

# Tube Furnaces up to 1800 °C

Tube furnaces are ideal for heat treating small components and can be perfectly adapted to the different processes by using an extensive range of accessories. Particularly due to the different gas supply systems, tube furnaces are ideal for processes in a defined atmosphere with flammable or non-flammable process gases or under vacuum and are characterized by excellent temperature uniformity.

The following equipment applies to all furnaces in this chapter:



Dual shell ventilated housing made of textured stainless steel sheets for low surface temperature and high stability



Solid state relays provide for lownoise operation



Exclusive use of insulation materials without categorization according to EC Regulation No 1272/2008 (CLP). This explicitly means that alumino silicate wool, also known as "refractory ceramic fiber" (RCF), which is classified and possibly carcinogenic, is not used.



Defined application within the constraints of the operating instructions



Controller with intuitive touch operation



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



Freeware NTEdit for convenient program input via Excel™ for Windows™ on the PC



Freeware NTGraph for evaluation and documentation of firings using Excel™ for Windows™ on the PC



MyNabertherm App for online monitoring of the firing on mobile devices for free download



As additional equipment: Process control and documentation via VCD software package for monitoring, documentation and control



Furnace Group	Model	Page
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## Compact Tube Furnaces up to 1100 °C

The RD 30/200/11 tube furnace impresses with its very good price-performance ratio, particularly compact external dimensions and its low weight. This all-rounder is equipped with a working tube, which also serves as support for the heating wires. The working tube is therefore part of the furnace heating, with the advantage that the tube furnace reaches very high heating speeds. The furnace is designed for horizontal use up to 1100 °C.



Tube furnace RD 30/200/11

### Standard Equipment

- Tmax 1100 °C
- Inner diameter of the tube: 30 mm, heated length: 200 mm
- Ceramic working tube C 530 including two fiber plugs for operation under air
- Thermocouple type K (1100 °C)
- Heating wires wound directly around the working tube resulting in very fast heat-up rates
- Controller R7, alternative controllers see page 84

### Additional Equipment

- Over-temperature limiter with adjustable cutout temperature as temperature limiter to protect the furnace and load
- Gas supply system 1 for non-flammable process gas see page 34

Model	Tmax <sup>1</sup> in °C	Outer dimensions <sup>2</sup> in mm			Inner tube Ø in mm	Heated length in mm	Length constant temperature <sup>1</sup> +/- 5 K in mm	Max. connected load in kW	Heating time <sup>3</sup> in min	Electrical connection <sup>*</sup>	Weight in kg
		W	D	H							
RD 30/200/11	1100	350	200	350	30	200	65	1.65	20	1-phase	12

<sup>1</sup>Values outside the tube. Difference to temperature inside the tube up to + 50 K

<sup>2</sup>External dimensions vary when furnace is equipped with additional equipment. Dimensions on request.

<sup>3</sup>Heating time of the empty and closed furnace up to Tmax - 100 K (connected to 230 V 1/N/PE)

<sup>\*</sup>Please see page 84 for more information about supply voltage



Controller R7



Gas panel for one non-flammable process (N<sub>2</sub>, Ar, He, CO<sub>2</sub>, air, forming gas)



Example of an over-temperature limiter

## Compact Tube Furnaces up to 1300 °C

These compact tube furnaces with integrated control systems can be used universally for many processes. Equipped with a standard working tube of C 530 ceramic and two fiber plugs, these tube furnaces have a very good price/performance ratio.



Tube furnace R 170/1000/13



Tube furnace R 50/250/13 with gas supply system 2

### Standard Equipment

- Tmax 1200 °C or 1300 °C
- Single-zoned design
- Outer tube diameter of 50 mm to 170 mm, heated length from 250 mm to 1000 mm
- Ceramic working tube C 530 including two fiber plugs for operation under air see page 32
- Thermocouple type N (1200 °C) or type S (1300 °C)
- Heating elements on support tubes provide for free radiation see page 38
- Controller with touch operation B510 (5 programs with each 4 segments), alternative controllers see page 84

### Additional Equipment

- Over-temperature limiter with adjustable cutout temperature as temperature limiter to protect the furnace and load
- Charge control with temperature measurement in the working tube see page 38
- Three-zoned design (heated length from 500 mm) for optimization of temperature uniformity
- Alternative working tubes see page 32
- Gas supply systems 1, 15, 2 or 4 see page 34

Model	Tmax <sup>1</sup>	Outer dimensions <sup>3</sup> in mm			Outer tube Ø in mm	Heated length in mm	Length constant <sup>1</sup> temperature +/- 5 K in mm		Tube length in mm	Max. connected load in kW	Electrical connection*	Weight in kg
	in °C	W <sup>2</sup>	D	H			single-zoned	three-zoned				
R 50/250/12	1200	434	340	508	50	250	80	-	450	1.9	1-phase	22
R 50/500/12	1200	670	340	508	50	500	170	250	700	3.4	1-phase	34
R 120/500/12	1200	670	410	578	120	500	170	250	700	6.6	3-phase	44
R 170/750/12	1200	920	460	628	170	750	250	375	1070	10.6	3-phase	74
R 170/1000/12	1200	1170	460	628	170	1000	330	500	1400	13.7	3-phase	89
R 50/250/13	1300	434	340	508	50	250	80	-	450	1.9	1-phase	22
R 50/500/13	1300	670	340	508	50	500	170	250	700	3.4	1-phase	34
R 120/500/13	1300	670	410	578	120	500	170	250	700	6.6	3-phase	44
R 170/750/13	1300	920	460	628	170	750	250	375	1070	12.0	3-phase	74
R 170/1000/13	1300	1170	460	628	170	1000	330	500	1400	13.7	3-phase	89

<sup>1</sup>Values outside the tube. Difference to temperature inside the tube up to + 50

<sup>2</sup>Without tube

<sup>3</sup>External dimensions vary when furnace is equipped with additional equipment. Dimensions on request.

\*Please see page 84 for more information about supply voltage



Tube furnace R 50/500/12 with three zone control



Gas panel for one non-flammable process (N<sub>2</sub>, Ar, He, CO<sub>2</sub>, air, forming gas)



Thermocouple for charge control

## Split-Type Tube Furnaces for Horizontal or Vertical Operation up to 1300 °C

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

Using a wide range of accessories, these professional tube furnaces can be optimally tailored for your process. By adding different gas supply packages, you can work in a protective gas atmosphere, with gases or in a vacuum. In addition to the convenient standard controllers, modern PLC controls can also be used to control the process.



