FIBROTHAL® Handbook
Heating and Insulation Systems

KANTHAL

Kanthal – a world-renowned name within the field of electric heating

Since the early thirties, Kanthal has developed market leading, electric resistance alloy products and materials.

Our R&D efforts have always been directed at improving our materials to function fully at ever higher temperatures.

The centre for production, product development and metallurgy is in Hallstahammar, Sweden, whilst sales and production finishing plants are located around the world, close to our customers and operated through our subsidiaries and local representatives.

Kanthal - Head office and main facility in Hallstahammar, Sweden

Kanthal – a member of the Sandvik Group

The Sandvik Group is a global high technology enterprise with 38,000 employees and annual sales of approximately SEK 55 billion. Sandvik's operations are concentrated on its three core businesses of Sandvik Tooling, Sandvik Mining and Construction and Sandvik Materials Technology. Sandvik spends about 4 percent of is turnover on research and development.

Kanthal is a part of the business area Sandvik Materials Technology – a world-leading manufacturer of high-value-added products in advanced stainless steels, special alloys, metallic and ceramic resistance materials, as well as process plants and sorting systems.

As a member of the Sandvik Group, Kanthal has got full access to world-class competence within materials and process technology, as well as Sandvik Materials Technology's R&D-centre in Sweden, which is one of the most distinguished in the world. Through Sandvik's global sales organisation Kanthal is represented in 130 countries.

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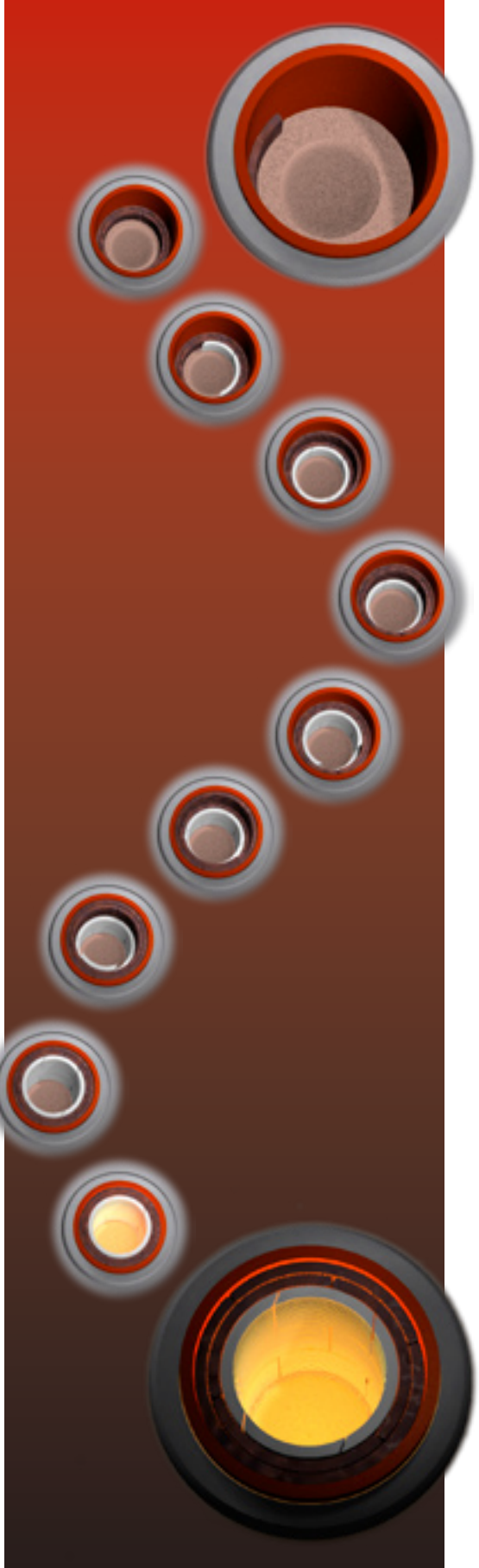


Introduction

Lightweight construction has become the norm in many industrial furnaces, with the use of ceramic fibres (KF) up to furnace temperatures of 1550°C.

The low thermal mass and thermal conductivity of the ceramic fibre furnace linings mean that you can build industrial furnaces which, depending on the type and mode of operation, contribute significantly to energy saving, higher output and better availability.

In the electrically heated furnace, however, it is very expensive and time consuming to combine ceramic fibres, such as for example blankets or folding blocks, with electric heating elements. This has led to the product concept which we introduced on to the market in 1978 under the name FIBROTHAL®.

Today the name FIBROTHAL covers a family of products consisting of vacuum-formed ceramic fibre components, with or without electric heating elements.

Today, under the registered trademark **FIBROTHAL** we supply:

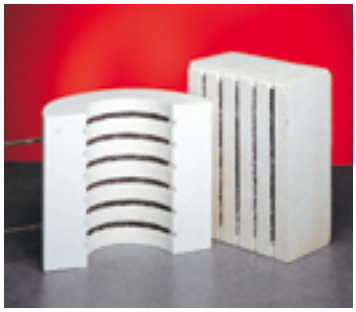


Fig. 1. Heating modules with embedded heating elements made of KANTHAL alloys for a maximum element temperature of 1150°C

Fig. 2. RAC tubes with embedded but virtually free-radiating heating element, for a maximum element temperature of 1300°C

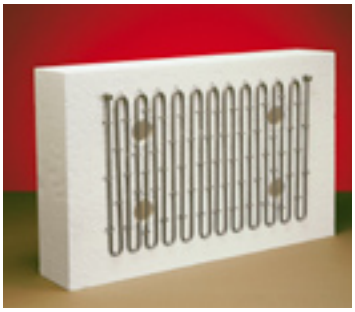


Fig. 3. MEANDERTHAL II module with free-radiating heating elements for a maximum element temperature of 1300°C, mainly for roof heating and tilting furnaces

Fig. 4. ROB with free-radiating heating elements for a maximum element temperature of 1300°C, mainly for wall and floor heating

Fig. 5. Muffles with embedded heating elements made of KANTHAL alloys for a maximum element temperature of 1150°C

Fig. 6. Insulation parts of vacuum-formed fibre in the most varied shapes for application temperatures up to 1550°C

Fig. 7. FibroSiC are unsupported roof insulating parts, which are strengthened by SiC tubes

KF-Modules

Chemical Properties: the KF-modules possess high resistance to chemicals, including most acids, with the exception of hydrofluoric acid, phosphoric acid and strong bases. Wetting with water and oil has no influence on the properties of the ceramic fibres themselves. After drying or evaporation the thermal and physical properties are restored. Care must however be taken when they are fitted with heating elements because of possible corrosion.

	F-3/LS	F-17/LS	F-19	F-14
Classification temp. (°C)*	1260	1400	1500	1600
Max. continuous duty temperature (°C)	1150	1300	1400	1550
Density (kg/m^3) approx.	200	200	200	250
Linear shrinkage (%) (24 hours at maximum continuous duty temp.)	3/<1	4.5/<2	4.5	3.5
Guide analysis (%): **Al_2O_3** **SiO_2**	46 54	50 50	67 33	77 23
Thermal conductivity (W/ mk) at 200°C**	0.07	0.07	0.07	—
at 400°C	0.10	0.10	0.10	0.09
at 600°C	0.14	0.14	0.14	0.13
at 800°C	0.21	0.21	0.20	0.19
at 1000°C	0.28	0.29	0.28	0.24
at 1200°C	—	0.41	0.39	0.35
at 1300°C	—	0.49	0.46	0.39
at 1400°C	—	—	0.54	0.46
at 1500°C	—	—	—	0.54
at 1600°C	—	—	—	—

* Classification temperature of the fibres used
** Measuring method F3, F17, F19, F14: calorimeter

Fibre free versions see MODUTHAL brochure
Bio soluble fibre and special fibre grades on request

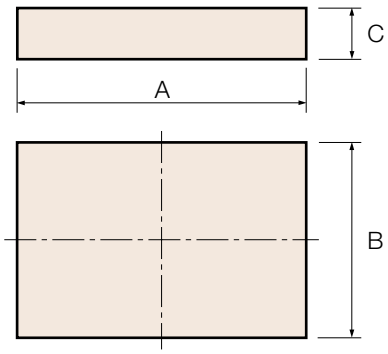
Table 1. Technical data of ceramic fibre modules

Tolerances

Module Dimensions

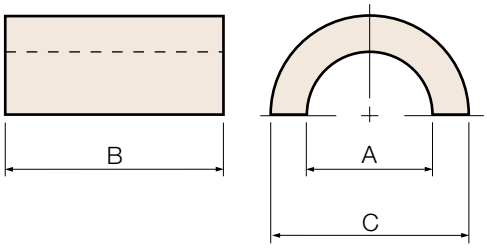
The following tolerances apply to the vacuum-formed insulation with or without heating element.

