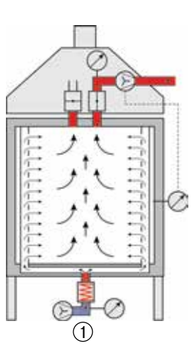
NB .. BOWAX, page 27

Thermal afterburning

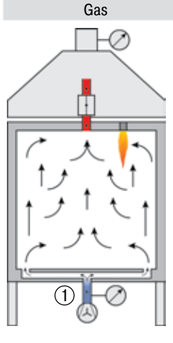
Electric

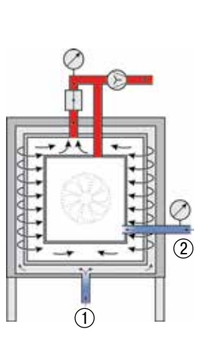


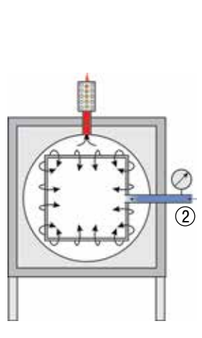


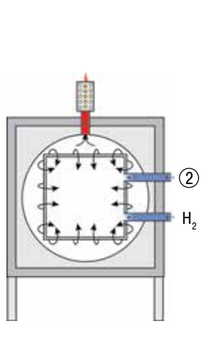


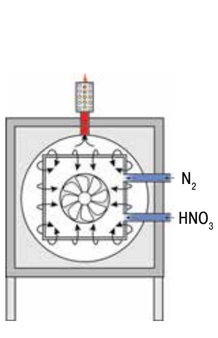
Gas



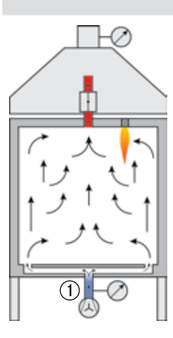


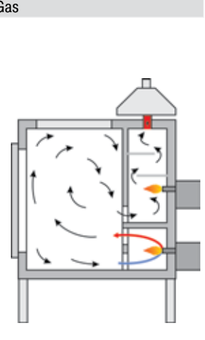


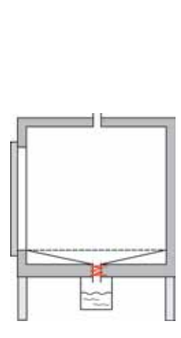




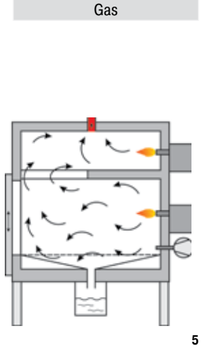
Gas







Gas



Safety Concept for Debinding

Debinding of technical ceramics is a critical process due to the released hydrocarbons which subject to the corresponding concentration can cause a formation of an ignitable mixture inside the furnace. Depending on the process and the quantity of binder, Nabertherm offers tailored passive and active safety packages to ensure a safe operation of the furnace.

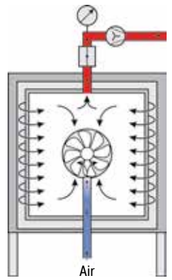
I. Debinding in Air

1. Debinding in an Electrically Heated Furnace

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

1.1. Passive Safety Concept

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

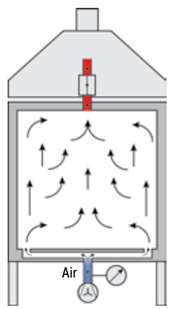


DB10 Debinding Package for Air Circulation Furnaces (Convection Heating) up to 450 °C

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

Monitored process states for safe operation:

- Exhaust gas volumetric flow rate
- Function of air circulation
- Temperature gradient: If the heating gradient, selected by the customer is exceeded, the furnace is immediately switched off.



DB50 Debinding Package for Laboratory Furnaces

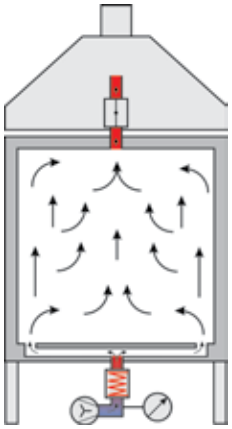
The DB50 debinding package is especially suitable for laboratory furnaces and for processes with low vaporization rates. The furnace is equipped with a fresh air fan. The fresh air fan is pre-set in the factory for the minimum volume of fresh air required for the debinding process. The furnace is operated with overpressure during the debinding process.

Monitored process states for safe operation:

- Fresh air volumetric flow rate

DB100 Debinding Package for Production Furnaces with Radiation Heating

The DB100 debinding package is the basic option for safe debinding in furnaces with radiation heating. The furnace is equipped with a fresh air fan and a fresh air preheater. The fresh air fan is pre-set in the factory for the minimum volume of fresh air required for the debinding process. The furnace is operated with overpressure during the debinding process. Exhaust air and exhaust gas are blown out via an outlet equipped with a motor driven flap into an exhaust hood with exhaust interruption. This is the interface to the customer's exhaust air system.

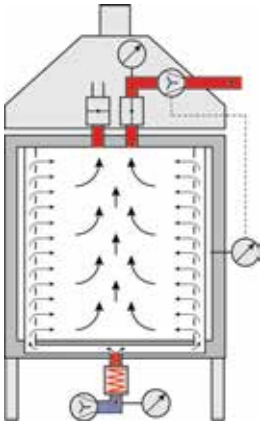


Monitored devices and process states for safe operation:

- Electromagnetic door lock
- Redundant fresh air volumetric flow rate
- Position of the fresh-air flap
- Position of the exhaust air flap
- Temperature gradient
- Power loss (emergency program after power has returned)
- Fresh air fan
- Thermocouple break
- The furnace controls respond differently depending on the specific malfunction and put the furnace into a safe condition.

DB200 Debinding Package for Production Furnaces with Air Circulation or Radiation Heating

The DB200 debinding package is the professional solution for the variable ceramics production because it can be used flexibly for different debinding processes and also for frequently changing debinding processes. Like with the DB100 debinding package, the fresh air required for the process is preheated. The air is introduced via perforated ceramic tubes that blow the preheated air into the furnace chamber horizontally. This ensures very good heat transfer and improves the temperature uniformity.



As opposed to the DB100 debinding package, exhaust air and exhaust gas are extracted via separate outlets, each equipped with a motor driven flap. The furnace is equipped with a fresh air fan and an exhaust gas fan. Both devices are reconciled so that the volume of air required for the debinding process is blown in and, at the same time, negative pressure is controlled in the furnace chamber. The exhaust gases during the debinding phase are extracted through the exhaust gas outlet, which is connected directly to the local exhaust gas piping. Due to the direct connection, the exhaust gas volumes are reduced and subsequent exhaust gas treatment systems can be dimensioned smaller. For cooling, the exhaust air blown out into the exhaust hood with exhaust interruption, which is the interface to the customer's exhaust air system.

Monitored devices and process states for safe operation:

- Electromagnetic door lock
- Redundant fresh air and exhaust gas volumetric flow rate
- Position of the fresh-air flap
- Position of the exhaust gas flap
- Position of the exhaust air flap
- Temperature gradient
- Power loss (emergency program after power has returned)
- Fresh air fan
- Malfunction of exhaust gas fan
- Underpressure in the furnace chamber
- Thermocouple break
- The furnace controls respond differently depending on the specific malfunction and put the furnace into a safe condition

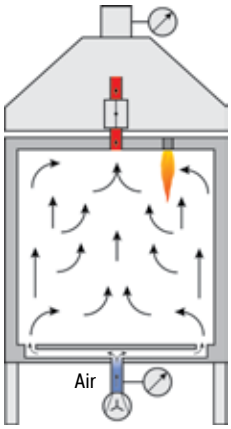
Safety Concept for Debinding

The main differences and/or advantages between the DB100 and DB200 debinding packages are:

- Automatic control of the exhaust gas fan in relation to the selected volume of fresh air. This is beneficial for temperature management (uniform temperature) and an adaptable extraction of the exhaust gas volumes. Reduced odors and condensation in the exhaust gas piping.
- Perforated tubes in the furnace chamber for even distribution of preheated fresh air throughout the horizontal charging levels
- Exhaust gas system can be dimensioned smaller, since no cold air is added via an exhaust interruption system (energy efficiency).

1.2. Active Safety Concept

Alternatively, the passive safety concept can be upgraded into an active safety system with additional equipment so that safety is monitored actively. The current limit concentrations in the furnace are monitored by flame thermal analysis (FTA). Accordingly, the fresh air and exhaust gas fans, as well as the furnace heating, are controlled automatically. For example, if the furnace is in an unsafe condition, due to overloading, too rapid heating gradients or too little fresh air, the necessary emergency program is initiated depending on the process step.



2. BO Safety Concept in Electrically Heated Furnaces for Processes with High Vaporization Rates

The BO safety concept that burns off ignitable gas mixtures by means of an additional gas-fired ignition burner can be used to burn off organic residues. The concept is recommended for products that are resistant against an uncontrolled temperature rising during the firing process. Please see page 10 for a detailed description of this safety concept.

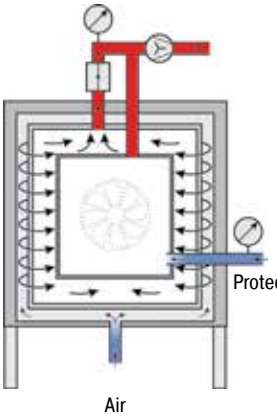
3. Debinding in Direct Gas-Fired Furnaces

Compared to electrically heated furnaces, gas fired furnaces have the advantage that large quantities of released hydrocarbons are incinerated directly in the furnace during the process. In this respect, gas-fired furnaces are especially suitable if the vaporization process is difficult to manage, for example, due to high vaporization dynamics. Complex process controls or long process times are avoided even for dynamic processes with a high degree of released hydrocarbons. Gas-fired furnaces are especially suitable for debinding when precise temperature management or optimum temperature uniformity during debinding are not top priority.

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

IDB Safety Concept for Debinding in Protective Gas Boxes under Non-Flammable Protective Gases with Low Residual Oxygen

The IDB safety concept with an inert atmosphere in protective gas boxes is ideal for debinding processes under protective gas where a small amount of residual oxygen for the materials is permitted. The furnace technology in combination with a protective gas box made from heat-resistant stainless steel has a very good price performance ratio.

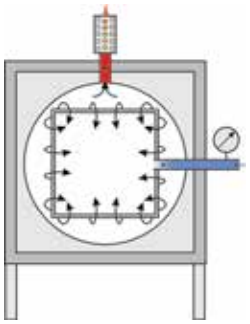


A monitored inert gas pre-flushing and conservation flushing during the process ensure that a residual oxygen concentration of 3 % is not exceeded in the protective gas box. The customer must check this limit value with regular measurements.

- Monitored inert gas pre-flushing and conservation flushing in the protective gas box
- Monitor of inert gas inlet pressure
- Monitored flushing of the furnace chamber with fresh air to dilute the furnace atmosphere in case of any leakages of the protective gas box

IDB Safety Concept in Retort Furnaces for Debinding under Non-Flammable Protective Gases or for Pyrolysis Processes

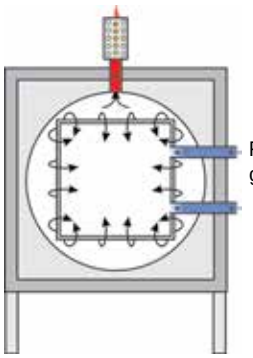
The retort furnaces in the NR(A) and SR(A) series are ideal for debinding under non-flammable protective gases or for pyrolysis processes. With the IDB option, the furnace chamber is flushed with protective gases. Exhaust gases are incinerated in an exhaust gas torch. The flushing and the torch function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



- Process management under monitored overpressure of 35 mbar relative
- Failsafe Siemens PLC and graphic touch panel to enter data
- Monitored process gas inlet pressure
- Bypass for safe flushing of the furnace chamber with inert gas
- Torch for thermal incineration of the exhaust gases

Safety Concept for Heat Treatment under Flammable Process Gases

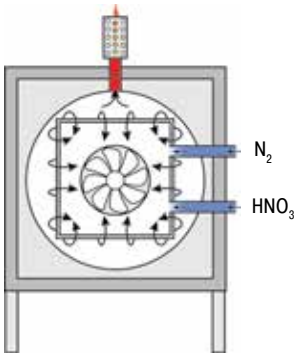
If flammable process gases, such as hydrogen, are used, the retort furnace is also equipped and delivered with the required safety technology. Only components with the corresponding certification are used as safety-relevant sensors. The furnace is controlled by a failsafe PLC control system (S7300/safety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



- Inlet of flammable process gas with controlled overpressure
- Certified safety concept
- Process control H3700 with PLC control and graphic touch panel to enter data
- Redundant gas inlet valves for hydrogen
- Monitored inlet pressures of all process gases
- Bypass for safe flushing of the furnace chamber with inert gas
- Torch (electric or gas) for thermal afterburning of flammable process gas
- Emergency flood container for purging the furnace with protective gas in case of malfunction

CDB Safety Package for Catalytic Debinding with Nitric Acid

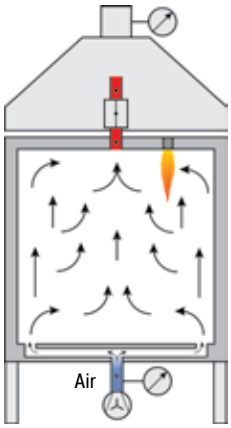
- The safety concept prevents explosive gas mixture forming when the furnace is operated with nitric acid. For this purpose, the gastight retort is automatically flushed with a controlled flow of nitrogen which displaces the atmospheric oxygen before nitric acid is introduced. During debinding, the monitored mixing ratio between the nitrogen and acid prevents an excess acid dosis and, or consequently, the formation of an explosive atmosphere.
- Monitoring the pumping rate of the acid pump
- Nitrogen volumetric flow with redundant flow sensors
- Failsafe Siemens PLC
- Over-temperature limit controller to monitor excess and low temperatures
- Emergency flood container for purging the furnace with protection gas in case of malfunction
- Torch for thermal incineration of the exhaust gases



Safety Concept for other Processes where Organic Exhaust Gases Form

I. BO Safety Concept for Processes with High Organic Vaporization Rates

The BO safety concept is recommended for processes with high vaporization dynamics that are difficult to control. Diluting the furnace atmosphere with air is not sufficient to guarantee non-ignitable mixtures in the furnace. Examples of this are processes with high binder amounts or rapid vaporization rates. This furnace concept is also suitable for processes in which the product is incinerated through ignition.