Tube furnace RSH 50/500/13



Tube furnace RSV 170/1000/11 with gas-tight quartz glass working tube and water-cooled vacuum flanges

### Standard Equipment

- Tmax 1100 °C or 1300 °C
- Single-zoned design
- RSV models with frame for vertical operation
- Split-type design for simple insertion of the working tube (opening temperature < 180 °C)
- Ceramic working tube C 530 including two fiber plugs for operation under air see page 32
- Thermocouple type N (1100 °C) or type S (1300 °C)
- Heating elements on support tubes provide for free radiation see page 38
- RSH: switchgear and control unit integrated in furnace housing
- RSH: controller with touch operation B510 (5 programs with each 4 segments), alternative controllers see page 84
- RSV: switchgear and control unit separate from furnace in own wall or standing cabinet
- RSV: controller with touch operation B500 (5 programs with each 4 segments), alternative controllers see page 84

### Additional Equipment

- Charge control with temperature measurement in the working tube see page 38
- Three-zone control for optimization of temperature uniformity see page 38
- Alternative working tubes see chart page 32
- Cooling systems for accelerated cooling of the working tube and charge
- Gas supply systems 1, 15 or 2 for non-flammable process gas operation see page 34
- Gas supply system 4 for hydrogen operation see page 36
- Vacuum package to evacuate the working tube see page 37



Tube furnace RSH 80/500/13 with gas-tight quartz glass working tube and air-cooled vacuum flanges (gas supply system 15)

Model	Tmax <sup>1</sup> in °C	Outer dimensions <sup>2</sup> in mm			Max. outer tube Ø in mm	Heated length in mm	Length constant temperature <sup>1</sup> +/- 5 K in mm		Tube length in mm	Max. connected load in kW		Electrical connection <sup>4</sup>	Weight in kg
		W <sup>3</sup>	D	H			single zoned	three zoned		1100 °C	1300 °C		
RSH 50/250/..		420	385	510	50	250	80	-	450	1.9	1.9	1-phase	25
RSH 50/500/..		670	385	510	50	500	170	250	700	3.4	3.4	1-phase <sup>4</sup>	36
RSH 80/500/..		670	450	580	80	500	170	250	850	6.6	6.6	3-phase <sup>4</sup>	46
RSH 80/750/..		920	500	920	80	750	250	375	1100	10.6	12.0	3-phase <sup>4</sup>	76
RSH 80/1000/..	1100	1170	500	920	80	1000	330	500		13.7	13.7	3-phase <sup>4</sup>	91
RSH 120/500/..	or	670	450	580	120	500	170	250	850	6.6	6.6	3-phase <sup>4</sup>	46
RSH 120/750/..	1300	920	500	920	120	750	250	375	1100	10.6	12.0	3-phase <sup>4</sup>	76
RSH 120/1000/..		1170	500	920	120	1000	330	500	1350	13.7	13.7	3-phase <sup>4</sup>	91
RSH 170/750/..		920	500	920	170	750	250	375	1100	10.6	12.0	3-phase <sup>4</sup>	76
RSH 170/1000/..		1170	500	920	170	1000	330	500	1350	13.7	13.7	3-phase <sup>4</sup>	91
RSV 50/250/..		410	585	975	50	250	80	-	450	1.9	1.9	1-phase	25
RSV 50/500/..		410	585	1225	50	500	170	250	700	3.4	3.4	3-phase <sup>4</sup>	36
RSV 80/500/..		480	585	1225	80	500	170	250	850	6.6	6.6	3-phase <sup>4</sup>	46
RSV 80/750/..		540	635	1480	80	750	250	375	1100	10.6	12.0	3-phase <sup>4</sup>	76
RSV 80/1000/..	1100	540	635	1730	80	1000	330	500		13.7	13.7	3-phase <sup>4</sup>	91
RSV 120/500/..	or	480	585	1225	120	500	170	250	850	6.6	6.6	3-phase <sup>4</sup>	46
RSV 120/750/..	1300	540	635	1480	120	750	250	375	1100	10.6	12.0	3-phase <sup>4</sup>	76
RSV 120/1000/..		540	635	1730	120	1000	330	500	1350	13.7	13.7	3-phase <sup>4</sup>	91
RSV 170/750/..		540	635	1480	170	750	250	375	1100	10.6	12.0	3-phase <sup>4</sup>	76
RSV 170/1000/..		540	635	1730	170	1000	330	500	1350	13.7	13.7	3-phase <sup>4</sup>	91

<sup>1</sup>Values outside the tube. Difference to temperature inside the tube up to + 50 K

<sup>2</sup>External dimensions vary when furnace is equipped with additional equipment. Dimensions on request.

<sup>3</sup>Without tube

<sup>4</sup>At 3-phase execution an N conductor ist required (3/N/PE)

\*Please see page 84 for more information about supply voltage



Tube furnace RSH 80/500/13 with gas tight tube and water-cooled flanges



RSH 120/500/11S with sliding furnace



RSH 210/1000/11S with quartz glass working tube and gas supply package 2

## Rotary Tube Furnaces for Batch Operation up to 1100 °C

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



Rotary tube furnace RSRB 80/500/11 as tabletop version for batch operation

### Standard Equipment

- Tmax 1100 °C
- Single-zoned design
- Thermocouple type N
- Heating elements on support tubes provide for free radiation see page 38
- Tube furnace designed as table-top model with quartz glass reactor which opens on both sides, tapered ends
- Reactor is removed for emptying out of the rotary tube furnace. Beltless drive and hinged furnace housing (opening temperature < 180 °C) provide for very easy removal through
- Adjustable drive of approx. 1-40 rpm
- Controller with touch operation B510 (5 programs with each 4 segments), alternative controllers see page 84

### Additional Equipment

- Charge control with temperature measurement in the working tube see page 38
- Three-zone control for optimization of temperature uniformity see page 38
- Reactor open on both sides, made of quartz glass with knobs for better mixing of the charge in the tube
- Gas supply system 25 for operation under non-flammable process gases with a gas-tight rotating outlet see page 34
- Gas supply system 4 for hydrogen operation see page 36
- Vacuum package for evacuating the working tube, depending on the pump used up to  $10^{-2}$  mbar see page 37
- Left/right tilting device for easier loading and unloading of the work tube
  - For filling, the furnace is tilted to the right to convey the batch into the furnace. After the heat treatment, the furnace is swiveled to the opposite side for emptying, in order to convey the product out of the reactor again. It is not necessary to remove the reactor.
  - Mixing reactor made of quartz glass with integrated blade for better mixing of the batch, closed on one side, large opening on the opposite side
  - Rotary tube furnace assembled on base with integrated switchgear and controller, incl. transport casters



Rotary tube furnace RSRB 120/750/11 S with tilting mechanism to the left/to the right



RSRB 170/1000/11 H<sub>2</sub> with gas supply package 4 for hydrogen application

Model	Tmax <sup>1</sup> in °C	Outer dimensions <sup>2</sup> in mm (Table-top model)			Max. outer tube Ø in mm	Ø Terminal end in mm	Heated length in mm	Length constant Temperature <sup>1</sup> +/- 5 K in mm		Tube length in mm	Max. connected load in kW	Electrical connection*	Weight in kg
		W	D	H				single zoned	three zoned				
RSRB 80/500/11	1100	1200	445	580	76	28	500	170	250	1140	6.6	3-phase	100
RSRB 80/750/11	1100	1450	495	630	76	28	750	250	375	1390	10.6	3-phase	115
RSRB 120/500/11	1100	1200	445	580	106	28	500	170	250	1140	6.6	3-phase	105
RSRB 120/750/11	1100	1450	495	630	106	28	750	250	375	1390	10.6	3-phase	120
RSRB 120/1000/11	1100	1700	495	630	106	28	1000	330	500	1640	13.7	3-phase	125

<sup>1</sup>Values outside the tube. Difference to temperature inside the tube up to + 50 K

<sup>2</sup>External dimensions vary when furnace is equipped with additional equipment. Dimensions on request.