Electrical Resistance: R_k ±5%



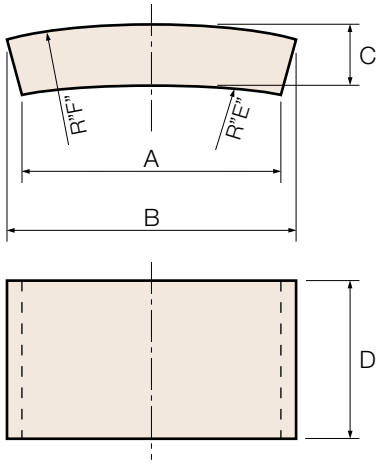
A,B	C, with machining on one surface	C, with machining on two surfaces
≤ 700 ±3	±5	±3
>700 ±5	±5/-10	±3

Fig. 8. FIBROTHAL Panels



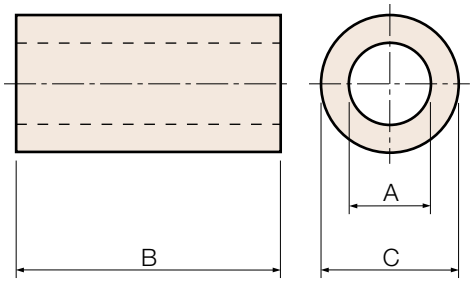
A		B	C	
≤200	+4		≤350	±5
>200/≤350	+6	±3	>350	±10
>350	+10			

Fig. 9. FIBROTHAL Half-cylinders



A, B and D		C	R "E"	R "F"
≤700	±3	±5	±5	±5
>700	±5		±10	±10

Fig. 10. FIBROTHAL Shells



A	B	C
+8/-2	+10/-5	±10

Fig. 11. FIBROTHAL Tubes

Atmospheres

Furnace atmosphere	Max. element temperature		Remarks
	KANTHAL heating elements	FIBROTHAL heating elements	
H_2	1400°C	1000°C	H_2 increases heat throughput of FIBROTHAL 3-4 times.
N_2	1200°C preoxidised	1150°C preoxidised	FIBROTHAL heating modules without heating elements up to maximum duty temperature.
N	don't use	don't use	
Endogas	1050°C preoxidised	1050°C preoxidised	Pay attention to carbon deposition! Better with gas-tight muffle.
Exogas	1150°C preoxidised	1050°C preoxidised	Pay attention to carbon deposition! Better with gas-tight muffle.
Sulphur	approx. 1000°C	—	Does not withstand sulphur pentoxide.
Chlorine, fluorine, alkali	attacks all types of resistance alloys	attacks all types of resistance alloys	FIBROTHAL can be used without elements below 900°C.
Vacuum < 10^{-3} hPa	1150°C preoxidised	800 -850°C	Vacuum higher than 10^{-3} bar will take too long to evacuate the fibre block. Better with vacuum-tight muffle.
Pressurised	1400°C	1250°C	FIBROTHAL can be used in gas or air-tight furnaces only.
Scale	see remarks	see remarks	Spray scale from heat-resistant parts is usually satisfactorily tolerated, iron oxide scale attacks KANTHAL – fit cover.
Vapours	see remarks	see remarks	Vapours must not form condensates from salts or oxides, otherwise electrical bridges will be formed.
Gas velocity	see remarks	see remarks	FIBROTHAL withstands high gas velocities up to 50 m/s. Pay attention to butt joints with ceramic fibre blankets.

Table 2. Maximum permissible element temperatures in various furnace atmospheres

Power limitation

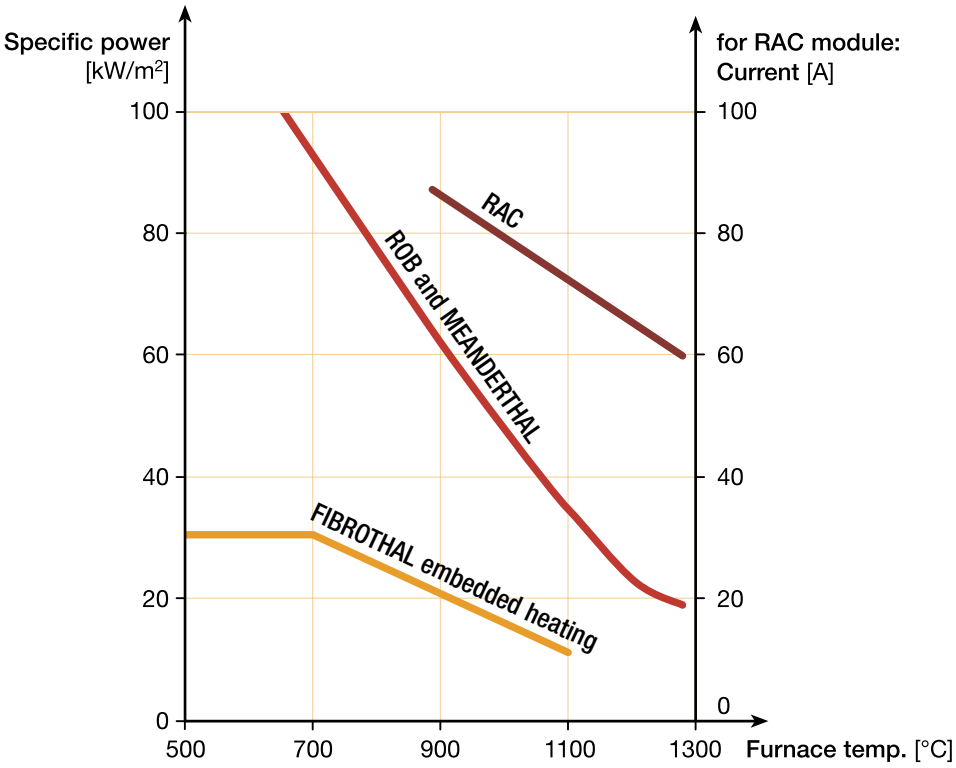


Fig. 12. shows for the various heating module designs the maximum recommended load in relation to the furnace temperature

Rule of Thumb

To install a voltage of 230 V with a free radiating wire (ROB, MEANDERTHAL) an area of 1 m^2 is needed.

To install a voltage of 230 V with an embedded element (FIBROTHAL) an area of 0,25 m^2 is needed.

Technical Data – Standard Range

Heating modules

FIBROTHAL Standard Heating Modules are manufactured with embedded heating elements, two principles being followed.

For optimum heat radiation:

- *The heating wire is made with oval cross-section*
- *Part of the face of the heating wire is bare*
- *The inside of the heating wires is largely free of ceramic fibres*

Principle 1

With this method the KANTHAL A-1 heating wires (diameter <3.5 mm) are embedded in the ceramic fibre module made of F3 fibre. The maximum element temperature is 1150°C.

This design is protected by patent.

Panels and half-cylinders are manufactured according to this principle.

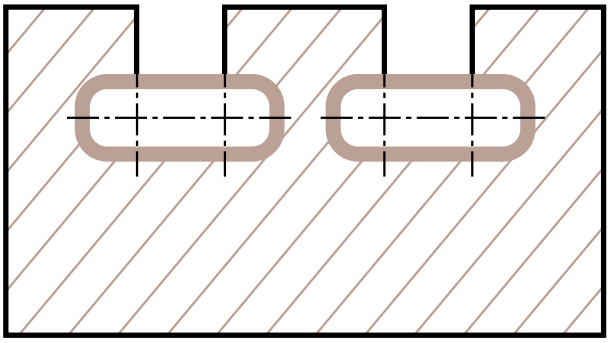


Fig. 13. Embedding principle

Principle II

With this method – used exclusively for heating tubes – a heating wire of KANTHAL A-1 (diameter 5 mm) is formed to fit into a ceramic fibre module of F17 fibre with ceramic spacers. In this case the heating element lies on the surface of the insulation and is virtually free-radiating. The maximum element temperature is 1300°C.

A complete range of moulds is available for manufacturing the standard modules. There are therefore no mould costs in this case.

In the new edition of this brochure the previous voltages have been converted to the Eurovoltage (400/230V). The modules can however also be operated with the voltages previously used (380/220V or 415/240V).

If low power is required, the modules can also be operated at lower voltages. Higher power is also possible if allowance is made for the maximum wall loading (see Fig. 12).