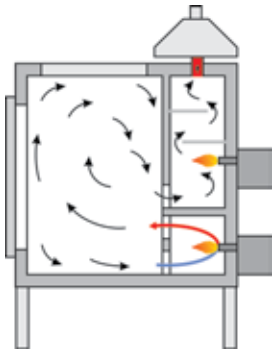


Air is continuously added to the furnace atmosphere to ensure a constant surplus of air. If, despite of this, an ignitable mixture forms in the atmosphere, this is ignited by a gas-fired ignition burner in the furnace. The system ensures that no considerable ignitable concentrations can form and ensures a safe incineration of the generated gases. The concept is recommended for products that are resistant against an uncontrolled temperature rising during the firing process. Debinding of organics can also be done at temperatures above 500 °C. Depending on the furnace model, the burn-off process can be followed by a subsequent process to max. 1400 °C.

Monitored devices and process states for safe operation:

- Temperature-controlled door lock
- Gas inlet pressure of burner system
- Flame of the ignition burner
- Flow rate of fresh air
- Exhaust gas flow
- The furnace controls respond differently depending on the specific malfunction and put the furnace into a safe condition

II. NB .. CL Safety Concept for Thermal Cleaning through Pyrolysis

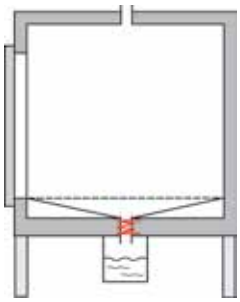


The NB .. CL safety concept is used for thermal cleaning of components through pyrolysis, i.e. in a low-oxygen atmosphere. Examples are thermal cleaning of coated steel surfaces or nozzles of plastic injection molding machines. The furnaces are gas fired and have an integrated thermal afterburning system, which is also gas fired. The preset reducing atmosphere in the furnace effectively prevents the charge from self ignition to avoid damage caused by flames and the resulting temperature increase. The exhaust gases are extracted from the furnace into the integrated thermal afterburning system, where they are incinerated. Residue-free conversion is possible, depending on the type of exhaust gas. The NBCL safety concept is not suitable for evaporating solvents or for products with a high water content.

Monitored devices and process states for safe operation:

- Gas inlet pressure of burner system
- Ensuring the thermal afterburning function: The furnace is equipped with a multi-stage safety monitoring system so that no untreated exhaust gases can escape. If the temperature in the thermal afterburning system rises above a set limit due to the generated volume of exhaust gases, the furnace gas heating switches from high to low load until the temperature in the thermal afterburner falls below the limit value again. If this is not sufficient because the volume of exhaust gases generated in the furnace is too high, the furnace heating is switched off and the process is interrupted.
- Pressure relief flap: in case of a pressure shock in the furnace, for example, due to incorrect charging or process control, a pressure relief flap is triggered to prevent the housing rupturing. The process is stopped.
- Extinguishing system: In case of unwanted self-ignition, fires can be extinguished with an ABC extinguisher through a special opening in the furnace
- Door lock: when the process starts, the door is electrically locked
- The furnace controls respond differently depending on the specific malfunction and put the furnace into a safe condition

III. WAX Safety Concept for Electrically Heated Furnaces to Melt Out Wax below its Flashpoint

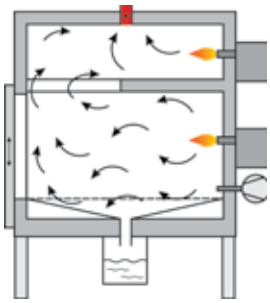


Furnaces of the WAX series with the corresponding safety concept are suitable for dewaxing parts, e.g. ceramic molds, below the wax flashpoint. The melted wax is collected in a container underneath the furnace. This collection container is positioned in an airtight drawer which can be removed for emptying. The wax runs through a grid into a funnel-shaped drain in the base of the furnace. The drainage channel is heated to stop the wax hardening. The furnace program is started only when the set temperature of the drain is reached. The customer has to choose the melting temperature and the melting time. When the melting process is complete, the furnace can be heated to 850 °C to sinter the molds.

Monitored safety functions for safe processes

- Temperature of the wax drain
- Two independent over-temperature limiters
  - First over-temperature limiter is set below the wax flashpoint. This prevents the wax from igniting during the melting process. The customer sets the duration of the dewaxing process. When this time has elapsed, the program deactivates the over-temperature limiter so that the furnace can continue the sintering process.
  - Second over-temperature limiter with manual reset as over-temperature protection for the furnace and the charge during sintering

IV. BOWAX Safety Concept to Melt Out/Burn Wax above its Flashpoint (Flashfire Dewaxing)



Gas-fired furnaces with the BOWAX safety concept are designed to melt out and burn- off wax above its flashpoint. Flashfire processes cause the wax to melt out suddenly. The hot furnace is charged i.e. at a temperature above 750 °C. This principle can also be used for large quantities of wax or if the flashpoint is unknown. The same applies to large quantities of residual wax that cannot be melted out using conventional methods.

Part of the wax melts and runs through a drain in the furnace bottom into a container filled with water. The second part of the wax vaporizes and forms an ignitable mixture in the furnace. This is ignited by a gas-fired ignition burner in the furnace. The furnace has an integrated thermal afterburning system that cleans the remaining exhaust gases and minimizes odors.

The ignition may cause uncontrolled temperature increases in the furnace. Therefore, the charge must be able to withstand temperature fluctuations and temperatures > 1000 °C.

Monitored safety functions for safe processes

- Gas pressure of the burners
- Flame monitoring of the burners
- Over-temperature limiter with manual reset as over-temperature protection for the furnace and charge
- Electromagnetic lift door lock, when the furnace has been charged
- Display when the permitted charging temperature is reached

Safety Concept for other Processes where Organic Exhaust Gases Form

V. Safety Concept EN 1539 (NFPA 86) to Dry Liquid Solvents in Ovens

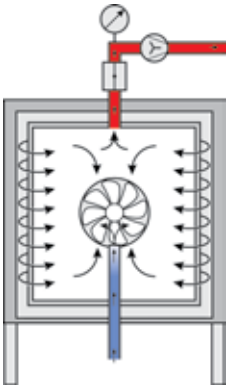
The safety technology of furnaces and dryers used for processes in which solvents or other flammable substances are released and vaporized relatively quickly is regulated throughout Europe in EN 1539 (or NFPA 86 in the USA)

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

EN 1539 distinguishes between safety concept types A and B.

1. Safety Concept EN 1539 Type A

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



Air

Implementation of the standard requirements

- An exhaust gas fan ensures continuous ventilation in the dryer or furnace. The fan functionis monitored for safe performance. The vapors occurring during heat treatment are extracted from the furnace chamber with the aid of the exhaust gas fan.
- The air exchange rate is ensured via a differential pressure system (differential pressure monitoring of the air circulation and the exhaust gas). If the system reports a fault, the furnace alarms malfunction and the heating is stopped.
- Underpressure ensures that the solvent safely exits the furnace
- The interior of the furnace is completely welded and prevents from solvent penetration and accumulation in the insulation

NABERTHERM specifies the amount of solvents that can be introduced in relation to the working temperature and furnace model. The amount of solvent is calculated in relation to the worst case scenario; in other words, rapid vaporization of solvent on the largest possible surface area.

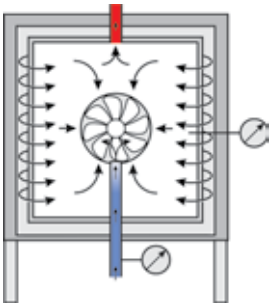
The standard also allows for exceptions where in the case of lower vaporization rates larger quantities of solvents per charge may be introduced to the dryer. Therefore, the customer has to assess the process to comply with the permitted solvent amounts.

When mold varnishes are being dried, the standard values can be increased by a factor of 10. If the customer's process involves drying of impregnating resin (e.g. for transformers, motor windings, etc.), the maximum quantities of flammable materials calculated for rapid vaporization can even be increased by a factor of 20. Depending on the process, customer must comply with the current valid standards.

The high rate of air exchange results in relatively high energy consumption. According to EN 1539, when the main vaporization time has expired, the minimum volumetric flow rate of the exhaust air may be reduced to 25 %. According to the norm, the main vaporization time is the time in which the main amounts of flammable substances are released. For dryers with safety technology, Nabertherm offers an additional control system to implement this energy saving option. Customers must set and acknowledge the end of the main vaporization time. When this time has elapsed, the system reduces the volumetric flow rate of the exhaust gas accordingly.

2. Safety Concept EN 1539 Type B

EN 1539-B describes an alternative safety concept based on dilution of the air in the furnace atmosphere. The safety concept specifies preventing the formation of explosive mixtures by limiting the oxygen concentration in every area of the vapor space.



Protective gas

Before the start of the process and after the debinding process the gas-tight container is flushed automatically with inert gas, which is monitored, to prevent flammable or explosive mixtures forming.
During the process, the flushing is safely monitored.

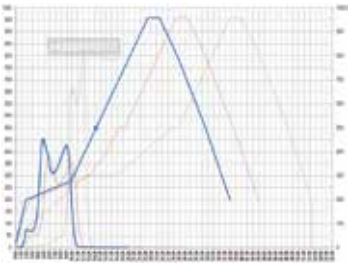
Implementation of the standard requirements

- Process control via failsafe PLC (F-PLC)
- Overpressure monitoring in the furnace
- Monitoring process gas inlet pressure and emergency flushing path
- Monitoring the door lock to prevent unauthorized opening of the furnace during operation
- In case of a malfunction, the furnace is flushed and the heating and air circulation are deactivated. The customer must provide for a failsafe protective gas supply.
- The oxygen concentration is monitored with oxygen sensors located in the exhaust gas stream.

Process Optimization by Nabertherm with Flame Ionization Detector (FID)

The binder removal often accounts for the largest part of the overall process time. Consequently, there is a lot of potential in this sequence to optimize the process curve times.

For process optimization, Nabertherm offers a production accompanying analysis of the debinding process by means of FID measurement. The aim of the measurement is to determine a possible reduction of the process time, an increase in throughput and an associated reduction of production costs. Based on the recommendations, the customer checks and validates the practical feasibility with respect to the material properties of his charge.



Process curves before and after optimization

- Process analysis including FID measurement and recommendations for potential process optimization
  - Recording of the current raw gas values using FID measurement
  - Evaluation and determination of periods with lower vaporization activity
  - Provision of the FID measurement device
  - Preparation of the evaluation and reports

- Process adjustment
  - Proposals for an optimized temperature profile
  - Implementation of the proposal, by performing one process cycle with accompanying measurement and evaluation after the customer has approved the proposal
  - Recommendations for the customer to carry out further optimization steps if feasible

Catalytic and Thermal Afterburning Systems, Scrubber

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

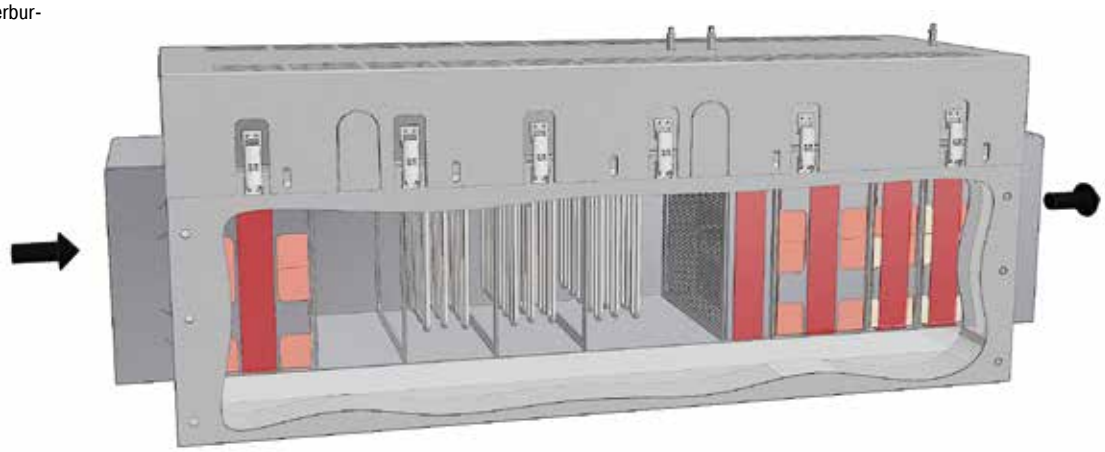
For exhaust gas cleaning, in particular in debinding, Nabertherm offers exhaust gas cleaning systems tailored to the process. The afterburning system is permanently connected to the exhaust gas fitting of the furnace and accordingly integral part of the control system and the safety matrix of the furnace.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

Catalytic afterburning systems (KNV)

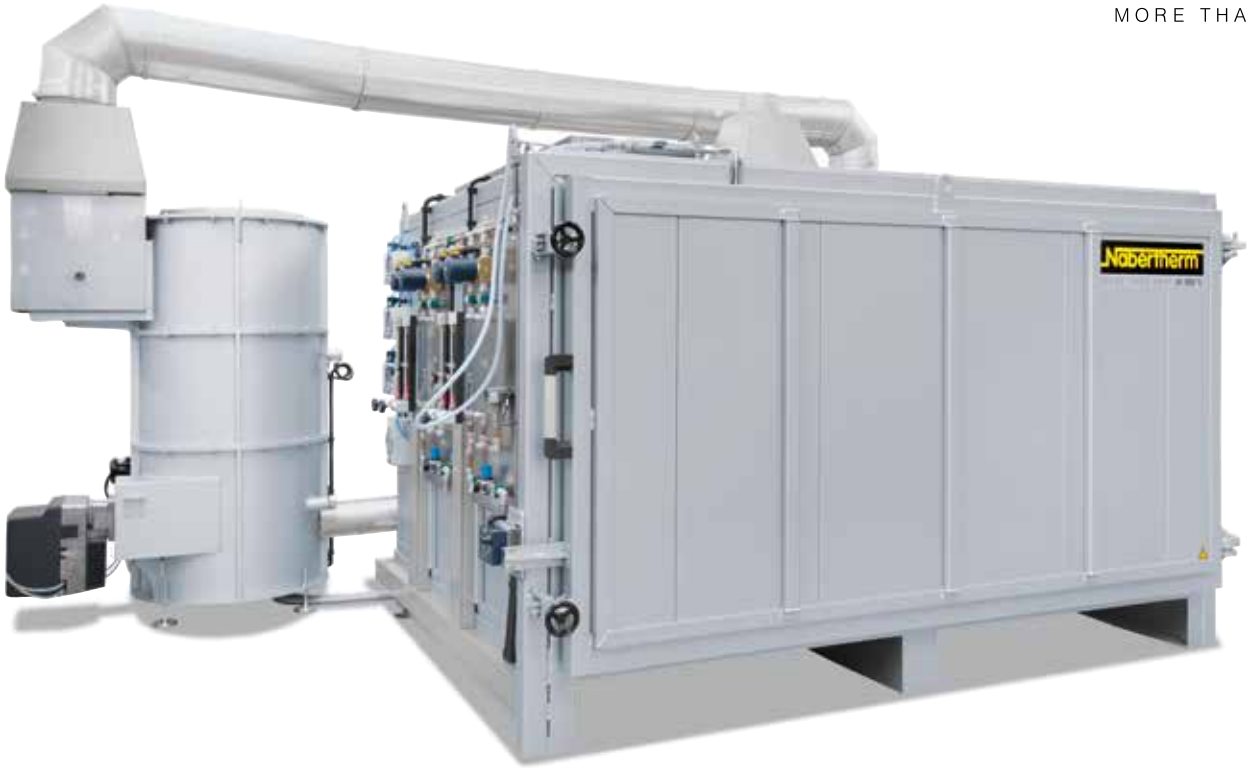
Catalytic exhaust cleaning is recommended due to energetic reasons when only pure hydrocarbon compounds must be cleaned during the debinding process in air. They are recommended for small to medium exhaust gas amounts.