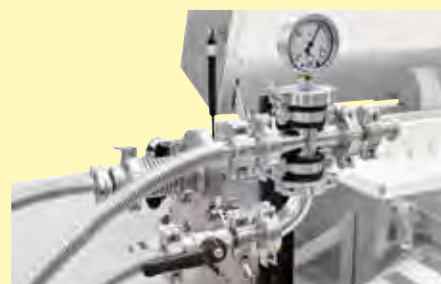
\*Please see page 84 for more information about supply voltage



Gas tight closing plug for tubes made of quartz glass closed at one side as additional equipment



Gas tight rotating union with gas cooler and charge thermocouple



Connection set for vacuum operation



## Rotary Tube Furnaces for Processes with Continuous Movement up to 1300 °C

The rotary tube furnaces of the RSRC series are particularly suitable for processes in which continuously running batch material is heated short-time. These rotary furnaces can be used very flexibly for various purposes. The rotary tube furnace is slightly inclined and brought to the target temperature. The material is then fed continuously at the top of the pipe. It passes through the heated zone of the tube and falls out of the pipe at the lower end. The time of the heat treatment depends on the angle of inclination, the speed of rotation and the length of the working tube, as well as from the flow properties of the batch material. Equipped with the optionally available closed feeding system, the rotary tube furnace can also be used for processes in a defined atmosphere or in a vacuum. Depending on the process, batch and required maximum temperature, work tubes made of different materials are used.



Rotary tube furnace RSRC 120750/13

### Standard Equipment

- Tmax 1100 °C
  - Working tube made of quartz glass open at both sides
  - Thermocouple type N
- Tmax 1300 °C
  - Open ceramic tube C 530
  - Thermocouple type S
- Heating elements on support tubes provide for free radiation see page 38
- Adjustable drive of approx. 0.5-20 rpm
- Digital display unit for the tilting angle of the rotary tube furnace
- Split-type furnace housing (opening temperature < 180 °C) provide for easy tube change
- Compact system, rotary tube furnace positioned on a base frame with
  - Manual spindle drive with crank to set the tilting angle
  - Switchgear and controls integrated
  - Castors
- Controller with touch operation B500 (5 programs with each 4 segments), alternative controllers see page 84

### Additional Equipment

- Charge control with temperature measurement in the working tube see page 38
- Three-zone control for optimization of temperature uniformity see page 38
- Alternative work tubes for different process requirements see page 32
- Quartz glass batch reactors (Tmax 1100 °C)
- Higher temperatures up to 1500 °C available on request
- Vibrating channel on the rotary tube for convenient material supply, suitable for processes in air
- Powder discharge tube for easy material discharge, suitable for processes in air
- Feeding system for the continuous delivery of 5 liters of material under a defined atmosphere or vacuum, consisting of:
  - Stainless steel funnel incl. electric vibration unit to optimize the material feeding into the working tube
  - Electrically driven screw-conveyor at the inlet of the working tube with 10, 20 or 40 mm pitch and adjustable speed between 0.25 and 20 rpm
  - Collecting bottle made of laboratory glass at the outlet of the working tube
- Gas supply package 26 for operation under non-flammable process gases (only in connection with the feeding system) see page 34
- Gas supply package 4 for hydrogen applications (only in connection with feeding system) see page 36
- Vacuum package for evacuating the working pipe, depending on the pump used up to  $10^{-2}$  mbar see page 37



Vibration unit at the charging funnel for improved powder supply



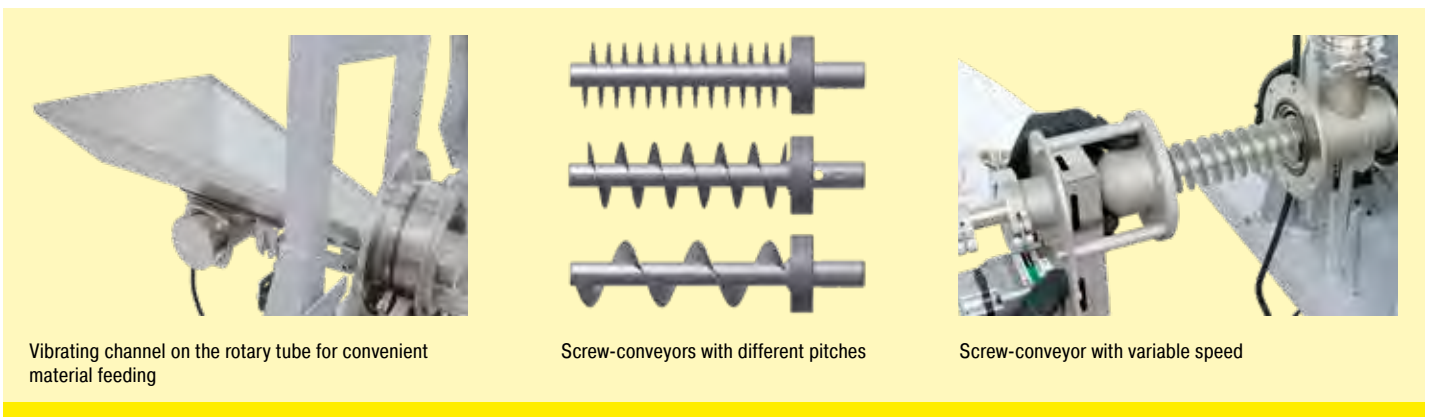
Rotary tube furnace RSRC 80/500/11 with feeding system and gas supply system 26 for processes under protective gas

Model	Tmax <sup>1</sup> in °C	Outer dimensions <sup>2</sup> in mm			Max. outer tube Ø in mm	Heated length in mm	Length constant Temperature <sup>1</sup> +/- 5 K in mm		Tube length in mm	Max. connected load in kW	Electrical connection*	Weight in kg
		W	D	H			single zoned	three zoned				
RSRC 80/500/11	1100	1770	1050	1310	80	500	170	250	1540	6.7	3-phase	305
RSRC 80/750/11	1100	2020	1050	1360	80	750	250	375	1790	10.8	3-phase	340
RSRC 120/500/11	1100	1770	1050	1310	110	500	170	250	1540	6.7	3-phase	305
RSRC 120/750/11	1100	2020	1050	1360	110	750	250	375	1790	10.8	3-phase	340
RSRC 120/1000/11	1100	2270	1050	1360	110	1000	330	500	2040	13.9	3-phase	350
RSRC 80/500/13	1300	1770	1050	1310	80	500	170	250	1540	6.7	3-phase	305
RSRC 80/750/13	1300	2020	1050	1360	80	750	250	375	1790	12.2	3-phase	340
RSRC 120/500/13	1300	1770	1050	1310	110	500	170	250	1540	6.7	3-phase	305
RSRC 120/750/13	1300	2020	1050	1360	110	750	250	375	1790	12.2	3-phase	340
RSRC 120/1000/13	1300	2270	1050	1360	110	1000	330	500	2040	13.9	3-phase	350

<sup>1</sup>Values outside the tube. Difference to temperature inside the tube up to + 50 K

<sup>2</sup>External dimensions vary when furnace is equipped with additional equipment. Dimensions on request.