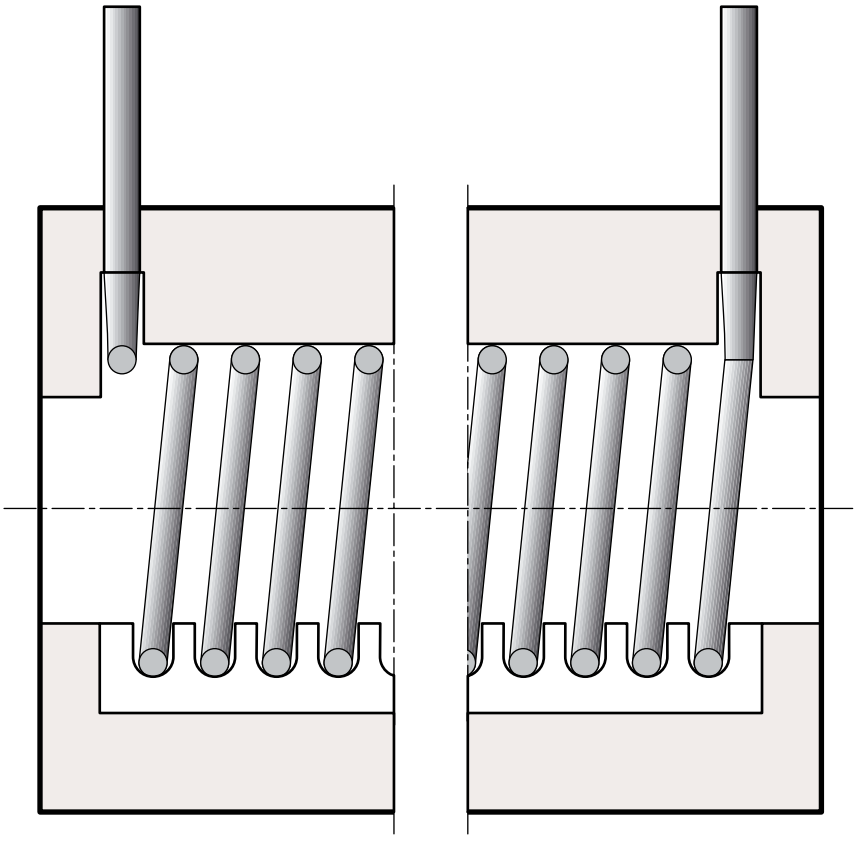


Fig. 14. RAC forming principle

Panels

The heating surface is the surface which accomodates the heating element. The standard module dimensions are based on the heated surface dimensions plus the minimum required unheated edge area. Panels can be manufactured to a maximum width or length of 1050 mm.

Unheated edges can be manufactured to any dimension as long as the overall panel dimension does not exceed the maximum width or length already specified. Standard modules can also be supplied with additional 125 mm unheated edges on either the width or length (type SL; SB).

If modules are to be attached to roofs or side walls, there is a design available with ceramic cup assembly mountings. For roofs in particular we recommend additional element anchorage using ceramic cement pins.

The standard design of connections is in the form of threaded rod M8 × 75 mm long at the back of the module. Other connection designs are available on request, e. g. flexible leads (see accessoroies).

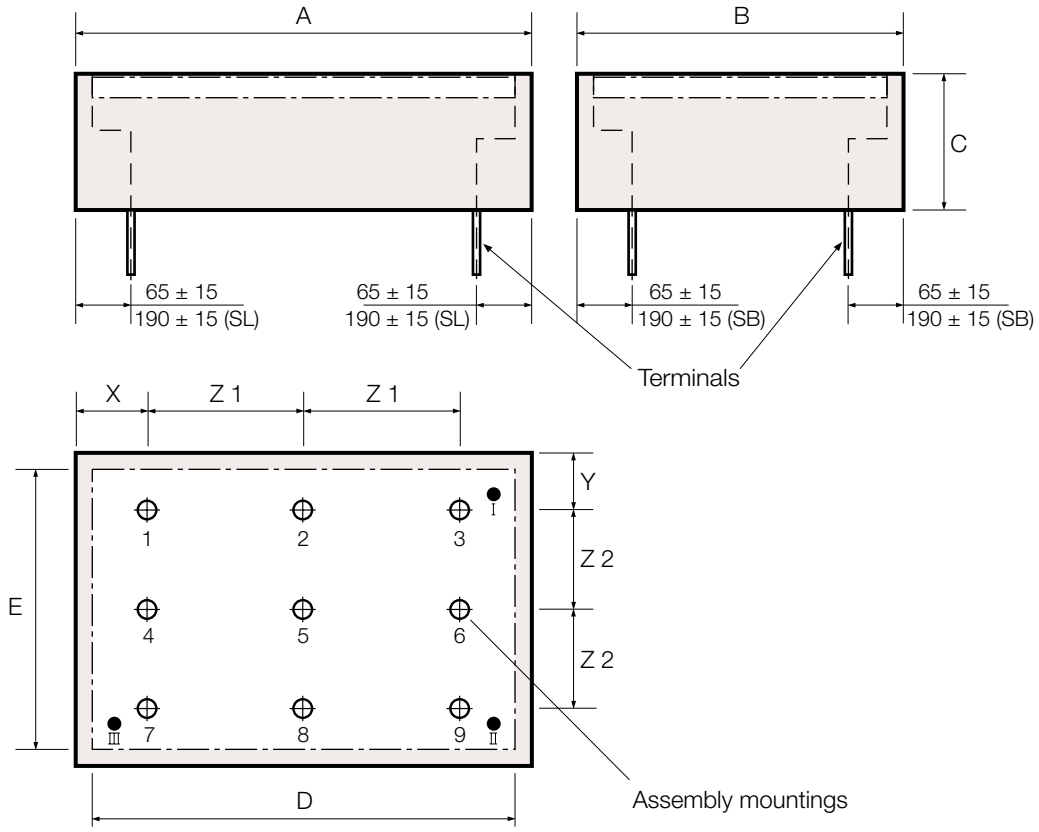


Fig. 15. FIBROTHAL Standard panels

FIBROTHAL Heating Panels

Type designation	Part No.	Standard dim. A × B × C mm	Heated area D × E mm	Power W	Voltage V	Resistance R20 Ohm	Term. arr. Position	Assembly Nos. Pcs./Pos.	Grid dim. X/Z1 Y/Z2 mm	Approx. weight kg
PAS 300/225/57.5	DF830004	300×225×125	270×195	1050	57.5	3.03	I–III	–	–	2.1
PAS 300/225/57.5 S/D	DF830007	300×225×125	270×195	1050	57.5	3.03	I–III	2/1-9	75/150 92/42	2.1
PAS 300/225/57.5 SL	DF830011	550×225×125	270×195	1050	57.5	3.03	I–III	–	–	3.5
PAS 300/225/57.5 SB	DF830012	300×475×125	270×195	1050	57.5	3.03	I–III	–	–	3.9
PAS 375/225/57.5	DF830016	375×225×125	335×195	1350	57.5	2.35	I–III	–	–	2.7
PAS 375/225/57.5 S/D	DF830019	375×225×125	335×195	1350	57.5	2.35	I–III	2/1-9	75/112 92/21	2.7
PAS 375/225/57.5 SL	DF830021	625×225×125	335×195	1350	57.5	2.35	I–III	–	–	4.1
PAS 375/225/57.5 SB	DF830022	375×475×125	335×195	1350	57.5	2.35	I–III	–	–	5
PAS 450/300/100	DF830026	450×300×125	410×250	2100	100	4.58	I–II	–	–	4.2
PAS 450/300/100 S/D	DF830029	450×300×125	410×250	2100	100	4.58	I–II	2/4-6	100/125 150/0	4.2
PAS 450/300/100 SL	DF830031	700×300×125	410×250	2100	100	4.58	I–II	–	–	6.1
PAS 450/300/100 SB	DF830032	450×550×125	410×250	2100	100	4.58	I–II	–	–	7
PAS 450/300/115	DF830036	450×300×125	410×250	2100	115	6.06	I–II	–	–	4.2
PAS 450/300/115 S/D	DF830039	450×300×125	410×250	2100	115	6.06	I–II	2/4-6	100/125 150/0	4.2
PAS 450/300/115 SL	DF830041	700×300×125	410×250	2100	115	6.06	I–II	–	–	6.1
PAS 450/300/115 SB	DF830042	450×550×125	410×250	2100	115	6.06	I–II	–	–	7
PAS 450/300/133	DF830046	450×300×125	410×250	2100	133	8.1	I–III	–	–	4.5
PAS 450/300/133 S/D	DF830049	450×300×125	410×250	2100	133	8.1	I–III	2/1-9	100/125 131/19	4.5
PAS 450/300/133 SL	DF830051	700×300×125	410×250	2100	133	8.1	I–III	–	–	5.9
PAS 450/300/133 SB	DF830052	450×550×125	410×250	2100	133	8.1	I–III	–	–	6.9
PAS 450/375/115	DF830056	450×375×125	410×325	2700	115	4.9	I–II	–	–	4.5
PAS 450/375/115 S/D	DF830059	450×375×125	410×325	2700	115	4.9	I–II	2/4-6	100/125 187/0	4.5
PAS 450/375/115 SL	DF830061	700×375×125	410×325	2700	115	4.9	I–II	–	–	7.7
PAS 450/375/115 SB	DF830062	450×625×125	410×325	2700	115	4.9	I–II	–	–	8.2
PAS 450/375/133	DF830066	450×375×125	410×325	2700	133	6.3	I–II	–	–	5.3
PAS 450/375/133 S/D	DF830069	450×375×125	410×325	2700	133	6.3	I–II	2/4-6	100/125 187/0	5.3
PAS 450/375/133 SL	DF830071	700×375×125	410×325	2700	133	6.3	I–II	–	–	7.7
PAS 450/375/133 SB	DF830072	450×625×125	410×325	2700	133	6.3	I–II	–	–	8

