

## Cold-Wall Retort Furnaces up to 2400 °C



Retort furnace VHT 500/22-GR H<sub>2</sub> with CFC-process box and extension package for operation under hydrogen

The compact retort furnaces of the VHT product line are available as electrically heated chamber furnaces with graphite, molybdenum, tungsten or MoSi<sub>2</sub> 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.



Graphite heating chamber

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<sup>-5</sup> mbar. The basic furnace is suited for operation with non-flammable protective or reactive gases or under vacuum. The H<sub>2</sub> version provides for operation under hydrogen or other flammable gases. Key of the specification up is a certified safety package providing for a safe operation at all times and triggers an appropriate emergency program in case of failure.

### Alternative Heating Specifications

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

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

- Suitable for processes under protective and reaction gases or under vacuum
- Tmax 1800 °C, 2200 °C or 2400 °C (VHT 40/.. - VHT 100/..)
- Max. vacuum up to 10<sup>-4</sup> 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<sup>-5</sup> mbar depending on pump type used
- Insulation made of molybdenum resp. tungsten radiation sheets

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

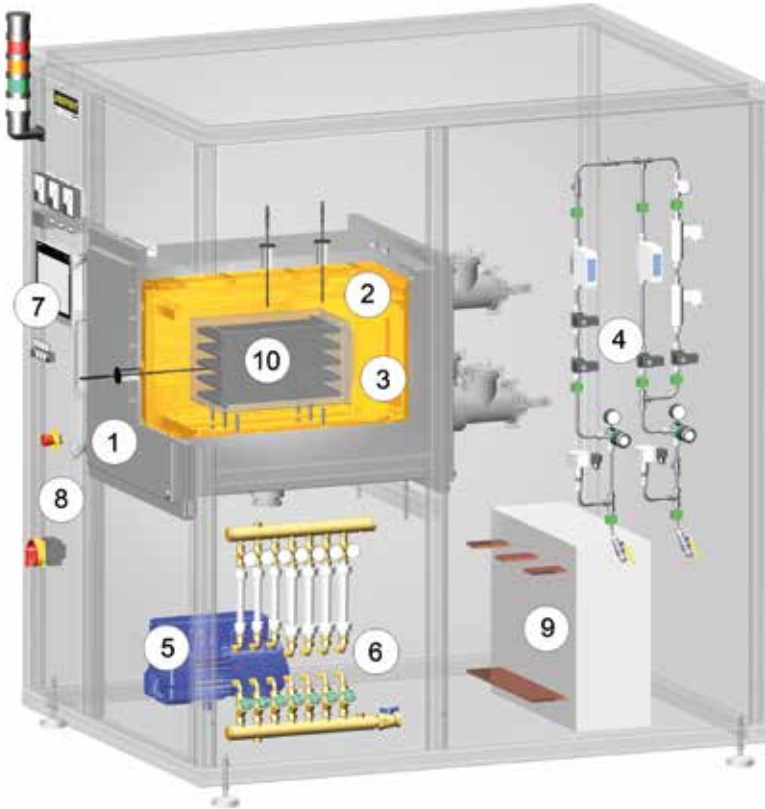
- Suitable for processes under protective and reaction gases, in air or under vacuum
- Tmax 1800 °C
- Max. vacuum up to 10<sup>-2</sup> mbar (up to 1300 °C) depending on pump type
- Insulation made of high purity aluminum oxide fiber
- Only fiber materials are used which are not classified as carcinogenic according to TRGS 905, class 1 or 2



Molybdenum or tungsten heating chamber



Molybdenumdisilicide heater and fiber insulation



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

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

#### Basic version

- Standard furnace sizes 8 - 500 liters
- Water-cooled retort made of stainless steel
- Frame made of stable steel profiles, easy to service due to easily removable stainless steel panels
- Housing of the VHT 8 model on castors for easy repositioning of furnace
- Cooling water manifold with manual tap, automatic flow monitoring, open-loop cooling water system
- Adjustable cooling water circuits with flowmeter and temperature indicator and overtemperature protection
- Switchgear and controller integrated in furnace housing
- Process control with controller P470
- Over-temperature limiter with adjustable cutout temperature for thermal protection class 2 in accordance with EN 60519-2
- Manual operation of the process gas and vacuum functions
- Manual gas supply for one process gas ( $N_2$ , 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



Retort furnace VHT 8/16-MO with automation package



Retort furnace VHT 100/16-MO with automation package



#### Additional equipment housing/heater

- Housing, optionally divisible, for passing through narrow door frames (VHT 8)
- Lift door
- Individual heating concepts

#### Additional equipment gas management system

- Manual gas supply for second process gas ( $N_2$ , Ar or non-flammable forming gas) with adjustable flow and bypass
- Mass flow controller for alternating volume flow and generation of gas mixtures with second process gas (only with automation package)
- Inner process box made of molybdenum, tungsten, graphite or CFC, especially recommended for debinding processes. The box is installed in the furnace with direct gas inlet and outlet and provides for better temperature uniformity. Generated exhaust gases will be directly lead out the inner process chamber during debinding. The change of gas inlet pathes after debinding results in a clean process gas atmosphere during sintering.