\*Please see page 84 for more information about supply voltage



Vibrating channel on the rotary tube for convenient material feeding

Screw-conveyors with different pitches

Screw-conveyor with variable speed

# Tube Furnaces with Stand for Horizontal and Vertical Operation up to 1500 °C

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



Tube furnace RT 50/250/13

## Standard Equipment

- Tmax 1100 °C, 1300 °C, or 1500 °C
- Compact design
- Vertical or horizontal operation infinitely adjustable
- Angle infinitely adjustable from 0° to 90°
- Working height infinitely adjustable
- Operation also possible without stand if safety guidelines are observed
- Ceramic working tube C 530 including two fiber plugs for operation under air
- Type S thermocouple
- Heating wires wound directly around the working tube resulting in very fast heat-up rates
- Control system integrated in furnace base
- Controller with touch operation B510 (5 programs with each 4 segments), alternative controllers see page 84

## Additional Equipment

- Over-temperature limiter with adjustable cutout temperature as temperature limiter to protect the furnace and load
- Gas supply system 1 for non-flammable process gas see page 34

Model	Tmax <sup>1</sup> in °C	Outer dimensions <sup>2</sup> in mm			Inner tube Ø in mm	Heated length in mm	Length constant temperature <sup>1</sup> +/- 5 K in mm	Tube length in mm	Max. connected load in kW	Electrical connection*	Weight in kg
		W	D	H							
RT 50/250/11	1100	350	380	740	50	250	80	360	2	1-phase	25
RT 50/250/13	1300	350	380	740	50	250	80	360	2	1-phase	25
RT 30/200/15	1500	445	475	740	30	200	70	360	2	1-phase	45

<sup>1</sup>Values outside the tube. Difference to temperature inside the tube up to + 50 K

<sup>2</sup>External dimensions vary when furnace is equipped with additional equipment. Dimensions on request.

\*Please see page 84 for more information about supply voltage



Horizontal operation



Gas panel for one non-flammable process gas (N<sub>2</sub>, Ar, He, CO<sub>2</sub>, air, forming gas)



Example of an over-temperature limiter

## High-Temperature Tube Furnaces with SiC Rod Heating up to 1600 °C

These compact tube furnaces with SiC rod heating and integrated switchgear with controller can be used universally for many processes. They represent an inexpensive variant in the high-temperature range. The standard mounting options for accessories make them flexible in use for a wide range of applications. The SiC heating elements arranged parallel to the working tube provide for an excellent temperature uniformity.



Tube furnace RHTC 80/450/16

### Standard Equipment

- Tmax 1600 °C
- Working temperature 1500 °C, increased wear and tear must be expected in case of working at higher temperatures
- Active cooling of housing for low surface temperatures
- Ceramic working tube C 799 including two fiber plugs for operation under air see page 32
- Type S thermocouple
- SiC heating elements, easy to replace
- Controller with touch operation P580 (50 programs with each 40 segments), alternative controllers see page 84

### Additional Equipment

- Over-temperature limiter with adjustable cutout temperature as temperature limiter to protect the furnace and load
- Charge control with temperature measurement in the working tube see page 38
- Alternative working tubes see page 32
- Gas supply systems 1, 2 or 4 see page 34

Model	Tmax <sup>1</sup> in °C	Outer dimensions <sup>2</sup> in mm			Outer tube Ø in mm	Heated length in mm	Length constant temperature <sup>1, 6</sup> +/- 5 K in mm	Tube length in mm	Max. connected load in kW	Electrical connection*	Weight in kg
		W	D	H							
RHTC 80/230/16	1600 <sup>5</sup>	600	440	585	80	230	120	600	7.4	3-phase <sup>3</sup>	50
RHTC 80/450/16	1600	820	440	585	80	450	210	830	11.0	3-phase <sup>4</sup>	70
RHTC 80/710/16	1600	1075	440	585	80	710	345	1080	13.4	3-phase <sup>4</sup>	90

<sup>1</sup>Values outside the tube. Difference to temperature inside the tube up to + 50 K

<sup>2</sup>External dimensions vary when furnace is equipped with additional equipment. Dimensions on request.

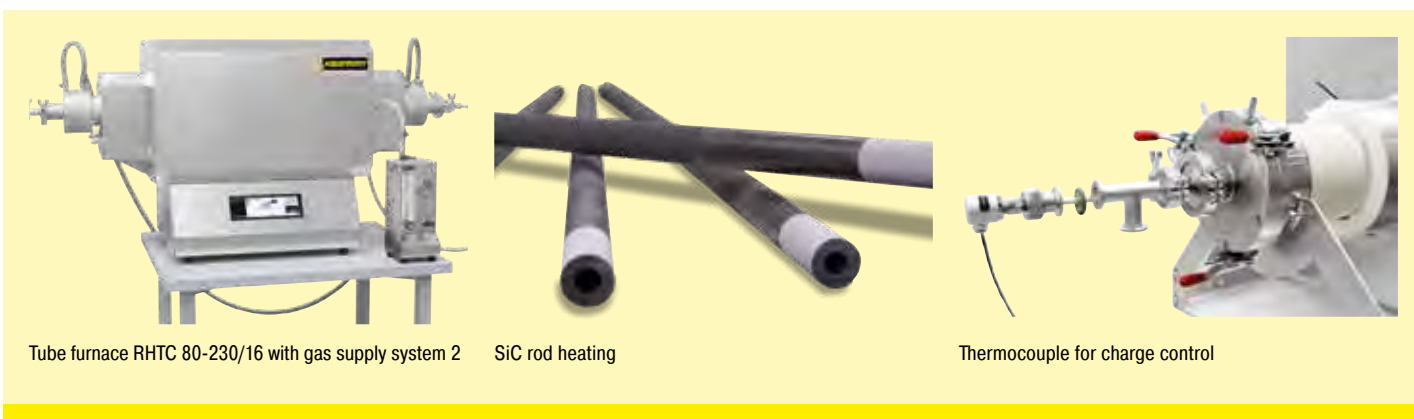
<sup>3</sup>Heating only between phase 1 and neutral