Table 3. Standard FIBROTHAL heating panel designs

Type designation	Part No.	Standard dim. A × B × C mm	Heated area D × E mm	Power W	Voltage V	Resistance R20 Ohm	Term. arr. Position	Assembly Nos. Pcs./Pos.	Grid dim. X/Z1 Y/Z2 mm	Approx. weight kg
PAS 600/450/200	DF830076	600×450×125	550×405	4200	200	9.16	I–II	–	–	8.7
PAS 600/450/200 S	DF830079	600×450×125	550×405	4200	200	9.16	I–II	2/4-6	150/150 225/0	8.7
PAS 600/450/200 D	DF830082	600×450×125	550×405	4200	200	9.16	I–II	4/1-3-7-9	150/150 100/125	8.7
PAS 600/450/200 SL	DF830083	850×450×125	550×405	4200	200	9.16	I–II	–	–	11.5
PAS 600/450/200 SB	DF830084	600×700×125	550×405	4200	200	9.16	I–II	–	–	12.5
PAS 600/450/230	DF830088	600×450×125	550×405	4200	230	12.11	I–II	–	–	8.6
PAS 600/450/230 S	DF830091	600×450×125	550×405	4200	230	12.11	I–II	2/4-6	150/150 225/0	8.6
PAS 600/450/230 D	DF830094	600×450×125	550×405	4200	230	12.11	I–II	4/1-3-7-9	150/150 100/125	8.6
PAS 600/450/230 SL	DF830095	850×450×125	550×405	4200	230	12.11	I–II	–	–	11.4
PAS 600/450/230 SB	DF830096	600×700×125	550×405	4200	230	12.11	I–II	–	–	12.3
PAS 750/450/200	DF830100	750×450×125	700×405	5400	200	7.12	I–III	–	–	11.1
PAS 750/450/200 S	DF830103	750×450×125	700×405	5400	200	7.12	I–III	2/4-6	143/232 225/0	11.1
PAS 750/450/200 D	DF830106	750×450×125	700×405	5400	200	7.12	I–III	6/1-2-3-7-8-9	–	11.1
PAS 750/450/200 SL	DF830107	1000×450×125	700×405	5400	200	7.12	I–III	–	–	14
PAS 750/450/200 SB	DF830108	750×700×125	700×405	5400	200	7.12	I–III	–	–	15.8
PAS 750/450/230	DF830112	750×450×125	700×405	5400	230	9.42	I–III	–	–	15.4
PAS 750/450/230 S	DF830115	750×450×125	700×405	5400	230	9.42	I–III	2/4-6	143/232 225/0	15.4
PAS 750/450/230 D	DF830118	750×450×125	700×405	5400	230	9.42	II–III	6/1-2-3-7-8-9	100/126 100/125	15.4
PAS 750/450/230 SL	DF830119	1000×450×125	700×405	5400	230	9.42	I–III	–	–	13.5
PAS 750/450/230 SB	DF830120	750×700×125	700×405	5400	230	9.42	I–III	–	–	15.4
PAS 900/600/400	DF830124	900×600×125	825×540	8400	400	18.32	II–III	–	–	17.4
PAS 900/600/400 S	DF830127	900×600×125	825×540	8400	400	18.32	II–III	2/4-6	198/252 300/0	17.5
PAS 900/600/400 D	DF830130	900×600×125	825×540	8400	400	18.32	II–III	6/1-2-3-7-8-9	156/147 150/150	17.4
PAS 900/600/400 SL	DF830472	1150×600×125	825×540	8400	400	18.32	II–III	1-3-7-9	75/500 150/300	23
PAS 900/600/400 SB	DF830131	900×850×125	825×540	8400	400	18.32	II–III	–	–	23
PAS 900/750/400	DF830135	900×750×125	825×680	10800	400	14.25	II–III	–	–	22.3
PAS 900/750/400 S	DF830138	900×750×125	825×680	10800	400	14.25	II–III	2/4-6	198/252 375/0	22.3
PAS 900/750/400 S	DF830141	900×750×125	825×680	10800	400	14.25	II–III	9/1...9	156/147 100/138	22.3
PAS 900/750/400 S	DF830142	900×1000×125	825×680	10800	400	14.25	II–III	–	–	27.9

Table 3. Standard FIBROTHAL heating panel designs

FIBROTHAL Half-Cylinders

For horizontal operation the upper half shell should be designed for the pin system (for explanation see heating panels).

The connections are designed as standard in the form of threaded bolts M8 × 75 mm long on the back of the module. Other connection designs are available on request, e.g. flexible leads (see accessories).