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



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

#### Additional equipment vacuum

- Two-stage rotary vane pump with ball valve for pre-evacuating and heat-treating in a fine vacuum (up to  $10^{-2}$  mbar) incl. electronic pressure sensor
- Turbo molecular pump with slide valve for pre-evacuation and for heat treatment in a high vacuum (up to  $10^{-5}$  mbar) including electronic pressure sensor and booster pump
- Other vacuum pumps on request
- Partial pressure operation: protective gas flushing at controlled underpressure (only with automation package)

#### Additional equipment cooling

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



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

#### Additional equipment for controls and documentation

- Charge thermocouple with display
- Temperature measurement at 2200 °C models with pyrometer in the upper temperature range and thermocouple, type C with automatic pull-out device for precise control results in the low temperature range (VHT 40/..-GR and larger)
- Automation package with process control H3700
  - 12" graphic touch panel
  - Input of all process data like temperatures, heating rates, gas injection, vacuum at the touch panel
  - Display of all process-relevant data on a process control diagram
  - Automatic gas supply for one process gas ( $N_2$ , argon or non-flammable forming gas) with adjustable flow
  - Bypass for flooding and filling the chamber with process gas controlled by the program
  - Automatic pre- and post programs, including leak test for safe furnace operation
  - Automatic gas outlet with bellows valve and overflow valve (20 mbar relative) for over-pressure operation
  - Transducer for absolute and relative pressure
- Process control and documentation via VCD software package or Nabertherm Control Center (NCC) for monitoring, documentation and control see page 75



Turbo-molecular pump



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<sup>-2</sup> mbar



Turbo-molecular pump with booster pump for heat treatment in a vacuum to 10<sup>-5</sup> mbar

### Process Box for Debinding in Inert Gas

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

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

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

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

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



Graphite inner process chamber incl. charge holder



Molybdenum inner process chamber incl. six charge supports



Front made of textured stainless steel for mostly all furnace models

	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	✓ <sup>3,4</sup>	✓ <sup>3</sup>	✓ <sup>3</sup>	✓ <sup>1,3</sup>
Rough vacuum and fine vacuum (>10 <sup>-3</sup> mbar)	✓	✓	✓	✓ <sup>2</sup>
High vacuum (<10 <sup>-3</sup> mbar)	✓ <sup>4</sup>	✓	✓	✓ <sup>2</sup>
Material of heater	Graphite	Molybdenum	Tungsten	MoSi <sub>2</sub>
Material of insulation	Graphite felt	Molybdenum	Tungsten/Molybdenum	Ceramic fiber

<sup>1</sup>Tmax reduces to 1400 °C

<sup>2</sup>Depending on the temperature

<sup>3</sup>Only with safety package for flammable gases

<sup>4</sup>Up to 1800 °C

Model	Inner dimensions of process box in mm			Volume in l
	w	d	h	
VHT 8/..	120	210	150	3,5
VHT 25/..	200	350	200	14,0
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 in l	Max. charge weight/kg	Outer dimensions <sup>6</sup> in mm			Heating power in kW <sup>4</sup>			
	w	d	h			W	D	H	Graphite	Molybdenum	Tungsten	Ceramic fiber
VHT 8/..	170	240	200	8	5	1250 (800) <sup>1</sup>	1100	2700 <sup>5</sup>	27/27/- <sup>2</sup>	19/34 <sup>3</sup>	50	12
VHT 25/..	250	400	250	25	20	1500	2500	2200	70/90/- <sup>2</sup>	45/65 <sup>3</sup>	85	25
VHT 40/..	300	450	300	40	30	1600	2600 <sup>5</sup>	2300	83/103/125 <sup>2</sup>	54/90 <sup>3</sup>	110	30
VHT 70/..	375	500	375	70	50	1800 <sup>5</sup>	3300 <sup>5</sup>	2400	105/125/150 <sup>2</sup>	70/110 <sup>3</sup>	130	55
VHT 100/..	450	550	450	100	75	1900	3500 <sup>5</sup>	2500	131/155/175 <sup>2</sup>	90/140 <sup>3</sup>	on request	85
VHT 250/..	600	750	600	250	175	3000 <sup>1</sup>	4300	3100	180/210/- <sup>2</sup>	on request	on request	on request
VHT 500/..	750	900	750	500	350	3200 <sup>1</sup>	4500	3300	220/260/- <sup>2</sup>	on request	on request	on request

<sup>1</sup>With separated switching system unit

<sup>2</sup>1800 °C/2200 °C

<sup>3</sup>1200 °C/1600 °C

<sup>4</sup>Depending on furnace design connected load might be higher

<sup>5</sup>Dimensions may be smaller depending on the heater type

<sup>6</sup>External dimensions vary when furnace is equipped with additional equipment. Dimensions on request.