<sup>4</sup>Heating only between two phases

\*Please see page 84 for more information about supply voltage

<sup>5</sup>For standard equipment

<sup>6</sup>For standard equipment. Tmax 1500 °C with gas supply systems



Tube furnace RHTC 80-230/16 with gas supply system 2

SiC rod heating

Thermocouple for charge control

## High-Temperature Tube Furnaces for Horizontal or Vertical Operation up to 1800 °C

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



Tube furnace RHTV 50/150/17 with stand and gas supply system 2

### Standard Equipment

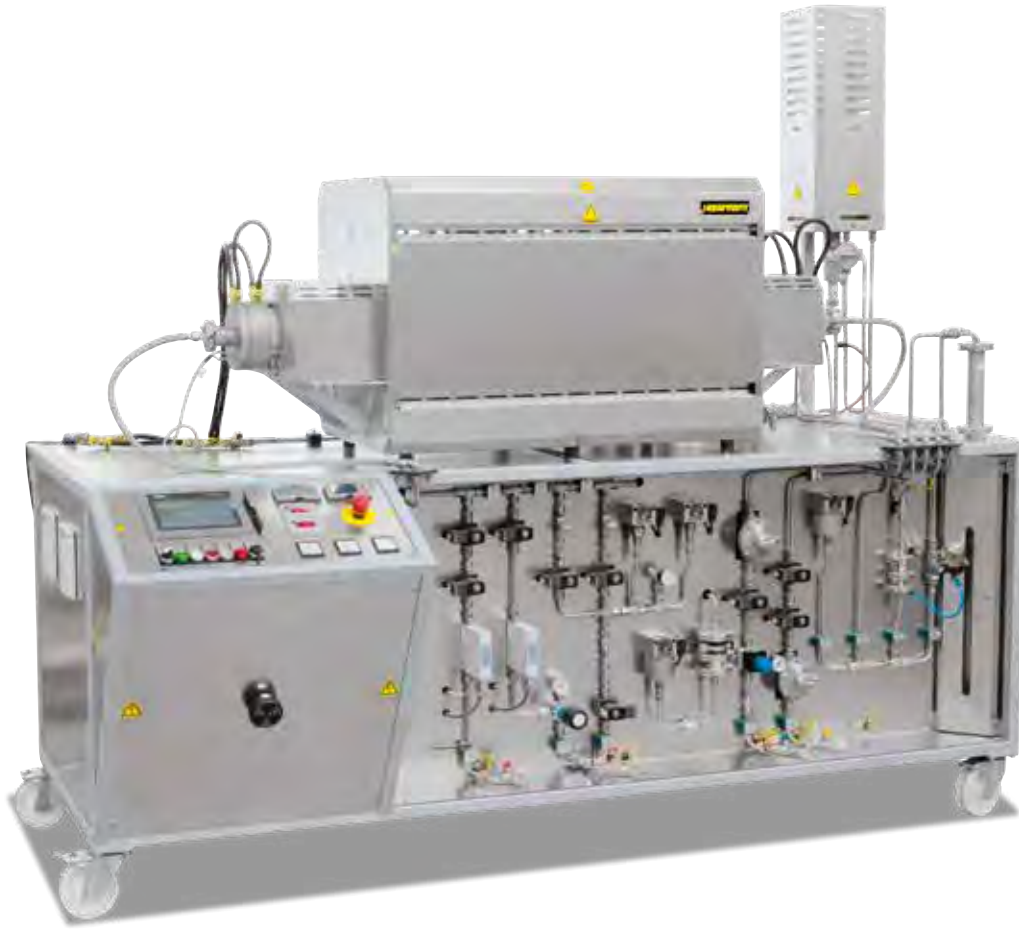
- Tmax 1600 °C, 1700 °C, or 1800 °C
- Single-zoned design
- Insulation with vacuum-formed ceramic fiber plates
- Tube furnaces RHTV with frame for vertical operation
- Type B thermocouple
- Ceramic working tube C 799 including two fiber plugs for operation under air see page 32
- Hanging and easy to change MoSi<sub>2</sub> heating elements
- Power unit with low-voltage transformer and thyristor
- Over-temperature limiter with adjustable cutout temperature as temperature limiter to protect the furnace and load
- Switchgear and control unit separate from furnace in separate floor standing cabinet
- Controller with touch operation P570 (50 programs with each 40 segments), alternative controllers see page 84

### Additional Equipment

- Charge control with temperature measurement in the working tube see page 38
- Three-zone control for optimization of temperature uniformity (only horizontal tube furnaces RHTH) see page 38
- Alternative working tubes see page 32
- Gas supply system 2 for non-flammable process gas operation see page 34
- Gas supply system 4 for hydrogen operation see page 36
- Vacuum package to evacuate the working tube see page 37



RHTH 80/300/18 tube furnace with water-cooled flanges and charge control



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

Model Horizontal design	Tmax <sup>1</sup> in °C	Outer dimensions <sup>3</sup> in mm			Max. outer tube Ø in mm	Heated length in mm	Length constant temperature <sup>1</sup> +/- 5 K in mm		Tube length in mm	Connected load in kW	Electrical connection <sup>*</sup>	Weight in kg
		W <sup>2</sup>	D	H			single zoned	three zoned				
RHTH 50/150/..	1600 or	530	480	640	50	150	50	70	380	5.8	3-phase <sup>4</sup>	70
RHTH 80/300/..	1700 or	680	550	640	80	300	100	150	530	9.4	3-phase <sup>4</sup>	90
RHTH 120/600/..	1800	980	550	640	120	600	200	300	830	14.8	3-phase <sup>4</sup>	110

Model Vertical design	Tmax <sup>1</sup> in °C	Outer dimensions <sup>3</sup> in mm			Max. outer tube Ø in mm	Heated length in mm	Length constant temperature <sup>1</sup> +/- 5 K in mm	Tube length in mm	Connected load in kW	Electrical connection <sup>*</sup>	Weight in kg
		W	D	H <sup>2</sup>							
RHTV 50/150/..	1600 or	610	700	1130	50	150	30	380	5.8	3-phase <sup>4</sup>	70
RHTV 80/300/..	1700 or	680	700	1280	80	300	80	530	10.7	3-phase <sup>4</sup>	90
RHTV 120/600/..	1800	680	700	1580	120	600	170	830	19.4	3-phase <sup>4</sup>	110

<sup>1</sup>Values outside the tube. Difference to temperature inside the tube up to + 50 K

<sup>2</sup>Without tube

<sup>3</sup>External dimensions vary when furnace is equipped with additional equipment. Dimensions on request.