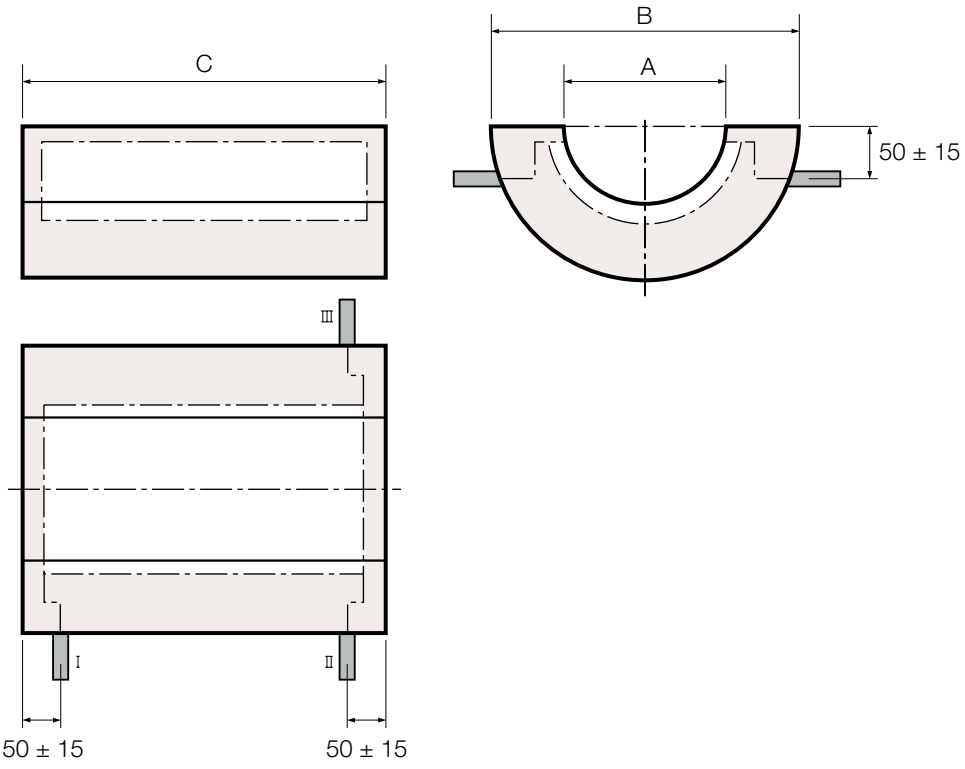


Fig. 16. FIBROTHAL Standard half-cylinders

Type designation	Part No.	Ø i.d. A mm	Ø o.d. B mm	Length C mm	Power W	Voltage V	Resistance R20 Ohm	Terminal arr. Position	Approx. weight kg
HAS 70/250/57.5	DF830256	70	220	250	450	57.5	7.06	I–III	1
HAS 70/500/115	DF830260	70	220	500	900	115	14.13	I–II	1.9
HAS 100/250/57.5	DF830264	100	250	250	650	57.5	4.89	I–II	1.2
HAS 100/300/57.5	DF830268	100	250	300	750	57.5	4.24	I–III	1.5
HAS 100/500/115	DF830272	100	250	500	1300	115	9.78	I–II	2.4
HAS 100/600/115	DF830276	100	250	600	1500	115	8.48	I–III	3
HAS 150/250/57.5	DF830280	150	300	250	950	57.5	3.35	I–II	1.7
HAS 150/300/57.5	DF830284	150	300	300	1150	57.5	2.76	I–II	2
HAS 150/500/115	DF830288	150	300	500	1900	115	6.69	I–II	3.4
HAS 150/600/115	DF830292	150	300	600	2300	115	5.53	I–III	4.1
HAS 200/250/57.5	DF830296	200	350	250	1250	57.5	2.54	I–III	2.2
HAS 200/300/57.5	DF830300	200	350	300	1500	57.5	2.12	I–II	2.7
HAS 200/500/115	DF830304	200	350	500	2500	115	5.09	I–III	4.5
HAS 200/600/115	DF830308	200	350	600	3000	115	4.24	I–III	5.3
HAS 250/375/115	DF830312	250	450	375	2350	115	5.41	I–II	5.3
HAS 250/400/115	DF830316	250	450	400	2500	115	5.09	I–II	5.3
HAS 250/750/200	DF830320	250	450	750	4700	200	8.18	I–III	10.7
HAS 250/750/230	DF830324	250	450	750	4700	230	10.82	I–III	10.4
HAS 250/800/230	DF830328	250	450	800	5000	230	10.17	I–II	11
HAS 300/375/115	DF830332	300	500	375	2800	115	4.54	I–II	6.1
HAS 300/400/115	DF830336	300	500	400	3000	115	4.24	I–II	6.5
HAS 300/750/230	DF830340	300	500	750	5600	230	9.08	I–III	13
HAS 300/800/230	DF830344	300	500	800	6000	230	8.48	I–II	12.9
HAS 350/500/200	DF830348	350	600	500	4400	200	8.74	I–III	11.5
HAS 350/500/230	DF830352	350	600	500	4400	230	11.56	I–III	11.5
HAS 350/600/230	DF830356	350	600	600	5300	230	9.6	I–III	13.5
HAS 350/750/230	DF830360	350	600	750	6600	230	7.71	I–III	17
HAS 350/800/230	DF830364	350	600	800	7000	230	7.27	I–III	17.7
HAS 400/500/200	DF830368	400	650	500	5000	200	7.69	I–III	13
HAS 400/500/230	DF830372	400	650	500	5000	230	10.17	I–III	13
HAS 400/600/200	DF830376	400	650	600	6000	200	6.41	I–II	14.8
HAS 400/600/230	DF830380	400	650	600	6000	230	8.48	I–III	15.2
HAS 400/750/400	DF830384	400	650	750	7500	400	20.51	I–II	18.5
HAS 400/900/400	DF830388	400	650	900	9000	400	17.09	I–III	21.7
HAS 450/600/400	DF830392	450	700	600	6800	400	22.62	I–III	15.8
HAS 450/900/400	DF830396	450	700	900	10200	400	15.08	I–II	26.1
HAS 500/600/400	DF830400	500	750	600	7500	400	20.51	I–II	17.1
HAS 500/900/400	DF830404	500	750	900	11300	400	13.61	I–II	27.3

Table 4. Standard FIBROTHAL half-cylinder designs

Tubes

For the power connections (strip 20 × 3) you can choose between radial (Design A) and face variants (Design B). Because of the high current levels a flexible wire connection is not possible.

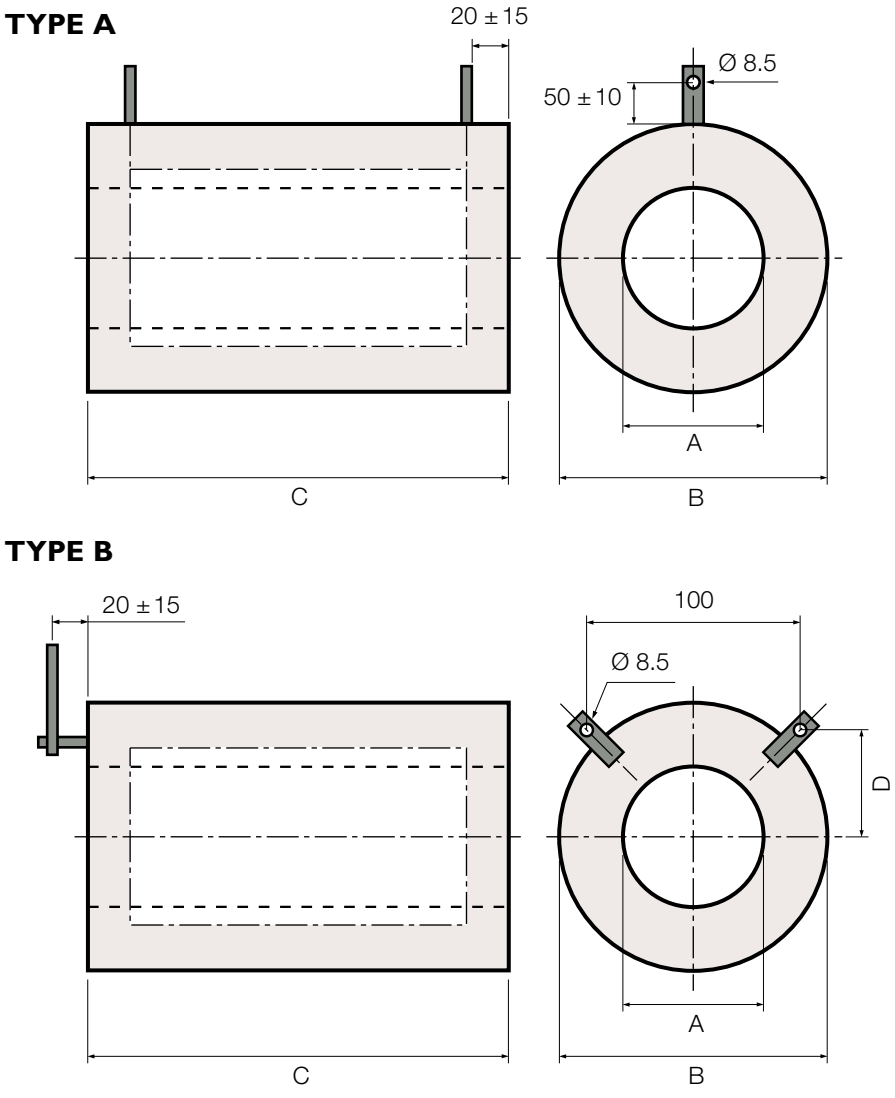


Fig. 17. FIBROTHAL Standard tubes

FIBROTHAL Tube

Type designation	Type A Part No.	Type B Part No.	Dimensions Øi.d. A (mm)	Dimensions Øo.d. B (mm)	Length C (mm)	Terminal arr. D (mm)	Voltage (V) Power (W) at 60 A	Voltage (V) Power (W) at 72 A	Voltage (V) Power (W) at 85 A	Resistance R20 (Ohm)	Weight (kg)
							15.8	19	22.5		
RAC 40/200	DF830147	DF830153	40	160	220	105	950	1369	1909	0.253	1.6
							40	48	56.7		
RAC 40/500	DF830158	DF830164	40	160	520	105	2398	3455	4818	0.639	3.8
							25	30	35.5		
RAC 70/200	DF830169	DF830175	70	240	220	135	1500	2161	3014	0.4	2.9
							63.1	75.8	89.5		
RAC 70/500	DF830180	DF830186	70	240	520	135	3786	5454	7608	1.008	6.9
							34.1	41	48.4		
RAC 100/200	DF830191	DF830197	100	270	220	150	2049	2952	4117	0.546	3.6
							86.2	103.5	122.2		
RAC 100/500	DF830202	DF830208	100	270	520	150	5170	7450	10391	1.377	8.5
							49.4	59.3	70.1		
RAC 150/200	DF830213	DF830219	150	350	220	215	2963	4269	5955	0.789	5.1
							127	152.5	180.2		
RAC 150/500	DF830224	DF830230	150	350	520	215	7620	10979	15314	2.03	12.5
							64.6	77.6	91.7		
RAC 200/200	DF830235	DF830241	200	450	220	240	3878	5587	7793	1.033	7.7
							163.1	195.8	231.4		
RAC 200/500	DF830246	DF830252	200	450	520	240	9787	14101	19669	2.607	18.7

Table 5. Standard FIBROTHAL tube designs

Insulating Parts

FIBROTHAL insulating parts are available in the same standard dimensions as the heating modules. The standard range also includes insulating end pieces which fit the outside diameters of the half-cylinders and tubes. If necessary these end pieces can also be supplied drilled to the size of the work tube. The standard thickness is 125 mm or 50 mm; other dimensions are also available.