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

Air circulation chamber furnace NA 500/65 DB200 with catalytic afterburner system.



Scheme of a catalytic afterburning system

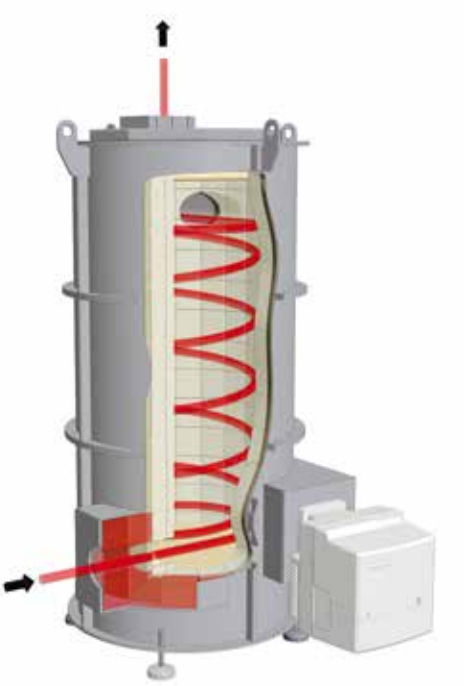


Air circulation chamber furnace N 4000/65 HA IDB with thermal afterburning system

Thermal afterburning systems (TNV)

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

- Optimally suited for debinding processes in air with large exhaust gas flow, erratic large exhaust gas volumes, large volume flow or for debinding processes under non-flammable or flammable protective or reaction gases



Scheme of a thermal afterburner system

- Gas-fired to burn the exhaust gases
- Burn-off at temperatures up to 850 °C provides for thermal decomposition of the exhaust gases
- Heating with compact gas burner with automatic firing device
- Thermocouples in the combustion chamber and in the raw gas inlet
- Over-temperature limiter for protecting the thermal afterburning
- Design depending on the exhaust gas flow
- Measuring port for clean gas measurements (FID)

Scrubber

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

Scrubber to clean generated process gases by washing out

Additive Manufacturing, 3D-Printing

Retort furnace NR 150/11 for annealing of metal parts of 3D- printing

Additive manufacturing allows for the direct conversion of design construction files fully functional objects. With 3D-printing objects from metals, plastics, ceramics, glass, sand or other materials are built-up in layers until they have reached their final shape.

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

In most cases, these objects must be heat treated after printing. Nabertherm offers solutions from binder curing for conservation of the green strength up to vacuum furnaces in which the objects of metal are annealed or sintered.

Oven TR 240 for drying of powders

Chamber dryer KTR 2000 for binder curing after 3D-printing

Compact tube furnace for sintering or annealing under protective gases or in a vacuum after 3D-printing

HT 160/17 DB200 for debinding and sintering of ceramics after 3D-printing

Metals	**Ceramics, Glass, Composites, Sand**	**Plastics**
Debinding Sintering Stress-relieving Solution annealing Hardening	Debinding Sintering Drying Curing	Curing Tempering Drying
under Protective Gases, Reaction Gases or in Vacuum	**in Air**	**in Air**
Chamber furnaces with gas-supply boxes see page 18	Debinding in chamber furnaces with air-circulation Sintering in chamber furnaces Debinding and Sintering in combi furnaces Dewaxing Furnaces	Ovens Chamber dryers Air circulation chamber furnaces
Hot-wall retort furnaces see page 58		
Cold-wall retort furnaces see page 62	See als concepts for drying, debinding, thermal cleaning and wax burnout on page 4	See als concepts for drying, debinding, thermal cleaning and wax burnout as well as catalog Thermal Process Technology
See also catalog Thermal Process Technology		

Also, concomitant or upstream processes of additive manufacturing require the use of a furnace in order to achieve the desired product properties, such as heat treatment or drying the powder.

Clean Room Solutions

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

The specific application determines the choice of the required furnace technology. In many cases 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.

KTR 8000 designed as a production oven in the clean room with filters for air circulation

Furnace Installation in the Clean Room

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

Furnace Installation in the Grey Room, Furnace Charging from the Clean Room

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

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

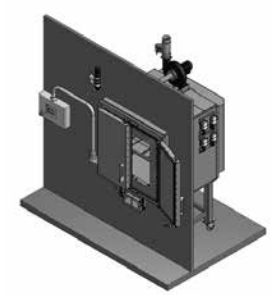
Sluice Furnace between Grey Room and Clean Room

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.

High-temperature furnace with loading from the clean room; switchgear and furnace installed in grey 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

Air Circulation Chamber Furnaces, Electrically Heated
Also for Debinding in Air and under Protective Gases

NA 120/45

NA 250/45

Air circulation chamber furnace
NA 120/45 DB10 for debinding in air

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

- Tmax 450 °C, 650 °C, or 850 °C
- Stainless steel air-baffles in the furnace for optimum air circulation
- Swing door hinged on the right side
- Base frame included in the delivery, N 15/65 HA designed as table-top model
- Horizontal air circulation
- Temperature uniformity up to +/- 5 °C according to DIN 17052-1 (model N 15/65 HA up to +/- 7 °C) see page 75
- Optimum air distribution enabled by high flow speeds
- One removable tray and rails for two additional trays included in the scope of delivery (N 15/65 HA without removable tray)
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm Controller: Recording of process data with USB-flash drive (NA 30/45 - N 675/85 HA)
- Controls description see page 76

Additional equipment (not for model N 15/65HA)

- Optimization of the temperature uniformity up to +/- 3 °C according to DIN 17052-1 see page 75
- Fan cooling to accelerate the cooling process
- Motor driven exhaust air flaps
- Manual lift door (up to model N(A) 250/.. (HA))
- Pneumatic lift door
- Adjustable air circulation for sensitive components

Air circulation chamber furnace N 250/65 HA IDB with gas supply box for debinding und protective gases

Air circulation chamber furnace N 500/65 HA DB200 for debinding in air with catalytic afterburner system

- Additional removable trays
- Roller conveyor in furnace chamber for heavy charges
- Designed for Tmax 950 °C
- Debinding packages with safety concept starting from 120 liters volume, see page 6 - 8
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 76

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
NA 30/45	450	290	420	260	30	1040	1290	1385	3.0	1-phase	195
NA 60/45	450	350	500	350	60	1100	1370	1475	6.0	3-phase	240
NA 120/45	450	450	600	450	120	1200	1470	1575	9.0	3-phase	310
NA 250/45	450	600	750	600	250	1350	1650	1725	12.0	3-phase	610
NA 500/45	450	750	1000	750	500	1500	1850	1800	18.0	3-phase	1030
NA 675/45	450	750	1200	750	675	1500	2050	1800	24.0	3-phase	1350
N 15/65 HA	650	295	340	170	15	470	845	460	2.4	1-phase	55
N 30/65 HA	650	290	420	260	30	607 + 255	1175	1315	5.5	3-phase[1]	195
N 60/65 HA	650	350	500	350	60	667 + 255	1250	1400	9.0	3-phase	240
N 120/65 HA	650	450	600	450	120	767 + 255	1350	1500	13.0	3-phase	310
N 250/65 HA	650	600	750	600	250	1002 + 255	1636	1860	20.0	3-phase	610
N 500/65 HA	650	750	1000	750	500	1152 + 255	1886	2010	30.0	3-phase	1030
N 675/65 HA	650	750	1200	750	675	1152 + 255	2100	2010	30.0	3-phase	1350
N 30/85 HA	850	290	420	260	30	607 + 255	1175	1315	5.5	3-phase[1]	195
N 60/85 HA	850	350	500	350	60	667 + 255	1250	1400	9.0	3-phase	240
N 120/85 HA	850	450	600	450	120	767 + 255	1350	1500	13.0	3-phase	310
N 250/85 HA	850	600	750	600	250	1002 + 255	1636	1860	20.0	3-phase	610
N 500/85 HA	850	750	1000	750	500	1152 + 255	1886	2010	30.0	3-phase	1030
N 675/85 HA	850	750	1200	750	675	1152 + 255	2100	2010	30.0	3-phase	1350

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

*Please see page 77 for more information about supply voltage

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
- Ovens TR 60 - TR 240 designed as tabletop models
- Ovens TR 450 and TR 1050 designed as floor standing models
- Horizontal, forced air circulation results in temperature uniformity better than +/- 5 °C see page 75
- 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 low-noise operation
- Defined application within the constraints of the operating instructions
- Controls description see page 76

TR 450

TR 1050 with double door

Additional equipment

- Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the oven and load
- Infinitely adjustable fan speed of the air circulation fan
- Window for charge observing
- Further removeable grids with rails
- Side inlet
- Stainless steel collecting pan to protect the furnace chamber
- Safety Technology according to EN 1539 for charges containing liquid solvents (TR .. LS) up to model TR 240 LS, achievable temperature uniformity +/- 8 °C see page 75
- 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 via VCD software package for monitoring, documentation and control see page 76

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	390	350	60	700	610	710	3	1-phase	90	1	4	120
TR 60 LS	260	450	360	350	57	700	680	690	6	3-phase	92	1	4	120
TR 120	300	650	390	500	120	900	610	860	3	1-phase	120	2	7	150
TR 120 LS	260	650	360	500	117	900	680	840	6	3-phase	122	2	7	150
TR 240	300	750	550	600	240	1000	780	970	3	1-phase	165	2	8	150
TR 240 LS	260	750	530	600	235	1000	850	940	6	3-phase	167	2	8	150
TR 450	300	750	550	1100	450	1000	780	1470	6	3-phase	235	3	15	180
TR1050	300	1200	670	1400	1050	1470	940	1920	9	3-phase	450	4	14	250

[1]Max load per layer 30 kg

*Please see page 77 for more information about supply voltage

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

Chamber Ovens
Electrically Heated or Gas-Fired

KTR 1500

KTR 4500

KTR 6125

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

KTR 1500 with charging cart

- Tmax 260 °C
- Electrically heated (via a heating register with integrated chrome steel heating elements) or gas-fired (direct or indirect gas-fired including injection of the hot air into the intake duct)
- Temperature uniformity up to +/- 3 °C according to DIN 17052-1 (for design wihout track cutouts) see page 75
- High-quality mineral wool insulation provides for outer temperatures of < 25 °C above room temperature
- High air exchange for fast drying processes
- Double-wing door for furnaces KTR 3100 and larger
- Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load

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

- Incl. floor insulation
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm Controller: Recording of process data with USB-flash drive
- Controls description see page 76

Additional equipment

- Track cutouts for level drive-in of charging cart
- Base frame to charge the oven via a charging forklift
- Additional Door in the back for charging from both sides or to use the oven as lock between two rooms
- Fan system for faster cooling with manual or motor-driven control of the exhaust flaps
- Programmed opening and closing of exhaust air flaps
- Air circulation with speed control, recommendable for processes with light or sensitive charge
- Observation window and furnace chamber lighting
- Safety technology according to EN 1539 (NFPA 86) (models KTR .. LS) for charges containing solvents see page 12
- Charging cart with or without rack system
- Design for clean room heat treatment processes see page 17
- Rotating systems for tempering processes
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 76