<sup>4</sup>Heating only between two phases

\*Please see page 84 for more information about supply voltage



Tube furnace RHTH 120/600/17



Sintering under hydrogen in a tube furnace of RHTH product line



Example of over-temperature limiter

# Working Tubes

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



Material	Tube outside Ø in mm	Max. heat-up ramp in K/h	Tmax in air <sup>3</sup> in °C	Tmax in vacuum operation in °C	Gas tight
C 530 (Sillimantin) <sup>1</sup>	< 120 from 120	unlimited 200	1300	not possible	no
C 610 (Pythagoras) <sup>1</sup>	< 120 from 120	300 200	1400	1200	yes
C 799 (Alsint 99.7 %) <sup>1</sup>	< 120 from 120	300 200	1800	1400	yes
Quartz glass <sup>2</sup>	all	unlimited	1100	950	yes
FeCrAl-Alloy <sup>2</sup> (APM)	all	unlimited	1300	1100	yes

<sup>1</sup>Tolerances with respect to form and position acc. to DIN 40680

<sup>2</sup>All dimensions are nominal dimensions, tolerances on request

<sup>3</sup>The max. allowed temperature might be reduced operating under aggressive atmospheres

Various working tubes as option

Measurements outer Ø x inner Ø x length	Article No. <sup>4</sup>		Rotary tube furnace, continuous operation										Batch operation				
	work tube	spare tube	RSRC										RSRB				
			1100 °C					1300 °C					1100 °C				
			80-500	80-750	120-500	120-750	120-1000	80-500	80-750	120-500	120-750	120-1000	80-500	80-750	120-500	120-750	120-1000
<b>Ceramic tube C 530</b>																	
80 x 65 x 1540 mm	6000058702	691404536	○					●									
80 x 65 x 1790 mm	6000058701	691404537		○		○			●		○						
80 x 65 x 2040 mm	6000058700	691404538					○					○					
110 x 95 x 1540 mm	6000058704	691404539			○					●							
110 x 95 x 1790 mm	6000058703	691403376				○						●					
110 x 95 x 2040 mm	6000058216	691404540					○						●				
<b>Ceramic tube C 610</b>																	
80 x 65 x 1540 mm	6000058707	691404541	○					○									
80 x 65 x 1790 mm	6000058706	691404542		○		○			○		○						
80 x 65 x 2040 mm	6000058705	691404543					○					○					
110 x 95 x 1540 mm	6000058709	691404544			○						○						
110 x 95 x 1790 mm	6000058708	691404561				○						○					
110 x 95 x 2040 mm	6000052969	691403437					○						○				
<b>Quartz glass tube</b>																	
76 x 70 x 1540 mm	6000058947	691404545	●					○		○							
76 x 70 x 1790 mm	6000054644	691404546		●		○			○		○						
76 x 70 x 2040 mm	6000058946	691404547					○					○					
106 x 100 x 1540 mm	6000058949	691403519			●						○						
106 x 100 x 1790 mm	6000058948	691403305				●						○					
106 x 100 x 2040 mm	6000030741	691404548					●						○				
<b>Quartz glass tube with pimple</b>																	
76 x 70 x 1540 mm	6000058953	691404549	○					○									
76 x 70 x 1790 mm	6000058952	691404550		○		○			○		○						
76 x 70 x 2040 mm	6000058951	691404551					○						○				
106 x 100 x 1540 mm	6000058956	691404552			○						○						
106 x 100 x 1790 mm	6000058955	691403442				○						○					
106 x 100 x 2040 mm	6000058954	691404553					○						○				
<b>CrFeAl-Alloy</b>																	
75 x 66 x 1540 mm	601405296	691405357	○		○			○		○							
75 x 66 x 1790 mm	601405297	691405231		○		○			○		○						
109 x 99 x 1540 mm	601405298	691403682			○					○							
109 x 99 x 1790 mm	601405299	691403607				○						○					
109 x 99 x 2040 mm	601405300	691405122					○						○				
<b>Quartz glass reactor</b>																	
76 x 70 x 1140 mm	601402746	691402548											●		○		
76 x 70 x 1390 mm	601402747	691402272												●		○	
106 x 100 x 1140 mm	601402748	691402629													●		
106 x 100 x 1390 mm	601402749	691402638														●	
106 x 100 x 1640 mm	600048571	600032705															●
<b>Quartz glass reactor with pimples</b>																	
76 x 70 x 1140 mm	601404723	691402804											○		○		
76 x 70 x 1390 mm	601404724	691403429												○		○	
106 x 100 x 1140 mm	601404725	691403355													○		
106 x 100 x 1390 mm	601404726	691403296														○	
<b>Quartz glass mixing reactor</b>																	
76 x 70 x 1140 mm	601404727	691403407												○			
76 x 70 x 1390 mm	601404728	691404554													○		
106 x 100 x 1140 mm	601404732	691404557														○	
106 x 100 x 1390 mm	601404733	691404558															○

● Standard working tube

○ Working tube available as an option

<sup>4</sup>Tubes/reactors incl. mounted sleeves for connection to the rotary drive. Spare tubes come without sleeves.





# Gas Supply Systems/Vacuum Package for Tube Furnaces

When equipped with different gas supply systems, most tube furnace product lines can be adapted for operation with non-flammable or flammable gases or for vacuum operation.



Fiber plug with protective gas connection, suitable for many laboratory applications (gas supply system 1)

## Gas Supply System 1

### For Non-Flammable Process Gases in Static Tube Furnaces, not Gas-Tight

Gas supply system 1 is a basic version for static tube furnaces, for operation with non-flammable process gases. This system is not completely gas-tight and can therefore not be used for vacuum operation.

#### Standard Equipment

- Available for RD, R, RT, RHTC, RSH and RSV tube furnaces
- Two plugs made of porous, non-classified ceramic fiber incl. protective gas connections
- The standard working tube supplied with the furnace can be used
- Gas panel for one non-flammable process gas ( $N_2$ , Ar, He,  $CO_2$ , air, forming gas\*)
- Shut-off valve and flow meter with manual valve
- Supply of gas with 300 mbar required

#### Additional Equipment

- Additional gas panels for further non-flammable gases
- Automatic segment-related switching on/off by a magnetic valve
- Bottle pressure reducer for use with bottled gas

## Gas Supply Systems 15 and 2

### for Non-Flammable Process Gases in Static Tube Furnaces, Gas-Tight

For increased atmospheric purity requirements in the working tube in static tube furnaces we recommend one of these gas-tight gas supply systems with stainless steel flanges on the end of the tube is recommended.

The less expensive gas supply system 15 for furnaces up to 1300 °C and working tubes to 120 mm diameter is available for R, RSH and RSV tube furnaces. It includes contact protection on the flange and a stainless steel type 1.4301 heat radiation protection insert for the tube ends to protect the seals. A heat radiation protection package cools the flanges and a water connection is thus not required. With this variant, the tube must not be opened while it is hot. It is also not suitable for applications with a turbomolecular pump to achieve high vacuum. Gas supply system 2 is the correct choice for this type of application.

Gas supply system 2 with water-cooled flanges is available for R, RHTC, RHTH, RHTV, RSH and RSV furnaces. Cooling water supply with NW9 hose connector to be provided by the customer.