FIBROTHAL end piece range

Outside diameter mm	Thickness mm	Weight kg
160	125/50	0.5
220	125/50	0.9
240	125/50	1.1
300	125/50	1.2
350	125/50	2.4
450	125/50	3.9
500	125/50	4.9
600	125/50	7.0
650	125/50	8.2
700	125/50	9.6
750	125/50	11.0

Table 6. FIBROTHAL Standard KANTHAL End pieces

Modules to special design

Over and above the standard range we offer an extensive special range of different heating systems. With these all furnace sizes and designs can in principle be created. The following systems are available:

- *Module with embedded heating*
- *ROB in panel and shell design*
- *Meander systems*
- *Special tube modules*
- *Muffles*
- *Insulating parts*

An extensive range of forming moulds is available for the manufacture of the special modules. Nevertheless, for special designs a proportion of the mould costs may be charged.

Modules with embedded heating

These modules can be used for almost all furnace layouts. In addition to panels for furnaces with flat walls we manufacture many different module designs for cylindrical surfaces, such as for example tubes up to 500 mm diameter and half-cylinders up to 650 mm diameter. For larger inside diameters shell modules (1/3, 1/4, 1/6 shells, etc.) are used. The design corresponds in principle to that of the standard panels or half-cylinders. The maximum element temperature is also 1150°C.

Advantages of this system:

1. *The heating element is directly incorporated into the module and requires no additional mountings*
2. *Shape and dimensions and electrical data variable within wide limits*
3. *Terminal voltages of the modules correspond to mains voltage or fractions of it*
4. *Easy interchangeability of the modules, if the furnace is suitably designed, during operation also*
5. *No limitation on the installation position*

ROB in panel and shell design

The ROB system consists of FIBROTHAL insulation modules with built-in mounting system and meander-shaped heating elements of round wire, the element legs mainly running next to each other in V-form. Both KANTHAL and NIKROTHAL alloys can be used here.

General ROB advantages:

1. *Free-radiating heating element up to 1300°C element temperature.*
2. *Heating element change possible.*
3. *Long heating element length over several modules possible, therefore far fewer terminals are required.*
4. *Larger heating conductor cross-section can be installed; this results in longer element working life.*
5. *High power concentrations can be installed (see Fig. 12).*

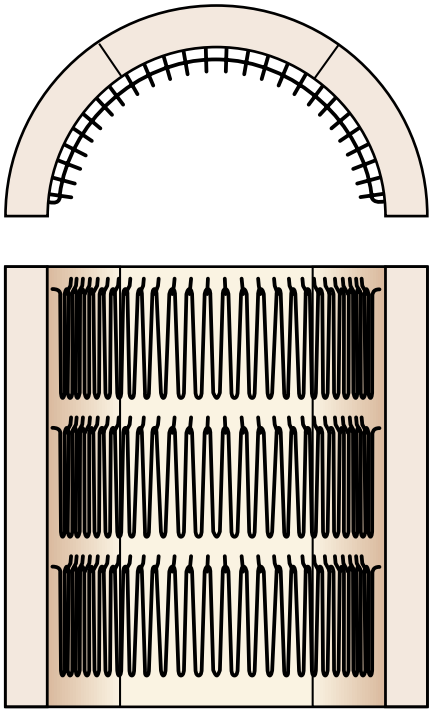


Fig. 18. ROB in panel design

MEANDERTHAL II

The heating element mountings consist of metallic hairpin-shaped parts, which are anchored in the ceramic fibre module.

Specific advantages:

1. *No limitation on the installation position; also suitable for tilting furnaces.*
2. *Valiable heating element pitch value.*
3. *Also suitable for round furnaces.*

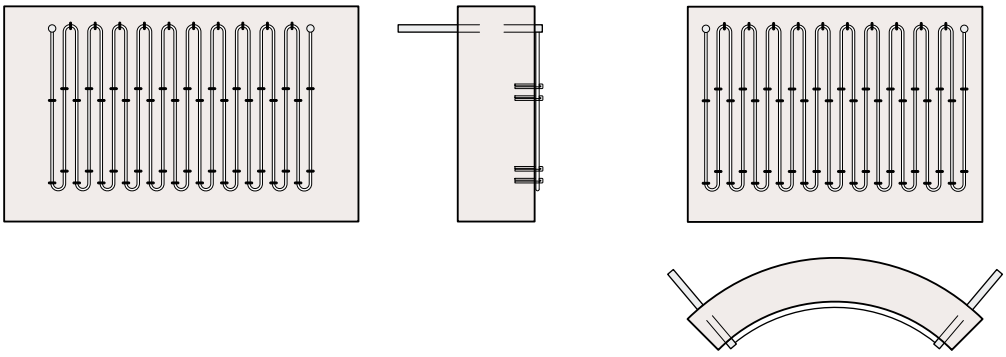


Fig. 19. MEANDERTHAL II modules

MEANDERTHAL III

The heating element mountings consist of metallic rod support and metallic holders, anchored in the ceramic fibre module. (MEANDERTHAL III replaces an earlier design called MEANDERTHAL I)

Specific advantages:

1. *Elements can be replaced.*
2. *Tilting of furnace up to 90° is possible.*
3. *Also suitable for round furnaces.*

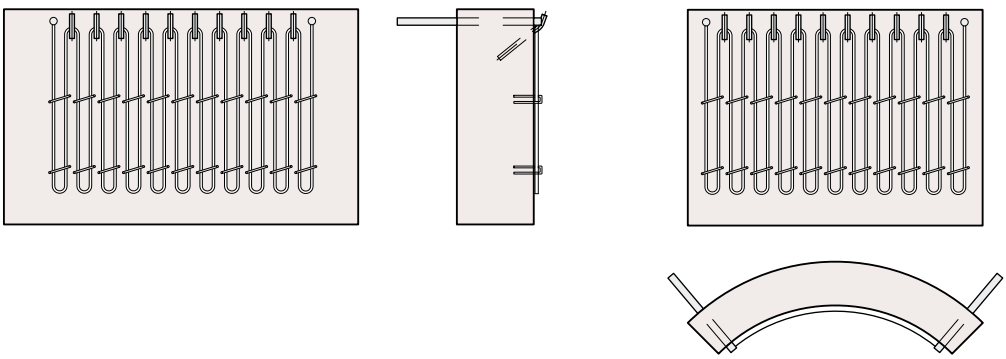


Fig. 20. MEANDERTHAL III modules

Special Tube Modules

These modules, usually multi-zone, correspond in their design to the RAC tubes (see Principle II, Fig. 14). The maximum inside diameter is 400 mm; lengths up to approx. 2000 mm can be manufactured. If required these heating tubes can also be supplied with a sheet metal shell. Depending on the requirements the alloys KANTHAL A1, AF or APM are used.

Advantages of the system:

1. *High temperature uniformity.*
2. *Precise temperature profiles can be achieved.*
3. *High power concentration (see Fig. 12)*
4. *Can be installed in any position.*

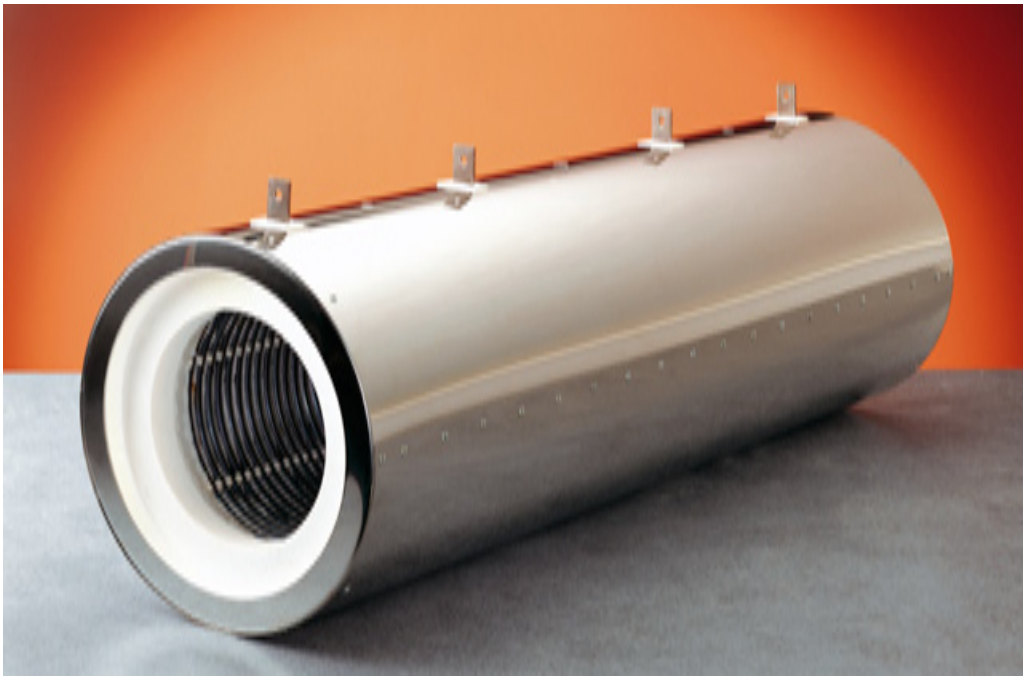


Fig. 21. Heating cassette (diffusion annealing tube)

Muffles

Monoblock ceramic fibre modules with embedded heating element, can be used for laboratory and small chamber furnaces. These can be heated on up to four sides. Maximum element temperature 1150°C. Matching door modules can be supplied.