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

Direct gas-firing at a chamber dryer

Chamber Ovens
Electrically Heated or Gas-Fired

Charging cart with pull-out trays

KTR 4500 with platform cart, inner lightning and observation windows

Drive-in tracks with sealing shoes

Accessories

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

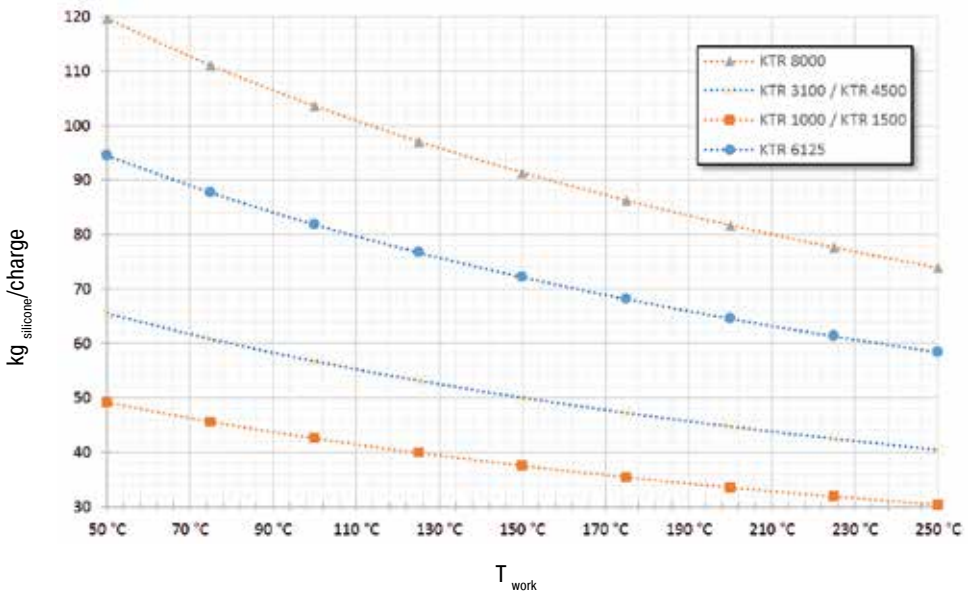
KTR 1500 with shelves

Model	Tmax	Inner dimensions in mm			Volume	Outer dimensions in mm			Heating power in kW[1]	Electrical
	°C	w	d	h	in l	W	D	H	KTR/KTR ..LS	connection*
KTR 1000 (LS)	260	1000	1000	1000	1000	1900	1430	1815	18/on request	3-phase
KTR 1500 (LS)	260	1000	1000	1500	1500	1900	1430	2315	18/36	3-phase
KTR 3100 (LS)	260	1250	1250	2000	3100	2150	1680	2905	27/45	3-phase
KTR 4500 (LS)	260	1500	1500	2000	4500	2400	1930	2905	45/54	3-phase
KTR 6125 (LS)	260	1750	1750	2000	6125	2650	2200	3000	45/63	3-phase
KTR 6250 (LS)	260	1250	2500	2000	6250	2150	3360	3000	54/on request	3-phase
KTR 8000 (LS)	260	2000	2000	2000	8000	2900	2450	3000	54/81	3-phase
KTR 9000 (LS)	260	1500	3000	2000	9000	2400	3870	3000	72/on request	3-phase
KTR 12300 (LS)	260	1750	3500	2000	12300	2650	4400	3000	90/on request	3-phase
KTR 16000 (LS)	260	2000	4000	2000	16000	2900	4900	3000	108/on request	3-phase
KTR 21300 (LS)	260	2650	3550	2300	21300	3800	4300	2500	108/on request	3-phase
KTR 22500 (LS)	260	2000	4500	2500	22500	2900	5400	3500	108/on request	3-phase

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

*Please see page 77 for more information about supply voltage

Max. amount of silicone per charge at a fresh air amount of 120 l/min/kg $_{silicone}$



Adjustable plate shutters to adapt the air guide to the charge

To ensure safe operation of the oven when tempering silicone, the fresh air supply of the oven must be monitored. A fresh air volume flow of 100 - 120 l/min/kg silicone (6-7,2 m³/h/kg silicone) has to be considered. The graph shows the maximum amount of silicone depending on the operating temperature for various KTR models at a fresh air supply of 120 l/min/kg silicone. The oven will be carried out in accordance with the requirements of the standard EN 1539 (NFPA 86) (Description see page 12).

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

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

Drive-in ramp

Dewaxing Furnaces
Electrically Heated

N 300/WAX

N 100/WAX - N 2200/WAX with Electrical Heating
These dewaxing 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 stainless steel grids in the bottom can be removed for cleaning . There is a tight stainless steel container under the dewaxing furnace with a removable drawer for wax collection. After the dewaxing process is finished the furnace continues heating in order to sinter the molds.

- Tmax 850 °C
- Chamber furnace with wide-opening swinging door
- Four side heating with freely radiating heating elements on ceramic carrier tubes

Grid bottom

Drain pan in floor

- 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 adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm Controller: Recording of process data with USB-flash drive
- Controls description see page 76

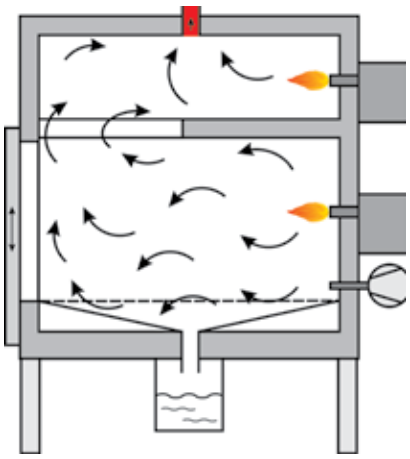
Drawer for collection of liquid wax

Model	Tmax	Inner dimensions in mm			Volume	Outer dimensions in mm			Max. drain-off volume	Heating power	Electrical	Weight
	°C	w	d	h	in l	W	D	H	in l	in kW[1]	connection*	in kg
N 100/WAX	850	400	530	460	100	720	1130	1440	5	7.5	3-phase	340
N 150/WAX	850	450	530	590	150	770	1130	1570	8	9.5	3-phase	360
N 200/WAX	850	500	530	720	200	820	1130	1700	10	11.5	3-phase	440
N 300/WAX	850	550	700	780	300	870	1300	1760	15	15.5	3-phase	480
N 440/WAX	850	600	750	1000	450	1020	1460	1875	17	20.5	3-phase	885
N 660/WAX	850	700	850	1100	650	1120	1560	1975	20	26.5	3-phase	1000
N 1000/WAX	850	800	1000	1250	1000	1580	1800	2400	25	40.5	3-phase	1870
N 1500/WAX	850	900	1200	1400	1500	1680	2000	2550	35	57.5	3-phase	2570
N 2200/WAX	850	1000	1400	1600	2200	1780	2200	2750	50	75.5	3-phase	3170

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

*Please see page 77 for more information about supply voltage

Dewaxing Furnaces
Gas-Fired



NB 300/BOWAX

NB 300/BOWAX with Gas-Fired

The chamber furnace of NB .. BOWAX series is suitable for Flash Fire processes in which the hot furnace is charged with raping castings.

For a quick loading and unloading, the furnace is equipped with a pneumatic lift door, which is controlled via a footswitch.

After charging, the wax liquefies in short time. The first part of the wax flows-out through the integrated pan directly into a catch basin under the furnace and is collected safely in a water tank.

The remainder of the wax evaporates in the oven chamber and is burned safely in the downstream thermal afterburning. The resulting exhaust air is conducted via an exhaust chimney and a secondary customer side piping out of the hall.

In the event of a flame failure of the burner or gas shortage takes place a process termination.

- Tmax 1000 °C
- Standard size with 300 l furnace volume, other sizes on request
- Fully automatic temperature control
- Integrated thermal afterburner incl. Exhaust hood (250 mm)
- Gas burner for operation with natural of LPG gas with permanent monitoring via a PLC
- Multilayer insulation with light-weight refractory bricks and special backing insulation
- Pneumatic lift-door with foot-switch and electromagnetic locking
- Withdrawable wax collecting pan under the furnace
- Optical indication when charging temperature has been reached
- Detailed description of safety functions see page 11
- Defined application within the constraints of the operating instructions
- Controls description see page 80

NB 300/BOWAX

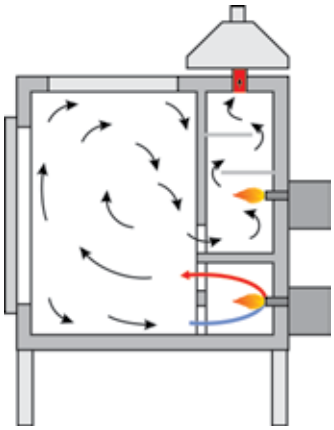
Model	Tmax	Inner dimensions in mm			Volume	Outer dimensions in mm			Max. drain-off volume	Heating power	Electrical
	°C	w	d	h	in l	W	D	H	in l	in kW[1]	connection*
NB 300/BOWAX	1000	550	700	780	300	1010	1700	3030	2	100,0	3-phase

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

*Please see page 77 for more information about supply voltage

Chamber Furnaces for Heat Cleaning

Gas-Fired with Integrated Thermal Afterburner



NB 2300 CL

Before

After

NB 1300 CL

Gas burners for furnace heating and thermal afterburner

The chamber furnaces in the model series NB .. CL 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.

- 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
- Description of safety concept see page 10
- Defined application within the constraints of the operating instructions
- Controls description see page 76

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

Chamber Furnaces for Processes with High Vaporization Rates of Organic Matter or for Thermal Cleaning by Ashing

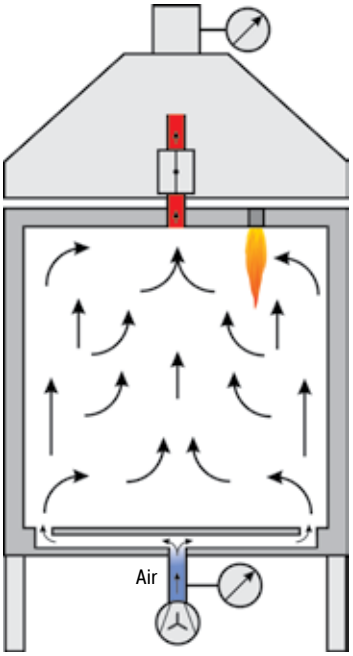
Electrically Heated or Gas-Fired

The chamber furnaces of the model series N .. BO are used for processes with large amounts of organic matters or high vaporization rates. Processes in which the product or contaminations on the product are ashed by ignition can be also carried out safely in this type of furnace. Examples include residual wax removal of pouring clustersfollowed by sintering, or thermal cleaning of oxide catalytic honey combs from soot or fuel residues. The furnaces are electrically heated or gas-fired. The electrically heated furnaces, for safety reasons, are equipped with an integrated gas torch for igniting the flammable components in the gas mixture. The accumulation of flammable components is avoided and their safe combustion is ensured.

The furnace series is suitable for products that will not be damaged by a temporary, uncontrolled temperature rise.

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

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



Models N 100 BO - N 650/14 BO, electrically heated and gas fired ignition flame

- Tmax 1000 °C or 1400 °C
- Standard sizes up to 650 liters furnace chamber, additional sizes on request
- Exhaust hood
- Fully automatic temperature control
- Optional thermal afterburning
- Ignition flame using natural gas or liquid gas (LPG)
- Defined application within the constraints of the operating instructions
- Controls description see page 76

Model	Tmax	Inner dimensions in mm			Outer dimensions in mm			Heating power
	°C	w	d	h	W	D	H	in kW[1]
N 100 BO	1000	400	530	460	1200	1300	2100	9
N 300 BO	1000	550	700	780	1350	1450	2200	20
N 300/14 BO	1400	550	700	780	1350	1450	2200	30
N 650/14 BO	1400	700	850	1100	1700	1900	2700	62

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

N 650/14 BO with ignition burner

Models NB 300 BO and NB 650 BO, gas-fired

- Tmax 1000 °C
- Standard sizes up to 650 liters furnace chamber, additional sizes on request
- Integrated thermal afterburning
- Gas burners operating with natural gas or liquid gas (LPG)
- Defined application within the constraints of the operating instructions
- Controls description see page 76

Model	Tmax	Inner dimensions in mm			Outer dimensions in mm			Output burner
	°C	w	d	h	W	D	H	in kW
NB 300 BO	1000	550	700	780	1250	1650	3000	100
NB 650 BO	1000	700	850	1100	1600	2100	3150	200

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

Fiber insulation and 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
- 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 adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm Controller: Recording of process data with USB-flash drive
- Controls description see page 76

W 2200/14 DB200 with debinding package and catalytical afterburning system

W 8250/S for tempering quartz glass

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
- 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
- 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
- Safety concepts see page 7
- Thermal or catalytic exhaust cleaning systems see page 14
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 76

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 77 for more information about supply voltage

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

Production plant, consisting of 3 lift-top furnaces HAS 1560/95S with sealed housing for operation with nitrogen. Including air/gas heat exchanger for reduced cooling times

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 1000/LB

H 1600/14 DB 200

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. Depending on process conditions, a lift-top- or lift-bottom version is advisable. The system can be expanded to include one or more changeable tables, either manually or motor driven. 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 DB100 or DB200 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
- Lift-top design: electrohydraulically driven hood with fixed table
- Lift-bottom design: driven table and fixed hood
- Five-sided heating from all four sides and from the table provides for a temperature uniformity up to +/- 10 °C according to DIN 17052-1 see page 75
- 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 adjustable cutout temperature 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/LT DB200 for debinding and sintering

H 500 DB200 with catalytic afterburning system, automatic table changing system and security scanners to protect the danger zone

- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm Controller: Recording of process data with USB-flash drive
- Controls description see page 76

Additional equipment

- Tmax to 1400 °C
- 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
- 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
- Safety concepts see page 7
- Exhaust air and exhaust gas piping
- Thermal or catalytic exhaust cleaning systems see page 14
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 76

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

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	1550	1500	2200	12	3-phase	1250
H 250/LB, LT	1280	1000	500	500	250	1530	1700	2300	18	3-phase	1400
H 500/LB, LT	1280	1200	600	600	500	2020	1800	2500	36	3-phase	1800
H 1000/LB, LT	1280	1600	800	800	1000	2200	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 77 for more information about supply voltage

Kiln furniture for small ceramics components

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

N 300/14 DB200

N 1000/14 DB100

Injection of preheated air through perforated ceramic tubes

Calibration interfaces for the measring range

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 is equipped with the debinding package DB100. This debinding package provides for an injection of fresh air for atmosphere dilution which means that the furnace works under overpressure during debinding.

As a professional solution for production furnaces, we recommend the debinding package DB200. The oven then a warm fresh-air injection with variable speed through distribution tubes in the furnace chamber. The exhaust fan operates also with a variable fan speed. The PLC automatically regulates a negative pressure inside the furnace chamber.