Flange with heat radiation protection insert (gas supply system 15)



Water-cooled vacuum flange (gas supply system 2)

#### Standard Equipment

- Extended gas-tight working tube made of C 610 for furnaces up to 1300 °C or C 799 for temperatures above 1300 °C
- Two vacuum-tight stainless steel flanges with KF flange on the outlet side
- Mounting system on furnace for the flanges

\* Country-specific regulations for permissible mixture ratios must be observed.



Water-cooled stainless steel flanges with quick locks as additional equipment

- Gas panel for one non-flammable process gas (N<sub>2</sub>, Ar, He, CO<sub>2</sub>, air, forming gas\*)
- Shut-off valve and flow meter with manual valve
- Supply of gas with 300 mbar required
- Check valve in the gas outlet to prevent air entering



Window as additional equipment for gas-tight flanges

### Additional Equipment for Gas Supply Systems 15 and 2

- Additional gas panels for further non-flammable gases
- Automatic segment-related switching on/off by a magnetic valve
- Bottle pressure reducer for use with bottled gas
- Vacuum package for a maximum final pressure of up to  $5 \times 10^{-5}$  mbar

### Other Additional Equipment only for Gas Supply System 2

- Quick-locks for water-cooled flanges
- Air-water heat exchanger for closed loop water circuit
- Window for charge observation

## Gas Supply Systems 25 and 26

### for Non-Flammable Process Gases in Rotary Tube Furnaces, Gas-Tight

Gas supply systems for non-flammable process gases are also available for RSRB and RSRC rotary tube furnaces.



Gas panel for one non-flammable process gas (N<sub>2</sub>, Ar, He, CO<sub>2</sub>, air, forming gas\*)

### Standard Equipment

- Gas panel for one non-flammable process gas (N<sub>2</sub>, Ar, He, CO<sub>2</sub>, air, forming gas\*)
- Shut-off valve and flow meter with manual valve
- Supply of gas with 300 mbar required

Gas supply system 25 for rotary tube furnaces for batch operation (RSRB) also includes gas-tight rotary lead-outs on the gas inlet and outlet as well as a gas cooler at the outlet. A check valve is also installed at the gas outlet to prevent air entering the tube.

For gas supply system 26 for rotary tube furnaces for continuous processes (RSRC) the furnace must also be equipped with a feeding system.

### Additional Equipment

- Additional gas panels for further non-flammable gases
- Automatic segment-related switching on/off by a magnetic valve
- Bottle pressure reducer for use with bottled gas
- Vacuum package for a maximum final pressure of up to  $5 \times 10^{-2}$  mbar

\* Country-specific regulations for permissible mixture ratios must be observed.



Example of an over-temperature limiter

## Gas Supply System 4 for Hydrogen Applications in Tube Furnaces from Room Temperature

Gas supply system 4 allows operation with a hydrogen atmosphere starting at ambient temperature. During hydrogen operation, a pressure of approx. 30 mbar is ensured in the working tube. At the gas outlet the hydrogen is burnt off in an exhaust gas torch. Equipped with a safety PLC control system, pre-purging, hydrogen inlet, operation, fault monitoring and purging at the end of the process are carried out automatically (with at least five times the volume of the tube). If a malfunction occurs, the tube is immediately purged with nitrogen and the system is automatically switched to a safe status.



Gas panels with mass flow controllers

### Standard Equipment

- Available for R, RHTC, RHTH, RHTV, RSH, RSV, RSRB and RSRC tube furnaces
- Gas panel for hydrogen and nitrogen
- Automatic segment-related switching on/off by a magnetic valve
- Control via safety PLC control system with touch panel
- Exhaust gas torch with temperature monitoring
- Over-temperature limiter with digital display as over-temperature protection for the furnace and charge
- Excess pressure monitoring
- Emergency purge container for nitrogen



Example of a torch

### Additional Equipment

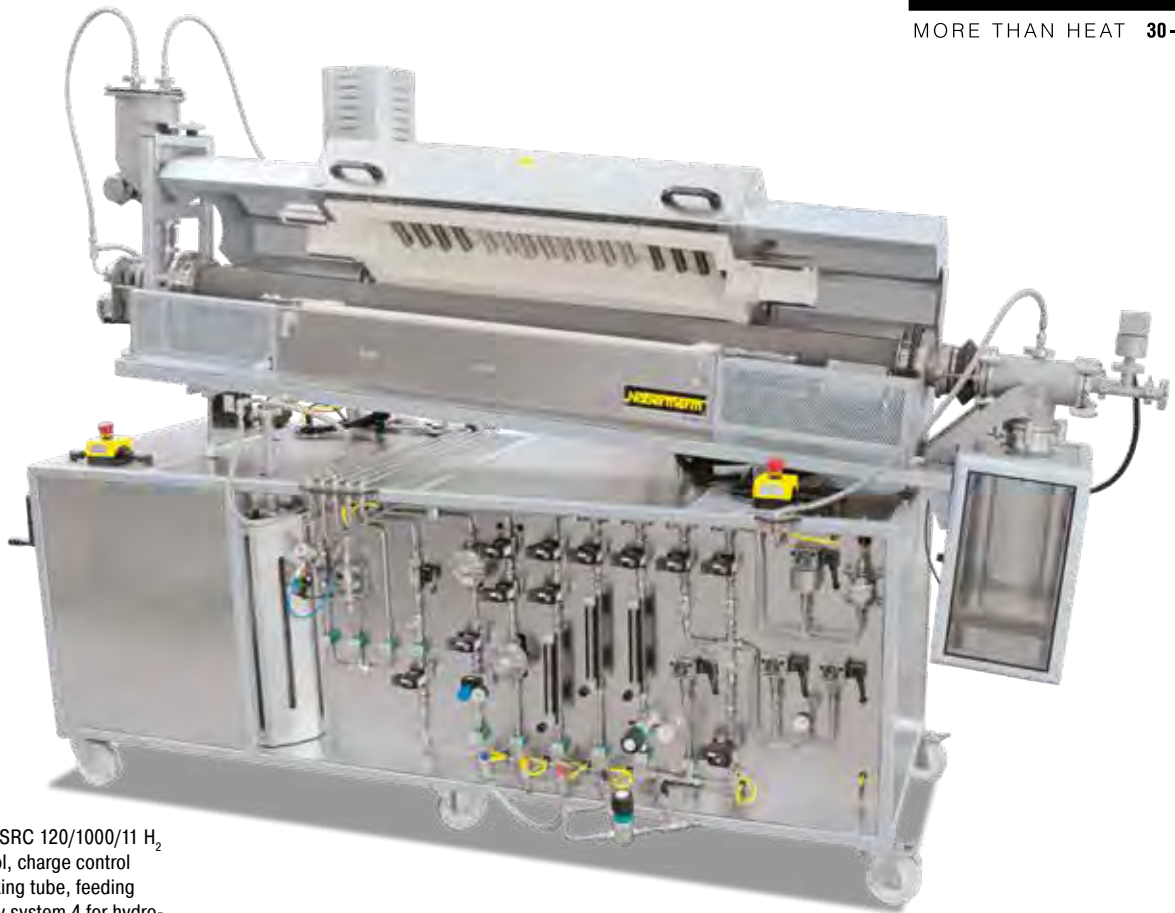
- Additional gas panels for further non-flammable gases
- Operation with other flammable gases
- Gassing via program-related controllable mass flow controllers
- Bottle pressure reducer for use with bottled gas
- Air-water heat exchanger for closed loop water circuit (apart from RSRB and RSRC)