Advantages of this system:

1. *Short assembly times.*
2. *Short heating up times.*
3. *Uniform temperature distribution in the furnace interior.*
4. *Rapidly and easily replaced.*

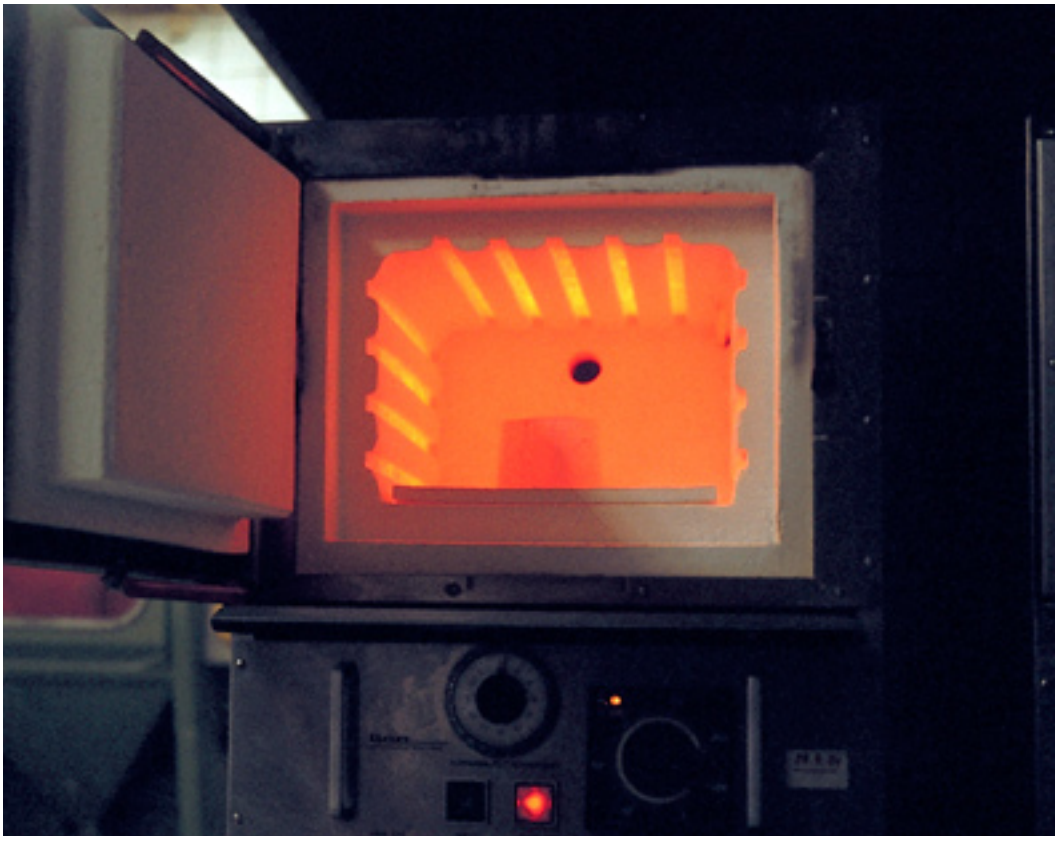


Fig. 22. FIBROTHAL Muffle in laboratory furnace

Insulating parts

Insulating parts to special designs can be supplied in the same dimensions as the heating modules described in the preceding section.

FibroSiC, unsupported roof modules

The further development of our FIBROTHAL system, in particular with the objective of achieving self-supporting, easy-to-assemble roof insulation, has led to the combination of ceramic fibre insulation modules and SiC tubes.

This design, introduced under the type designation FibroSiC, can be used for spans up to 2200 mm at Tf = 1200°C.

Advantages of this system:

1. *Unsupported up to 2200 mm at furnace temperature 1200°C.*
2. *Easy to assemble.*
3. *Economic design, since no other roof support is needed.*

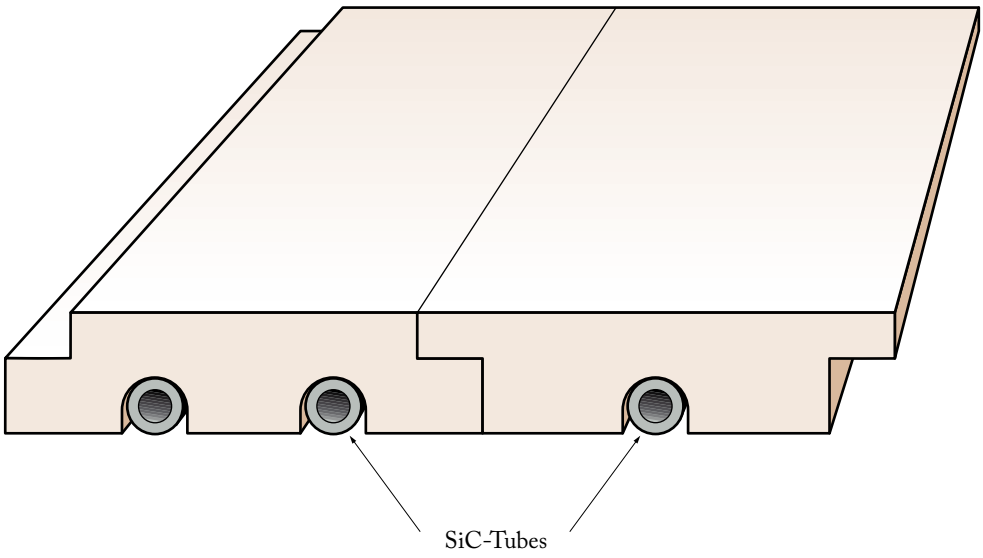


Fig. 23. FibroSiC

Accessories

Flexible bead-insulated connecting leads

Only for modules with embedded heating!

The lead consists of NIKROTHAL 40 and is multi-twisted. The choice of the necessary cross-section depends on the power consumption of the FIBROTHAL module. The diagrams below can be used to select the correct lead dimensions. Remember, however, that the temperatures at the terminals must never exceed 200°C.

It is also necessary to note that the temperature of the lead in the back insulation, in particular the welded connection to the terminal, should not exceed 800°C. The lead temperature is due to the combination of inherent heating caused by the passing current (see Figs. 24 and 25) and the temperature of the insulation.

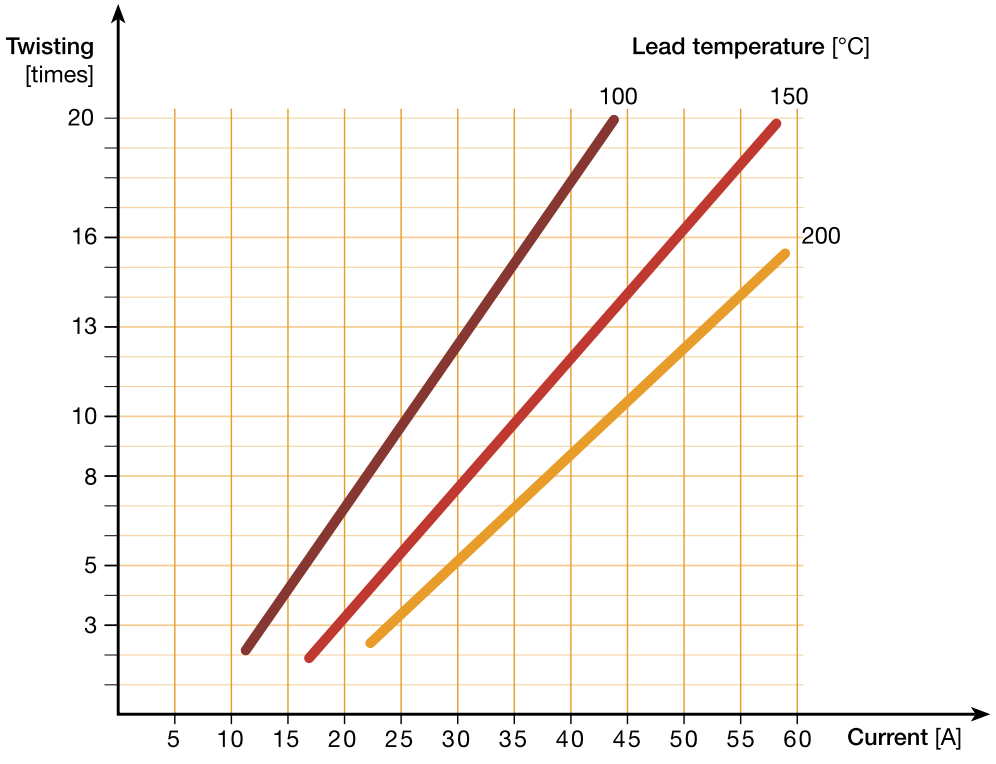


Fig. 24. Leads bead-insulated in air

	Number of twists (x- times)					
	3.0	5.0	6.0	8.0	10.0	13.0
Outside diameter of the twisted lead (mm)	3.5	4.5	5.0	6.5	7.0	8.5
Outside diameter of the insulating beads (mm)	11.0	11.0	11.0	14.0	14.0	14.0