- Tmax 1280 °C, 1340 °C or 1400 °C
- Dual shell housing with rear ventilation, provides for low shell temperatures
- 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
- Debinding package DB100 with fresh-air fan, air-preheater and controls see page 7
- Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm Controller: Recording of process data with USB-flash drive
- Controls description see page 76

Production system consisting of five combi chamber furnaces N 300/H DB200 with catalytic afterburning

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 13
- Debinding package DB200 with safety concept see page 7
- Exhaust air and exhaust gas tubing
- Thermal or catalytic exhaust cleaning systems see page 14
- Calibration interfaces for the measring range
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 76

N 697/HS DB200 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	370	530	720	140	1060	1160	1820	3-phase	370
N 300/DB	1280	420	700	780	230	1110	1330	1880	3-phase	410
N 450/DB	1280	470	750	1000	350	1390	1570	2150	3-phase	815
N 650/DB	1280	650	850	1100	610	1500	1670	2270	3-phase	1350
N 1000/DB	1280	740	1000	1250	940	2045	2150	2690	3-phase	2100
N 200/HDB	1340	370	530	720	140	1060	1160	1820	3-phase	420
N 300/HDB	1340	420	700	780	230	1110	1330	1880	3-phase	500
N 450/HDB	1340	470	750	1000	350	1390	1570	2150	3-phase	1040
N 650/HDB	1340	650	850	1100	610	1500	1670	2270	3-phase	1550
N 1000/HDB	1340	740	1000	1250	940	2045	2150	2690	3-phase	2500
N 200/14DB	1400	370	530	720	140	1060	1160	1820	3-phase	450
N 300/14DB	1400	420	700	780	230	1110	1330	1880	3-phase	550
N 450/14DB	1400	470	750	1000	350	1390	1570	2150	3-phase	1320
N 650/14DB	1400	650	850	1100	610	1500	1670	2270	3-phase	1750
N 1000/14DB	1400	740	1000	1250	940	2045	2150	2690	3-phase	2700

*Please see page 77 for more information about supply voltage

Pressure and flow rate displayed as part of debinding package DB200

Chamber Furnaces with Wire Heating up to 1400 °C

N 4550/S

N 1000

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
- Dual shell housing with rear ventilation, provides for low shell temperatures
- Five-side heating provide for good temperature uniformity
- Heating elements on support tubes provide for free heat radiation and long service life
- Controller mounted on furnace door and removable for comfortable operation
- Air outlet in the ceiling, motor driven exhaust air flap for models from N 440
- 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
- Protection of bottom heating and flat stacking surface provided by embedded SiC plate in the floor
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm Controller: Recording of process data with USB-flash drive

Chamber furnaces N 200/14 for sintering semiconductors

- Controls description see page 76

Additional equipment

- Motor driven exhaust air flap for models N 100 - N 300/..
- 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 work space
- 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
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 76

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	720	1130	1440	9	3-phase	275
N 150	1300	450	530	590	150	770	1130	1570	11	3-phase	320
N 200	1300	500	530	720	200	820	1130	1700	15	3-phase	375
N 300	1300	550	700	780	300	870	1300	1760	20	3-phase	450
N 440	1300	600	750	1000	450	1000	1400	1830	30	3-phase	780
N 660	1300	600	1100	1000	660	1000	1750	1830	40	3-phase	950
N 1000	1300	800	1000	1250	1000	1390	1760	2000	57	3-phase	1800
N 1500	1300	900	1200	1400	1500	1490	1960	2150	75	3-phase	2500
N 2200	1300	1000	1400	1600	2200	1590	2160	2350	110	3-phase	3100
N 100/H	1340	400	530	460	100	760	1150	1440	11	3-phase	325
N 150/H	1340	450	530	590	150	810	1150	1570	15	3-phase	380
N 200/H	1340	500	530	720	200	860	1150	1700	20	3-phase	430
N 300/H	1340	550	700	780	300	910	1320	1760	27	3-phase	550
N 440/H	1340	600	750	1000	450	1000	1400	1830	40	3-phase	880
N 660/H	1340	600	1100	1000	660	1000	1750	1830	52	3-phase	1080
N 1000/H	1340	800	1000	1250	1000	1390	1760	2000	75	3-phase	2320
N 1500/H	1340	900	1200	1400	1500	1490	1960	2150	110	3-phase	2700
N 2200/H	1340	1000	1400	1600	2200	1590	2160	2350	140	3-phase	3600
N 100/14	1400	400	530	460	100	760	1150	1440	15	3-phase	325
N 150/14	1400	450	530	590	150	810	1150	1570	20	3-phase	380
N 200/14	1400	500	530	720	200	860	1150	1700	22	3-phase	430
N 300/14	1400	550	700	780	300	910	1320	1760	30	3-phase	550
N 440/14	1400	600	750	1000	450	1000	1400	1820	40	3-phase	1320
N 660/14	1400	600	1100	1000	660	1000	1750	1820	57	3-phase	1560
N 1000/14	1400	800	1000	1250	1000	1390	1760	2000	75	3-phase	2500
N 1500/14	1400	900	1200	1400	1500	1490	1960	2150	110	3-phase	3000
N 2200/14	1400	1000	1400	1600	2200	1590	2160	2350	140	3-phase	3900

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

*Please see page 77 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

Chamber Furnaces with Drawer Bottom or as a Bogie

NW 440

NW 300

NW 150 - NW 1000/H

The chamber furnaces of NW model series combines the attractive quality advantages of the proven models N 150 - N 1000/H with an outstanding product characteristic which substantially simplifies charging.

With a drawer mechanism (NW 150 - NW 300/H) the kiln table can be easily pulled out. The larger models NW 440 - NW 1000/H are designed as shuttle kiln with completely free traversing bogie. Free access in front of the kiln allows for a simplified and clear charging the furnace.

Standard equipment like models N 100 - N 2200/14 (see page 38), except:

- Kiln table can be easily pulled-out (NW 150 - NW 300/H)
- From model NW 440 bogie on four castors (two with brakes) which can be pulled out completely. Accession assistance and removable drawbar for bogie
- Base included in delivery (NW 150 - NW 300/H). Fixed base for larger models.
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm Controller: Recording of process data with USB-flash drive
- Controls description see page 76

Additional equipment

- Motor driven exhaust air flap for models NW 150 - NW 300/..
- Fan system for faster cooling with manual or automatic control
- Multi-zone control for optimal temperature uniformity in the work space
- 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
- Process control and documentation via VCD software package for monitoring, documentation and control see page 76

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
NW 150	1300	450	530	590	150	810	1150	1570	11.0	3-phase	400
NW 200	1300	500	530	720	200	860	1150	1700	15.0	3-phase	460
NW 300	1300	550	700	780	300	910	1320	1840	20.0	3-phase	560
NW 440	1300	600	750	1000	450	1000	1400	1830	30.0	3-phase	970
NW 660	1300	600	1100	1000	660	1000	1750	1830	40.0	3-phase	1180
NW 1000	1300	800	1000	1250	1000	1470	1850	2000	57.0	3-phase	1800
NW 150/H	1340	450	530	590	150	810	1150	1570	15.0	3-phase	520
NW 200/H	1340	500	530	720	200	860	1150	1700	20.0	3-phase	600
NW 300/H	1340	550	700	780	300	910	1320	1840	27.0	3-phase	730
NW 440/H	1340	600	750	1000	450	1000	1400	1830	40.0	3-phase	1260
NW 660/H	1340	600	1100	1000	660	1000	1750	1830	57.0	3-phase	1530
NW 1000/H	1340	800	1000	1250	1000	1470	1850	2000	75.0	3-phase	2320

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

*Please see page 77 for more information about supply voltage

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

NB 2880/S

NB 4330/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
- Depending on the application, special positioning of the gas burners with flame guidance provides for optimal 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
- Exhaust hood
- Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Defined application within the constraints of the operating instructions

Additional equipment

- Fan burner with fully automatic control and ignition
- Safety concepts see page 8
- Exhaust air and exhaust gas piping
- Thermal or catalytic exhaust cleaning systems see page 14
- Recuperator technology for heat recovery
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 76

NB 2304/S with integrated thermal afterburner for hot cleaning of painted parts

Compact burners for standard models up to NB 600

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 11000/HS 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.

WB 3360/14 for reducing firing of porcelain

- 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 adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Defined application within the constraints of the operating instructions

Additional equipment

- Automatic lambda control to set the furnace atmosphere
- Safety concepts see page 8
- 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 exhaust cleaning systems
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 76
- Other additional equipment for bogie hearth furnaces see page 30

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

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.

SiC rod elements on both sides of the furnace

- 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 adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm Controller: Recording of process data with USB-flash drive

Additional equipment

- Safety concepts see page 7
- Exhaust air and exhaust gas piping
- Thermal or catalytic exhaust cleaning systems
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 76

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

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

Electrically Heated or Gas-Fired

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

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

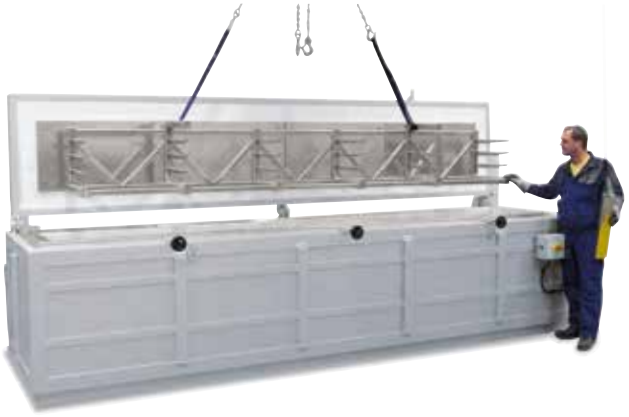
Our top-loading furnaces are perfectly suited for firing, sintering or tempering of long, heavy products. The furnace is usually charged with a factory crane. Due to their high-performance air circulation system, the furnaces provide for excellent temperature uniformity up to a maximum temperature of 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-fired. Customized dimensions are designed and produced to accomodate the size and weight of the components to be treated.

- Tmax 260 °C, 450 °C, 600 °C or 850 °C for furnaces with air circulation
- Tmax 900 °C or 1280 °C for furnaces with radiation heating
- Electrically heated or gas-fired
- Heating from both long sides for furnaces with air circulation
- 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 adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Defined application within the constraints of the operating instructions

Pit-type furnace S 11988/S with rolling lid

Additional equipment

- Motor driven exhaust air flaps for faster cooling
- Controlled fan cooling with motor driven exhaust air flaps
- Multi-zone control of the heating provides for optimum temperature uniformity
- Furnace chamber can be devided in length for short workparts, partitions can be controlled separately
- 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 via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 76



SAT 1512/85S

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

HTC 40/16

HTC 16/16 - HTC 450/16

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

- Tmax 1550 °C
- Dual shell housing with fan cooling for low shell temperatures
- Heating from both sides via vertically mounted SiC rods
- High-quality fiber insulation backed by special insulation
- Side insulation constructed with tongue and groove blocks provides for low heat loss to the outside
- Long-life roof insulation with special suspension
- Chain-guided parallel swivel door for defined opening and closing of the door without destroying the insulation
- Two-door design (front/back) for high-temperature furnaces > HTC 276/..
- Labyrinth sealing ensures the least possible temperature loss in the door area
- Reinforced floor as protection for fiber insulation and to load heavy weights
- Exhaust air opening in the furnace roof
- Heating elements switched via SCR's
- Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm Controller: Recording of process data with USB-flash drive
- Controls description see page 76

Additional equipment like HT models see page 47


Vertically mounted SiC rods and optional perforated air inlet tubes of the debinding system


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	1250	1050	1900	21,0	3-phase	800
HTC 276/16	1550	500	1000	550	276	1300	1600	1900	36,0	3-phase	1100
HTC 450/16	1550	500	1150	780	450	1350	1740	2120	64,0	3-phase	1500

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

*Please see page 77 for more information about supply voltage

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

HT 16/18 with gas supply system

HT 160/17 DB200

Protection of heating elements against mechanical damage

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

HT 04/16 - HT 450/18

The high-temperature furnaces HT 04/16 - HT 450/18 have proven reliability 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.

High-temperature 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 49), 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 rounds-off the system.

- Tmax 1600 °C, 1750 °C or 1800 °C
- Recommended working temperature 1750 °C (for models HT ../18), increased wear and tear must be expected in case of working at higher temperatures
- Dual shell housing with fan cooling for low shell temperatures
- Heating from both sides via molybdenum disilicide heating elements
- High-quality fiber insulation backed by special insulation
- Side insulation constructed with tongue and groove blocks provides for low heat loss to the outside
- Long-life roof insulation with special suspension
- Chain-guided parallel swivel door for defined opening and closing of the door
- Two-door design (front/back) for high-temperature furnaces > HT 276/..
- Labyrinth sealing ensures the least possible temperature loss in the door area
- Reinforced floor as protection for fiber insulation as standard from models HT 16/16 upwards
- Exhaust air opening in the furnace roof
- Heating elements switched via thyristors
- Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Defined application within the constraints of the operating instructions

HT 160/18 DB200 with pneumatically driven and parallel lift door

HT 64/17 DB100 with debinding package

- NTLog Basic for Nabertherm Controller: Recording of process data with USB-flash drive
- Controls description see page 76

Additional equipment

- Uncontrolled or controlled cooling system with frequency-controlled cooling fan and motor-driven exhaust air flap
- Furnace in DB design featuring fresh air preheating, exhaust gas ventilation and an extensive safety package for debinding and sintering in one process, i. e. without transfering the material from the debinding furnace to the sintering furnace
- Stainless steel exhaust gas hoods
- 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 49
- 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
- Inner process box to improve the gas tightness and to protect the furnace chamber against contamination
- Lift door
- Bottom insulation made of durable lightweight refractory bricks for heavy charge weights
- Motorized exhaust air flap, switchable via the program
- Safety concepts see page 6 + 7
- Exhaust air and exhaust gas piping
- Thermal or catalytic exhaust cleaning systems see page 14
- FID measurement for process optimization see page 11
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 76

Fresh air injection through perforated injection tubes with debinding package DB200

Display of pressure and volume flow with debinding package DB200

High-Temperature 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

Two-door design for models > HT 276/..