Furnace-unrelated measuring device for a pressure range of  $10^{-3}$  mbar or  $10^{-9}$  mbar

## Assignment of Gas Supply Systems to Furnace Models

Model	Gas supply system					
	1	15	2	25	26	4
RD	●					
R	●	●	●			●
RT	●					
RHTC	●		●			●
RHTH			●			●
RHTV			●			●
RSH	●	●	●			●
RSV	●	●	●			●
RSRB					●	●
RSRC						●



Rotary tube furnace RSRC 120/1000/11 H<sub>2</sub> with three-zone control, charge control as well as FeCrAl working tube, feeding system and gas supply system 4 for hydrogen operation

## Vacuum Package

The vacuum package enables the working tube to be evacuated for vacuum operation in tube furnaces. It consists of an intermediate component for the gas outlet, a ball valve, a pressure gauge and a manually operated vacuum pump that is connected to the gas outlet by a corrugated stainless steel hose. A gas-tight furnace system is required for the use of a vacuum package, e.g. with the gas-supply packages 15, 2, 25 or 26. To protect the vacuum pump, only cold stage evacuation is allowed. The pump can then remain switched during the running program. The maximum ultimate pressure in the working tube depends on the type of pump.

- Single-stage rotary vane pump for an achievable ultimate pressure of approx. 20 mbar
- Two-stage rotary vane pump for an achievable ultimate pressure of approx.  $5 \times 10^{-2}$  mbar
- Turbomolecular pump system, consisting of a diaphragm pump with downstream turbomolecular pump for an achievable ultimate pressure of up to approx.  $5 \times 10^{-5}$  mbar (not for models RSRB and RSRC and not in combination with gas supply package 15)



Single-stage rotary vane pump (similar to picture)

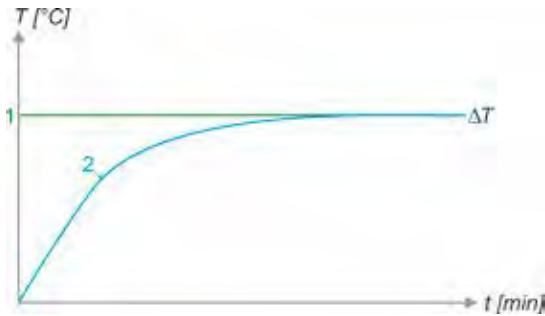


Two-stage rotary vane pump (similar to picture)

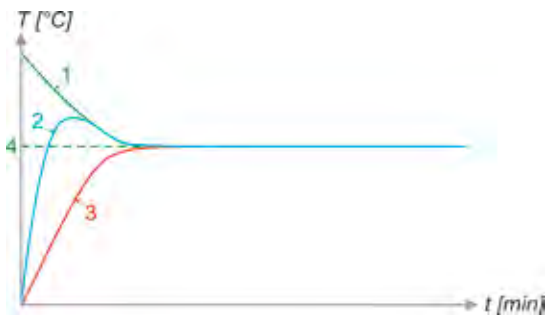


Turbomolecular pump with upstream pump (similar to picture)

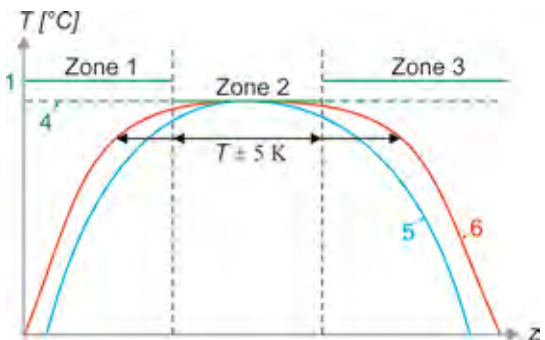
# Controls for Tube Furnaces



Furnace control

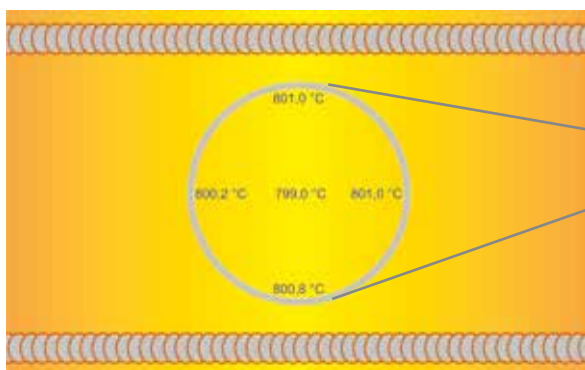


Charge control



Three-Zone Furnace Chamber Control

1. Set value furnace chamber
2. Actual value furnace chamber
3. Actual value charge
4. Set value charge
5. Actual value furnace chamber single zone
6. Actual value furnace chamber three zone



Temperature uniformity, measured in tube furnace RSH 170/750/13

## Furnace Chamber and Charge Controls

With the furnace chamber control, the temperature is only measured in the furnace chamber outside the working tube. This protects the thermocouples from damage and aggressive batch. The control is slow to avoid overshoots. Since the temperature inside the working tube is not measured in this mode, a significant temperature difference can occur between the batch temperature inside the tube and the furnace chamber temperature displayed in the controller.

With an additional charge thermocouple, the "charge control" mode can measure the temperature in the furnace as well as the temperature inside the working tube. This enables the batch temperature to be controlled very precisely and quickly. Charge control can be used with all tube furnaces, with the exception of the RD and RT series.

## Three-Zone Furnace Chamber Controls

The heated length is divided into three heating zones. The temperature is measured via one thermocouple per zone, which is positioned outside the working tube between the heating wires. The side zones are controlled via a setpoint offset in relation to the middle zone. In this way, the heat loss at the tube ends can be compensated in order to achieve an extended zone of constant temperature ( $\pm 5$  K).

## Freely Radiating Heating Elements

A very good temperature uniformity is achieved with the freely radiating heating elements on support tubes.



## Customized Tube Furnaces



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



RHTV 120/600/17 H<sub>2</sub> with gas supply system 4 for flammable gases, swiveling hook for hanging the batch and safety door in front of the lower flange



Hinged flange

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 delivered furnaces. From processes working under vacuum or protective gas via innovative control and automation technology for a wide selection of temperatures, sizes, lengths and other properties of tube furnace systems – we will find the appropriate solution for a suitable process optimization.



RSH 320/2000/09 H<sub>2</sub> with three-zone control for heat treatment of precious metals



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