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	730	490	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	1250	1050	1900	21.0	3-phase	800
HT 276/16	1600	500	1000	550	276	1300	1600	1900	36.0	3-phase	1100
HT 450/16	1600	500	1150	780	450	1350	1740	2120	64.0	3-phase	1500
HT 04/17	1750	150	150	150	4	730	490	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	1250	1050	1900	21.0	3-phase	800
HT 276/17	1750	500	1000	550	276	1300	1600	1900	36.0	3-phase	1100
HT 450/17	1750	500	1150	780	450	1350	1740	2120	64.0	3-phase	1500
HT 04/18	1800	150	150	150	4	730	490	1400	5.2	3-phase[1]	150
HT 08/18	1800	150	300	150	8	730	640	1400	8.0	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	1250	1050	1900	21.0	3-phase	800
HT 276/18	1800	500	1000	550	276	1300	1600	1900	42.0	3-phase	1100
HT 450/18	1800	500	1150	780	450	1350	1740	2120	64.0	3-phase	1500

[1]Heating only between two phases

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

*Please see page 77 for more information about supply voltage

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

HFL 160/17

HFL 16/17

HFL 16/16 - HFL 160/17

The high-temperature furnaces HFL 16/16 - HFL 160/17 are characterized by its lining with robust refractory insulation. 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
- Robust refractory insulation and special backing insulation
- Furnace floor made of lightweight refractory bricks accommodates high charge weights
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm Controller: Recording of process data with USB-flash drive
- Controls description see page 76

Additional equipment like HT models see page 47

Protection grid in front of heating elements prevent against mechanical damages

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
HFL 16/16	1600	200	300	260	16	1000	890	1620	12	3-phase[1]	500
HFL 40/16	1600	300	350	350	40	1130	915	1890	12	3-phase	660
HFL 64/16	1600	400	400	400	64	1230	980	1940	18	3-phase	880
HFL 160/16	1600	500	550	550	160	1400	1250	2100	21	3-phase	1140
HFL 16/17	1700	200	300	260	16	1000	890	1620	12	3-phase[1]	530
HFL 40/17	1700	300	350	350	40	1130	915	1890	12	3-phase	690
HFL 64/17	1700	400	400	400	64	1230	980	1940	18	3-phase	920
HFL 160/17	1700	500	550	550	160	1400	1250	2100	21	3-phase	1190

[1]Heating only between two phases

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

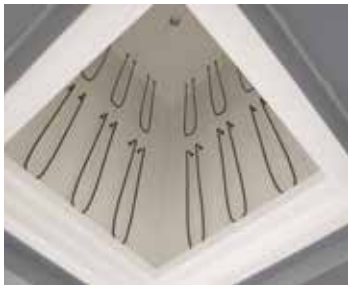
*Please see page 77 for more information about supply voltage

Lift-Top and Lift-Bottom Furnaces with Molybdenum Disilicide Heating Elements up to 1800 °C also as Combi Furnaces for Debinding and Sintering in one Process

HT 166/17 LB

HT 500/17 LB

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



Heating elements arranged one above the other for tall structures

HT 64/16 LB or LT - HT 1080/17 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.

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.

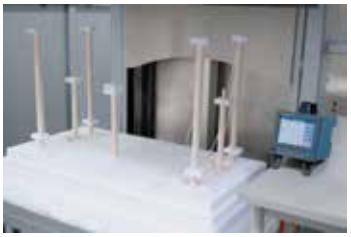
- Tmax 1600 °C, 1750 °C or 1800 °C
- Dual shell housing with fan cooling provides for low shell temperatures
- Lift-top design: electrohydraulically driven hood with fixed table
- Lift-bottom design: driven table and fixed hood
- Gently running, low-vibration spindle drive or electrohydraulic drive for larger models
- Safe and tight closing of the furnace by means of labyrinth seal
- 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
- 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
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm Controller: Recording of process data with USB-flash drive
- Controls description see page 76

Additional equipment

- Uncontrolled or controlled cooling system with frequency-controlled cooling fan and motor-driven exhaust air flap
- Furnace in DB design featuring fresh air preheating, exhaust gas ventilation and an extensive safety package for debinding and sintering in one process, i. e. without transfering the material from the debinding furnace to the sintering furnace
- Stainless steel exhaust gas hoods
- 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
- Special heating elements for zirconia sintering provide for longer service life with respect to chemical interaction between charge and heating elements
- 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
- Inner process box to improve the gas tightness and to protect the furnace chamber against contamination
- Bottom insulation made of durable lightweight refractory bricks for heavy charge weights
- 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
- Safety concepts see page 7
- Exhaust air and exhaust gas piping
- Thermal or catalytic exhaust cleaning systems see page 14
- FID measurement for process optimization see page 13
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 76

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



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

HT 276/17 LT DB200 with manual table changing system and debinding package

Lift-Top and Lift-Bottom Furnaces with Molybdenum Disilicide Heating Elements up to 1800 °C also as Combi Furnaces for Debinding and Sintering in one Process

High-temperature lift-top furnace HT 2600/16 LT DB200 for production

HT 750/18 LTS

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	1100	1750	2400	36	3-phase	1100
HT 166/16 LB, LT	1600	550	550	550	166	1350	2060	2600	42	3-phase	1500
HT 276/16 LB, LT	1600	1000	500	550	276	1800	2100	2600	45	3-phase	1850
HT 400/16 LB, LT	1600	1200	600	550	400	1900	2200	2680	69	3-phase	2600
HT 500/16 LB, LT	1600	1550	600	550	500	2100	2200	2680	69	3-phase	2700
HT 1000/16 LB, LT	1600	1000	1000	1000	1000	1800	2900	3450	140	3-phase	3000
HT 1030/16 LB, LT	1600	2200	600	780	1030	2950	2500	3050	160	3-phase	3200
HT 64/17 LB, LT	1750	400	400	400	64	1100	1750	2400	36	3-phase	1100
HT 166/17 LB, LT	1750	550	550	550	166	1350	2060	2600	42	3-phase	1500
HT 276/17 LB, LT	1750	1000	500	550	276	1800	2100	2600	45	3-phase	1850
HT 400/17 LB, LT	1750	1200	600	550	400	1900	2200	2680	69	3-phase	2600
HT 500/17 LB, LT	1750	1550	600	550	500	2100	2200	2680	69	3-phase	2700
HT 1000/17 LB, LT	1750	1000	1000	1000	1000	1800	2900	3450	140	3-phase	3000
HT 1030/17 LB, LT	1750	2200	600	780	1030	2950	2500	3050	160	3-phase	3200
HT 64/18 LB, LT	1800	400	400	400	64	1100	1750	2400	36	3-phase	1100
HT 166/18 LB, LT	1800	550	550	550	166	1350	2060	2600	42	3-phase	1500
HT 276/18 LB, LT	1800	1000	500	550	276	1800	2100	2600	45	3-phase	1850
HT 400/18 LB, LT	1800	1200	600	550	400	1900	2200	2680	69	3-phase	2600
HT 500/18 LB, LT	1800	1550	600	550	500	2100	2200	2680	69	3-phase	2700
HT 1000/18 LB, LT	1800	1000	1000	1000	1000	1800	2900	3450	140	3-phase	3000
HT 1030/18 LB, LT	1800	2200	600	780	1030	2950	2500	3050	160	3-phase	3200

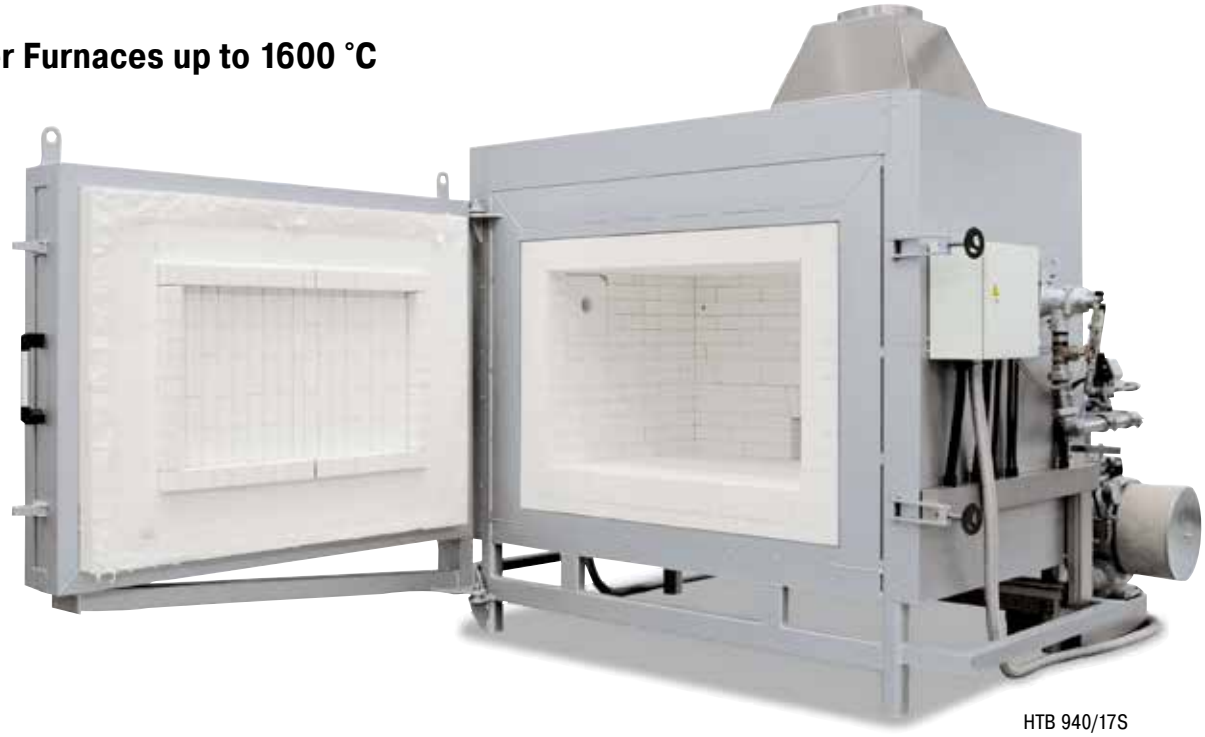
[1]Depending on furnace design connected load might be higher

*Please see page 77 for more information about supply voltage

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

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

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 76
- Defined application within the constraints of the operating instructions

HTB 645/17

Additional equipment

- Automatic lambda control to set the furnace atmosphere
- Exhaust air and exhaust gas piping
- Recuperator burners
- Thermal or catalytic exhaust cleaning systems see page 14
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 76

Continuous Furnaces

Electrically Heated or Gas-Fired

Continuous furnace D 1500/3000/300/14 for thermal ageing with mesh belt transport system and subsequent cooling station

Continuous furnaces are the right choice for processes with fixed cycle times such as drying or preheating, curing, aging, vulcanisation or degassing. The furnaces are available for various temperatures up to a maximum of 1400 °C. The furnace design depends on the required throughput, the process requirements for heat treatment and the required cycle time.

Continuous furnace for bulk materials in baskets

The conveyor technology is tailored to the required working temperature, geometry and weight of the charge and to the requirements regarding available space and integration into the process chain. The conveyor speed and the number of control zones are defined by the process specifications.

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

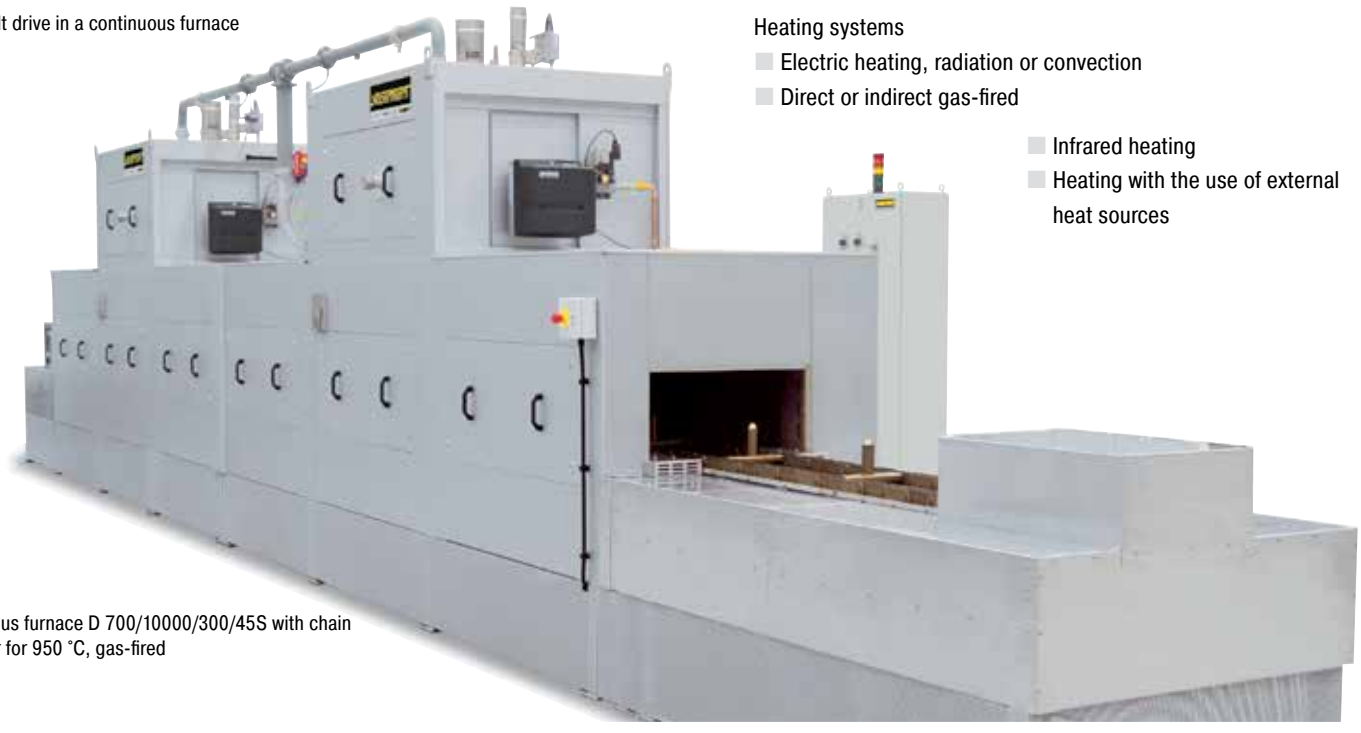
Continuous Furnaces
Electrically Heated or Gas-Fired

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

Mesh belt drive in a continuous furnace

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

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



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

Continuous furnace D 1100/3600/100/50 AS for annealing of springs incl. charging and discharging system

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

Mesh belt drive in continuous furnace D 1100/3600/100/50 AS

Process atmosphere
- In air
- For processes with organic outgassings incl. mandatory safety technology according to EN 1539 (NFPA 86)
- 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

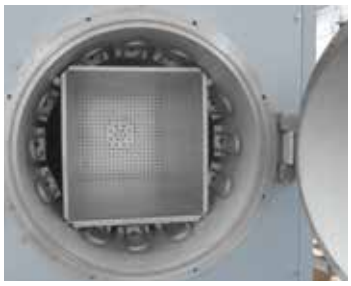
Basic configuration criteria
- Conveyor speed
- Temperature uniformity
- Operating temperature
- Process curve
- Work space width
- Charge weights
- Cycle time or throughput
- Length of charge and discharge zone
- Generated exhaust gases
- Specific industry standards such as AMS, CQI-9, FDA etc.
- Other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

Rotary hearth furnace for preheating

Hot-Wall Retort Furnaces up to 1100 °C

NRA 150/09 with automatic gas injection and process control H3700

NRA 25/06 with gas supply system



Inside heating in models NRA ../06

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

Parallel guided door to open the hot furnace as additional equipment

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 +/- 5 °C inside the work space see page 75
- 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 around the retort
- Temperature uniformity up to +/- 5 °C inside the work space see page 75
- 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 around the retort
- Temperature uniformity up to +/- 5 °C inside the work space see page 75
- Retort made of 1.4841

NRA 480/04S

NRA 50/09 H_2

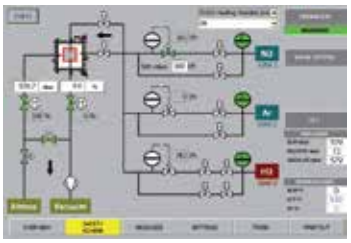
Basic version

- 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
- Depending on furnace volume for 950 °C- and 1100 °C-version the control system is divided in one or more heating zones
- Temperature control as furnace control with temperature measurement outside the retort
- Gas supply system for one non-flammable protective or reaction gas with flow meter and manual valve
- Operation under vacuum up to 600 °C with optional vacuum pumps
- Port for vacuum pump for cold evacuation
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm Controller: Recording of process data with USB-flash drive
- Controls description see page 76

Additional equipment

- Upgrade for other nonflammable gases
- Automatic gas injection, including MFC flow controller for alternating volume flow, controlled with process control H3700, H1700
- Vacuum pump for evacuating of the retort up to 600 °C, attainable vacuum up to 10^{-5} mbar subject to selected pump
- Cooling system for shortening process times
- Heat exchanger with closed-loop cooling water circuit for door cooling
- Measuring device for residual oxygen content
- Door heating
- Temperature control as charge control with temperature measurement inside and outside the retort
- Gas inlet with solenoid valve, controlled by the program
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 76

Vacuum pump for cold evacuation of the retort



Process control H3700 for automatic version

Hot-Wall Retort Furnaces up to 1100 °C

NRA 300/09 H_2 for heat treatment under hydrogen

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

H_2 Version for Operation with Flammable Process Gases

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

- Supply of flammable process gas at controlled overpressure of 50 mbar relative
- Certified safety concept
- PLC controls with graphic touch panel H3700 for data input
- Redundant gas inlet valves for hydrogen
- Monitored pre-pressures of all process gases
- Bypass for safe flushing of furnace chamber with inert gas
- Torch for thermal afterburning of exhaust gases
- Emergency flood container for purging the furnace in case of failore

NR 150/11 IDB with thermal afterburning system

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
- PLC controls with graphic touch panel H1700 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

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	590	900	590	300	3-phase
NRA 400/..	650 or 950	NR 400/11	1100	590	1250	590	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 77 for more information about supply voltage

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 +/- 5 °C inside the work space see page 75
- 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 +/- 5 °C inside the work space see page 75

SRA 300/06 with charging basket

Models SRA ../06 with Tmax 600 °C

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

- Heating inside the retort
- Temperature uniformity up to +/- 5 °C inside the work space see page 75
- Single-zone control
- Retort made of 1.4571

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

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
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm Controller: Recording of process data with USB-flash drive

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

Model	Tmax °C	Inner dimensions of alloy retort ø in mm	h in mm	Volume in l	Outer dimensions in mm W	D	H	Electrical connection*	Weight 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

*Please see page 77 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 8/16-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 retort furnace configurations even for sophisticated applications.

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

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

VHT ../..-GR with Graphite Insulation and Heating

- Suitable for processes under protective and reaction gases or under vacuum
- Tmax 1800 °C 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 VHT ../..-W with Molybdenum or Tungsten Heating

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

VHT ../..-KE with Fiber Insulation and Heating through Molybdenum Disilicide Heating Elements

- Suitable for processes under protective and reaction gases, in air or under vacuum
- Tmax 1800 °C
- Max. vacuum up to 10^{-2} mbar (up to 1300 °C) depending on pump type
- Insulation made of high purity aluminum oxide fiber

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
- H700 process control with clearly laid out 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, Ar or non-flammable forming gas) with adjustable flow
- Bypass with manual valve for rapid filling or flooding of furnace chamber
- Manual gas outlet with overflow valve (20 mbar relative) for over-pressure operation
- Single-stage rotary vane pump with ball valve for pre-evacuating and heat treatment in a rough vacuum to 5 mbar
- Pressure gauge for visual pressure monitoring
- Defined application within the constraints of the operating instructions

Additional equipment

- Tmax 2400 °C for VHT 40/..-GR and larger
- Housing, optionally divisible, for passing through narrow door frames (VHT 08)
- Manual gas supply for second process gas (N_2, Ar or non-flammable forming gas) with adjustable flow and bypass
- Inner process box made of molybdenum, tungsten, graphite or CFC, especially recommended for debinding processes. The box is installed in the furnace with direct gas inlet and outlet and provides for better temperature uniformity. Generated exhaust gases will be directly lead out the inner process chamber during debinding. The change of gas inlet pathes after debinding results in a cleaned process gas atmosphere during sintering.
- 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/..-GR and larger)
- Two-stage rotary vane pump with ball valve for pre-evacuating and heat-treating in a fine vacuum (up to 10^{-2} mbar)
- Turbo molecular pump with slide valve for pre-evacuation and for heat treatment in a high vacuum (up to 10^{-5} mbar) including electric pressure transducer and booster pump
- Other vacuum pumps on request
- Heat exchanger with closed-loop cooling water circuit
- Automation package with process control H3700
  - 12" graphic touch panel
  - Input of all process data like temperatures, heating rates, gas injection, vacuum at the touch panel
  - Display of all process-relevant data on a process control diagram
  - Automatic gas supply for one process gas (N_2, argon or non-flammable forming gas) with adjustable flow
  - Bypass for flooding and filling the chamber with process gas controlled by the program
  - Automatic pre- and post programs, including leak test for safe furnace operation
  - Automatic gas outlet with bellows valve and overflow valve (20 mbar relative) for over-pressure operation
  - Transducer for absolute and relative pressure
- Mass 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)
- Process control and documentation via Nabertherm Control Center (NCC) for monitoring, documentation and control see page 76

Graphite heating chamber

Molybdenum heating chamber

Tungsten heating chamber

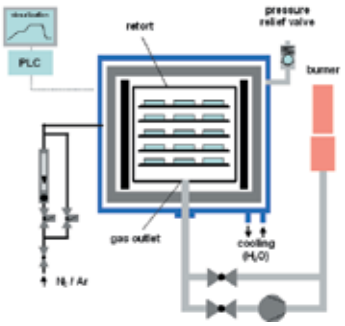
Ceramic fiber insulation

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

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

VHT 40/16-MO H_2

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 retort furnaces can be operated under hydrogen or other reaction gases. For these applications, the systems are additionally equipped with the required safety technology. Only certified and industry proven safety sensors are used. The 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
- Inner process hood in the process chamber for debinding under hydrogen
- Process control and documentation via Nabertherm Control Center (NCC) for monitoring, documentation and control see page 76

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

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

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

Process Box for Debinding in Inert Gas

Certain processes require charges to be debinded in non-flammable protective or reactive gases. For these processes we fundamentally recommend a hot-wall retort furnace (see models NR... or SR...). These 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 retort furnace should be designed to meet this contingency.

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

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

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

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	-	-	-	✓
Hydrogen	✓[3,4]	✓[3]	✓[3]	✓[1,3]
Rough vacuum and fine vacuum (>10^{-3} mbar)	✓	✓	✓	✓[2]
High vacuum (<10^{-3} mbar)	✓[4]	✓	✓	✓[2]
Material of heater	Graphite	Molybdenum	Tungsten	$MoSi_2$
Material of insulation	Graphite felt	Molybdenum	Tungsten/Molybdenum	Ceramic fiber

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

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]	54/60[3]	90	30
VHT 70/..	375	500	375	70	50	1700	2500	2400	105/125[2]	70/100[3]	150	55
VHT 100/..	450	550	450	100	75	1900	2600	2500	131/155[2]	90/140[3]	on request	85
VHT 250/..	600	750	600	250	175	3000[1]	4300	3100	180/210[2]	on request	on request	on request
VHT 500/..	750	900	750	500	350	3200[1]	4500	3300	220/260[2]	on request	on request	on request

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

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 62 ff), the retort furnaces of the SVHT product line offer improved performance data with regard to achievable vacuum and maximum temperature. Due to the design as pit-type furnace with tungsten heating, processes up to max. 2400 °C even in high vacuum can be implemented with 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
- Defined application within the constraints of the operating instructions

Graphite heating module

Cylindrical retort with tungsten heating

Cooling water distribution

- Further standard product characteristics see description for standard design of VHT models page 62

Heating Options

SVHT ..-GR

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

SVHT ..-W

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

Additional equipment such as automatic process gas control or design for the operation with flammable gases incl. safety system see VHT models page 62.

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	1300	2500	2000	55	3-phase
SVHT 9/24-W	2400	230 x 230	9,5	1400	2900	2100	95	3-phase
SVHT 2/30-GR	3000	150 x 150	2,5	1400	2500	2100	65	3-phase
SVHT 9/30-GR	3000	230 x 230	9,5	1500	2900	2100	115	3-phase

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

*Please see page 77 for more information about supply voltage

Lift-Bottom-Retort Furnace up to 2400 °C

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 62

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 77 for more information about supply voltage

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

Acid pump for nitric acid

Retort with internal heating and process chamber

- Large, graphic touch panel H3700 for entering data and for process visualization
- Emergency tank for flushing in case of a failure
- Defined application within the constraints of the operating instructions

Version NRA .. CDB

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

Version NRS .. CTDB

- Safety concepts see page 9
- Availabel for 600 °C and 900 °C with atmosphere circulation

Additional equipment

- Scale for the nitric acid vessel, connected to the PLC monitors the acid consumption and visualizes the fill level of the acid vessel (NRA 150/02 CDB)
- Lift truck for easy loading of the furnace
- Cupboard for acid pump
- Process control and documentation via Nabertherm Control Center (NCC) for monitoring, documentation and control see page 76

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	1400	1600	2400	2,0	3-phase[1]	800	max. 70 ml/h	1000 l/h
NRA 150/02 CDB	200	450	700	450	150	1650	1960	2850	20,0	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 77 for more information about supply voltage

Fast-Firing Furnaces

LS 12/13 and LS 25/13

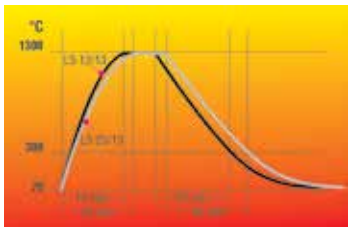
These fast-firing furnaces are ideal for simulation of typical fast-firing processes up to a maximum firing temperature of 1300 °C. The combination of high performance, low thermal mass and powerful cooling fans provides for cycle times from cold to cold up to 35 minutes with an opening temperature of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

- Tmax 1300 °C
- Very compact design
- Ceramic grid tubes as charge support
- Floor and lid heating
- Two-zone control, bottom and lid
- Integrated cooling fans, programmable to speed up charge cooling including housing cooling
- Programmable lid opening of approximately 20 mm for faster cooling without activating the fan
- Thermocouple PtRh-Pt, type S for top and bottom zone
- Castors for easy furnace moving
- Defined application within the constraints of the operating instructions
- Controls description see page 76

LS 25/13

Model	Tmax °C	Inner dimensions in mm w	d	h	Volume in l	Outer dimensions in mm W	D	H	Heating power in kW[1]	Electrical connection*	Weight 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 77 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 gradient furnace is usually charged from the side through the parallel swivel door. A maximum temperature gradient of 400 °C can then be stabilized over the heated length of 1300 mm. On request the furnace also is designed as a lab strand annealing furnace with a second door on the opposite side. If the included fiber separator are used charging is carried-out from the top.

GR 1300/13S

- Tmax 1300 °C
- Heated length: 1300 mm
- Heating elements on support tubes providing for free heat radiation in the kiln chamber
- Charging from the top or through the right side door
- Gas damper suspension of the lid
- 6-zone control
- Separate control of heating zones (each 160 mm long)
- Temperature gradient of 400 °C over the entire length of the kiln chamber, each zone can individually be controlled
- Fiber separators dividing the chamber in six equally sized chambers
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm Controller: Recording of process data with USB-flash drive
- Controls description see page 76

Additional equipment

- Up to ten control zones
- Second parallel swivel door for use as lab strand annealing furnace
- Vertical instead of horizontal lab strand annealing furnace
- Process control and documentation via VCD software package for monitoring, documentation and control see page 76

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

Model	Tmax °C	Inner dimensions in mm w	d	h	Outer dimensions in mm W	D	H	Heating power in kW[1]	Electrical connection*	Weight 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 77 for more information about supply voltage

Chamber Furnaces with Brick Insulation or Fiber Insulation

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

- Tmax 1200 °C, 1300 °C, or 1400 °C
- Dual shell housing with rear ventilation, provides for low shell temperatures
- Five-sided heating for very good temperature uniformity
- Heating elements on support tubes ensure free heat radiation and a long service life
- Controller mounted on furnace door and removable for comfortable operation
- Protection of bottom heating and flat stacking surface provided by embedded SiC plate in the floor
- LH models: multi-layered, fiber-free insulation of light refractory bricks and special backup insulation
- LF models: high-quality non-classified fiber insulation with corner bricks for shorter heating and cooling times
- Door with brick-on-brick seal, hand fitted
- Short heating times due to high installed power

LH 120/12S process box made of quartz glass

- 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
- Defined application within the constraints of the operating instructions
- Controls description see page 76

Additional equipment

- Parallel swinging door, pivots away from operator, for opening when hot
- Lift door with electro-mechanic linear drive

LH 60/13 DB50 for debinding in air

- Separate wall-mounting or floor standing cabinet for switchgear
- 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
- Debinding packages with safety concept up to 60 liters see page 6
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 76

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	680	860	1215	5.0	3-phase[1]	170
LH 30/12	1200	320	320	320	30	700	930	1285	7.0	3-phase[1]	200
LH 60/12	1200	400	400	400	60	780	1070	1365	8.0	3-phase	300
LH 120/12	1200	500	500	500	120	880	1170	1465	12.0	3-phase	410
LH 216/12	1200	600	600	600	216	980	1270	1565	20.0	3-phase	460
LH 15/13	1300	250	250	250	15	680	860	1215	7.0	3-phase[1]	170
LH 30/13	1300	320	320	320	30	700	930	1285	8.0	3-phase[1]	200
LH 60/13	1300	400	400	400	60	780	1070	1365	11.0	3-phase	300
LH 120/13	1300	500	500	500	120	880	1170	1465	15.0	3-phase	410
LH 216/13	1300	600	600	600	216	980	1270	1565	22.0	3-phase	460
LH 15/14	1400	250	250	250	15	680	860	1215	8.0	3-phase[1]	170
LH 30/14	1400	320	320	320	30	700	930	1285	10.0	3-phase[1]	200
LH 60/14	1400	400	400	400	60	780	1070	1365	12.0	3-phase	300
LH 120/14	1400	500	500	500	120	880	1170	1465	18.0	3-phase	410
LH 216/14	1400	600	600	600	216	980	1270	1565	26.0	3-phase	460
LF 15/13	1300	250	250	250	15	680	860	1215	7.0	3-phase[1]	170
LF 30/13	1300	320	320	320	30	700	930	1285	8.0	3-phase[1]	200
LF 60/13	1300	400	400	400	60	780	1070	1365	11.0	3-phase	300
LF 120/13	1300	500	500	500	120	880	1170	1465	15.0	3-phase	410
LF 15/14	1400	250	250	250	15	680	860	1215	8.0	3-phase[1]	170
LF 30/14	1400	320	320	320	30	700	930	1285	10.0	3-phase[1]	200
LF 60/14	1400	400	400	400	60	780	1070	1365	12.0	3-phase	300
LF 120/14	1400	500	500	500	120	880	1170	1465	18.0	3-phase	410

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

*Please see page 77 for more information about supply voltage

Parallel swinging door for opening when hot

Gas supply system

High-Temperature Furnaces Lift-Bottom up to 1700 °C

LHT 02/17 LB with a set of saggars

LHT 16/17 LB

Electrically driven lift-bottom

LHT/LB

The electrically driven lift-bottom considerably allows for proper charging of the high-temperature furnaces LHT/LB. 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.

Saggar

- 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
- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm Controller: Recording of process data with USB-flash drive
- Controls description see page 76

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
- 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 via VCD software package for monitoring, documentation and control see page 76

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	2.9	1-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 77 for more information about supply voltage

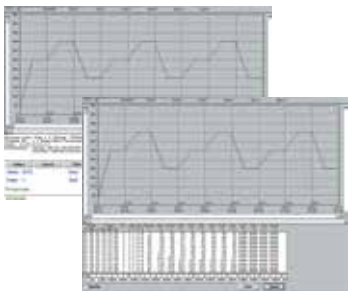
High-Temperature Furnaces with Scale for Determination of Combustion Loss and Thermogravimetric Analyses (TGA)

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

- Defined application within the constraints of the operating instructions
- NTLog Basic for Nabertherm Controller: Recording of process data with USB-flash drive



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

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 77 for more information about supply voltage

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

Customized Tube Furnaces

Rotary Tube Furnace RSR 250/3500/15S

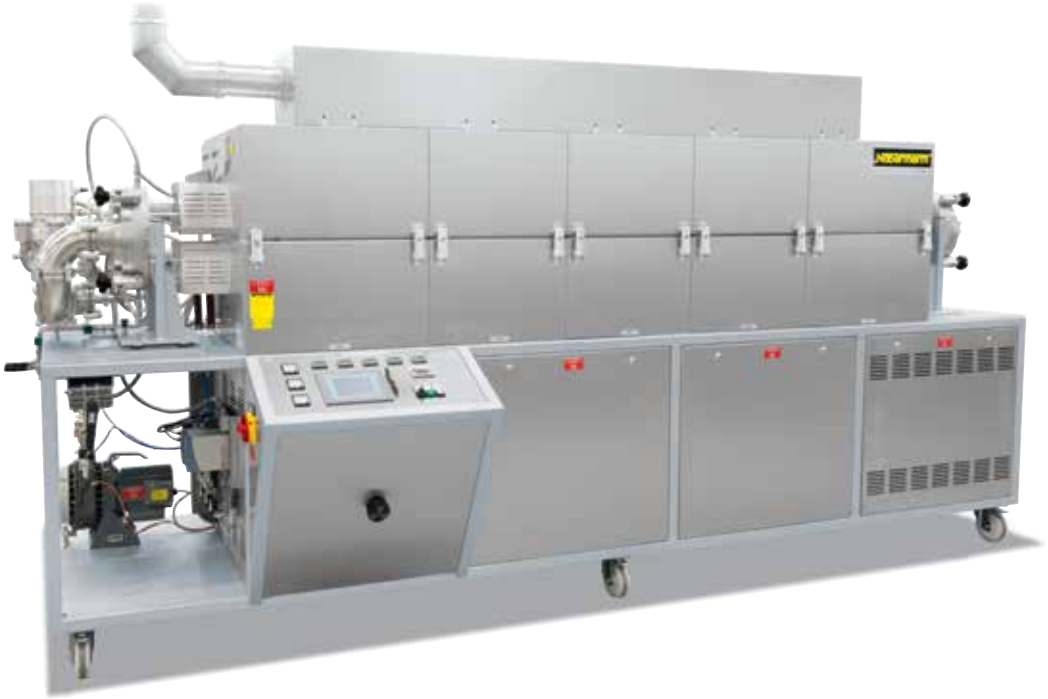
RS 460/1000/16S for integration in a production plant

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

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

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

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



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

Temperature Uniformity and System Accuracy

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

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

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

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

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

Temperature Uniformity in the Work Space incl. Protocol
In standard furnaces a temperature uniformity is guaranteed as +/- K without measurement of temperature uniformity. However, as additional feature, a temperature uniformity measurement at a reference temperature in the work space compliant with DIN 17052-1 can be ordered. Depending on the furnace model, a holding frame which is equivalent in size to the work space is inserted into the furnace. This frame holds thermocouples at 11 defined measurement positions. The measurement of the temperature uniformity is performed at a reference temperature specified by the customer at a pre-defined dwell time. If necessary, different reference temperatures or a defined reference working temperature range can also be calibrated.

Holding frame for measurement of temperature uniformity

Pluggable frame for measurement for air circulation chamber furnace N 7920/45 HAS

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

Precision of the controls, e.g. +/- 1 K

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

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

Process Control and Documentation

B400/C440/P470

B410/C450/P480

H1700 with colored, tabular depiction

H3700 with colored graphic presentation

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

Standard Controllers

Our extensive line of standard controllers satisfies most customer requirements. D60Based on the specific furnace model, the controller regulates the furnace temperature reliably and is equipped with an integrated USB-interface for documentation of process data (NTLog/NTGraph).

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

HiProSystems Control and Documentation

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

Alternative User Interfaces for HiProSystems

Process control H500/H700

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

Process control H1700

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

Process control H3700

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

Control, Visualisation and Documentation with Nabertherm Control Center NCC

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

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

Assignment of Standard Controllers to Furnace Families

	N 15/65 HA	NA, N .. HA	TR	TRS	KTR	N 100/WAX - N 2200/WAX	NB 300/BOWAX	NB .. CL	N .. BO	NB .. BO	W ..	W .../DB	H ../LB or LT	N 200/DB - N 1000/HDB	N 100 - N 2200/14	NW	NB	WB	WHTC	HTC 16/16 - HTC 450/16	HT	HFL	HT .../LB oder LT	HTB	NRA 17/06 - NRA 1000/11	NR, NRA .. H_2	NR, NRA .. IDB	SRA 17 - SR 1500	VHT	SVHT	LBVHT	NRA 40 .. CDB	NRA 150 .. CDB	LS	GR	LH	LHT/LB	LHT .. SW
Catalog page	18	18	20	20	22	26	27	28	29	29	30	30	34	36	38	40	41	42	43	45	46	49	50	54	58	60	60	61	62	66	67	68	68	69	69	70	72	73
Controller																																						
C280															○	○																						
P300		○			○	●[4]					●[4]	●[4]		●[4]	○	○									●[4]			●[4]							○		
P310															○	○				●[4]	●[4]	●[4]														●[4]	●[4]
C6/3208		○			○																																	
R7			●																																			
B130															●[4]	●[4]																						
B150		●[4]			●[4]																															●[4]		
B180	●		○																																			
P330	○		○	○																																		
3504		○	○	○	○													●[4]						○	○			○										
B400		●[4]			●[4]	●[4]									●[4]	●[4]																				●[4]		
B410			○	●																																		
C440						○									○	○																				○		
C450			○	○																																		
P470					○						●[4]	●[4]	●[4]	●[4]	○	○			●[4]	●[4]	●[4]	●[4]	●[4]		●[4]			●[4]						●[4]		○	●[4]	●[4]
P480			○	○																																		
H500/SPS											○				○				○	●[4]	●[4]	●[4]	●[4]											●[4]		○		
H700/SPS							●	●	●	●	○						●		○		○	○	○	●					●	●	●							
H1700/SPS		○			○	○			○	○	○	●[4]	●[4]	●[4]				●[4]		○	○	○	○	○			●	○				●			●			
H3700/SPS		○			○						○	○	○	○				○	○	○	○	○	○	○	○	●		○	○	○	○		●		○			
NCC		○			○						○	○	○	○			○	○	○	○	○	○	○	○				○	○	○	○	○	○		○			

Functionality of the Standard Controllers

	R7	C6	3216	3208	B130	B150	B180	B400/ B410	C280	C440/ C450	P300	P310	P330	P470/ P480	3504	H500	H700	H1700	H3700	NCC
Number of programs	1	1	1		2	1	1	5	9	10	9	9	9	50	25	20	1/10[4]	10	10	50
Segments	1	2	8		3	2	2	4	3	20	40	40	40	40	500[4]	20	20	20	20	20
Extra functions (e.g. fan or autom. flaps) maximum								2	2	2	2[3]	2[3]	2	2-6	2-8[4]	3[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	1	1	3	2[1,2]	1-3[4]	○[4]	8	8	8
Drive of manual zone regulation								●		●		●		●						
Charge control/bath control														●	○	○	○	○	○	○
Auto tune			●	●	●	●	●	●	●	●	●	●	●	●	●					
Real-time clock								●		●			●	●		●	●	●	●	●
Plain, blue-white LC-display					●	●	●	●	●	●	●	●	●	●						
Graphic color display																4"7"	7"	7"	12"	19"
Status messages in clear text				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Data input via number pad							●				●	●	●							
Data entry via touchpanel																●	●	●	●	
Data input via jog dial and buttons								●		●				●						
Entering program names (i.e."Sintering")								●		●				●						●
Keypad lock					●	●		●	●	●				●	●					
User administration								●		●				●		○	○	○	○	●
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]							
Set point output																○	○	○	○	
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 VCD software					○	○	○		○	○		○	●							
Malfunction memory					●	●	●	●	●	●	●	●	●	●		●	●	●	●	●

[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..

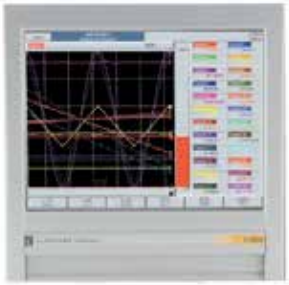
● Standard
○ Option

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).

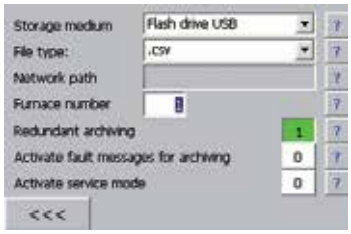


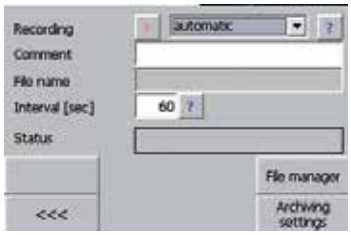
Temperature recorder

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





NTLog Comfort for data recording of a Siemens PLC

Data storing of Nabertherm controllers with NTLog Basic

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

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

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

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

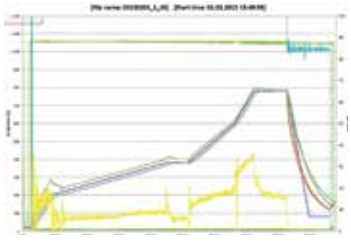
Data storing of HiProSystems with NTLog Comfort

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

Visualization with NTGraph

The process data from NTLog can be visualized either using the customer‘s own spreadsheet program (e.g. MS-Excel) or NTGraph (Freeware). With NTGraph Nabertherm provides for 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 for Windows (version 2003/2010/2013). After data import presentation as diagram, table or report can be chosen. The design (color, scaling, reference labels) can be adapted by using prepared sets.

NTGraph is available in seven languages (DE/EN/FR/SP/IT/CH/RU). In addition, selected texts can be generated in other languages.



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

VCD-Software for Visualization, Control and Documentation

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

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

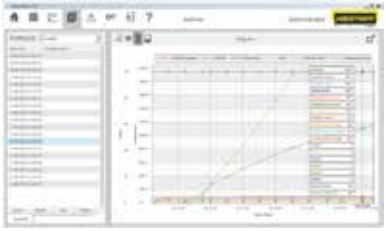
VCD Software for Control, Visualisation and Documentation

Example lay-out with 3 furnaces

Features

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

Graphic display of main overview (version with 4 furnaces)



Graphic display of process curve

Nabertherm
MORE THAN HEAT 30-3000 °C

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