Table 7. Twisted Connecting Leads

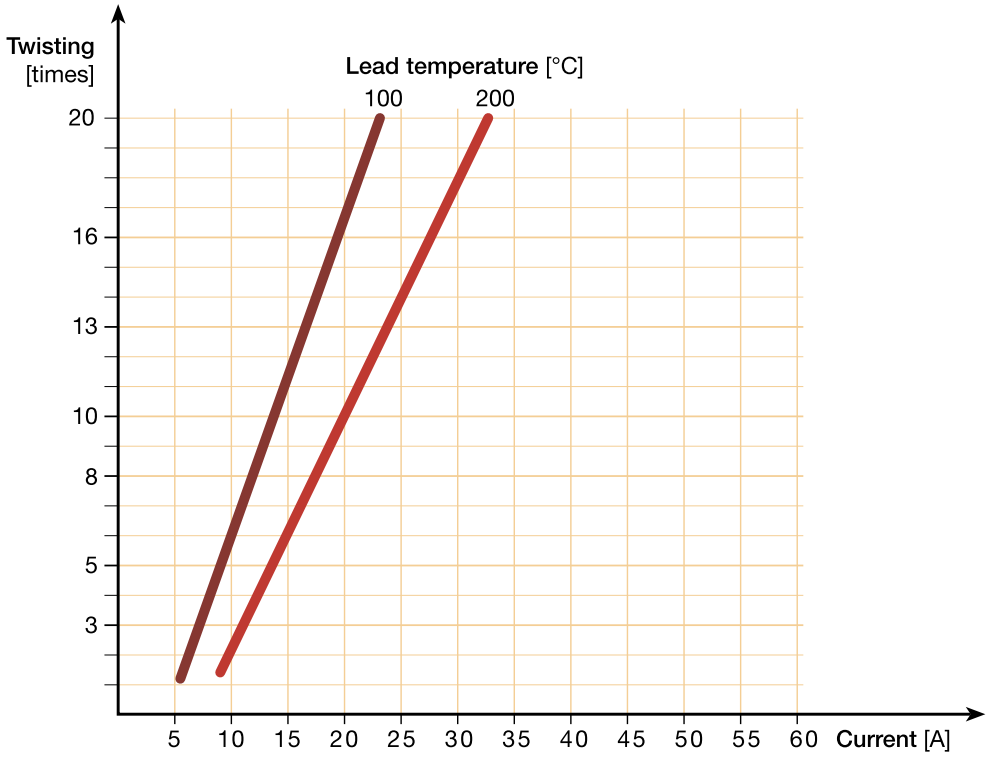


Fig. 25. Leads bead-insulated in FIBROTHAL

FIBROTHAL insulating blankets

for compensating for module and furnace tolerances and shrinkage, dimensions: 1/4" × 300 mm wide

Protection tubes for thermocouples

diameter 7/5 mm × desired length, both ends open

FIBROTHAL glue

for bonding FIBROTHAL modules together

FIBROTHAL hardener

for hardening machined surfaces

FIBROTHAL cement

for patching up damaged FIBROTHAL Modules

FIBROTHAL repair kit

consisting of: FIBROTHAL adhesive, hardener, powder, wool and felt

FIBROTHAL Mounting

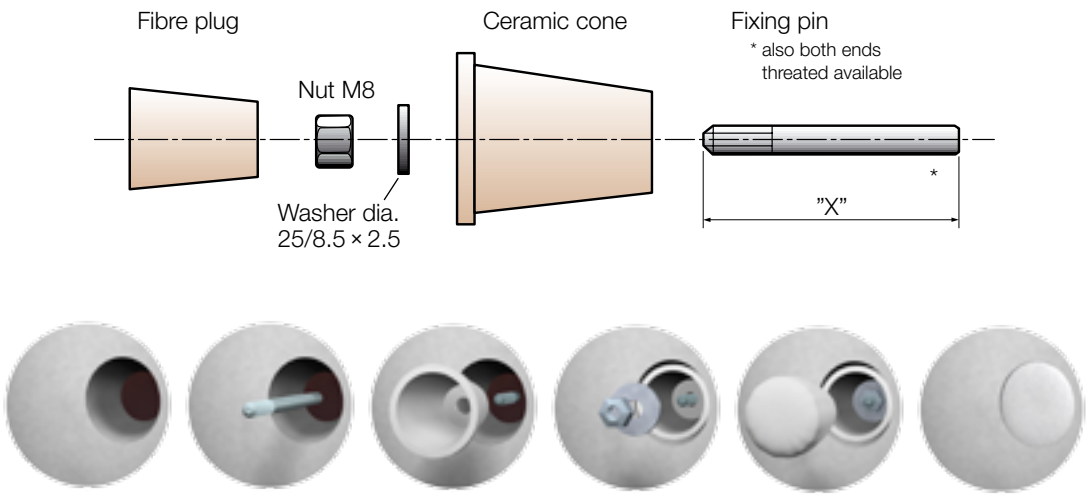
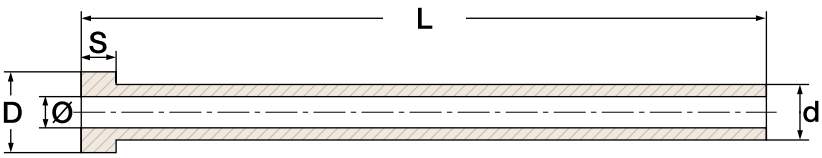


Fig. 26. FIBROTHAL Mountings

Ceramic Tubes with flange



Ref.	D	d	Ø	S	L stock
TUT-20-10	20	10	6	6	max 300
TUT-25-15	25	15	9	10	100-150-200-300
TUT-30-20	30	20	12	15	100-150-200-300
TUT-35-25	35	25	15	20	150-200-300
TUT-40-30	40	30	15	20	200-250-300
TUT-45-35	45	35	20	20	150-200-300
TUT-50-40	50	40	25	30	300

Dimensional tolerances according DIN 40680 norms
Usually manufactured in mat. A38E
Bold stock standard

Table 8. Ceramic Tubes with flange

Ceramic Insulators & plugs

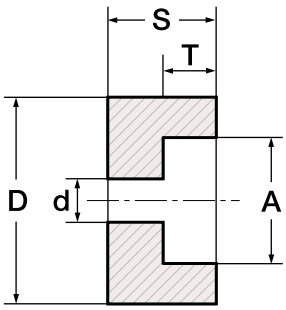


Fig. A

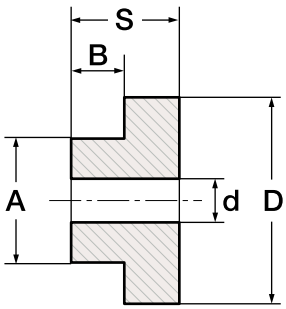


Fig. B

CODE	Ref.	Fig.	D	d	A	T	B	S	Mat.
ISM	025-16,5-5 M	B	15.5	5	10	–	1.5	6	Steatite
ISF	025-16,5-5 F	A	15.5	5	11	1.8	–	5	Steatite
ISM	025-22-6,5 M	B	22.5	6.5	11.5	–	4	10.5	Steatite
ISF	025-22-6,5 F	A	22.5	6.5	12.3	4.3	–	8	Steatite
ISM	025-30-8 M	B	30	8.5	16	–	7.5	15	Steatite
ISF	025-30-8 F	A	30	8.5	18	8.5	–	15	Steatite
TAP	025-23-7	B	23	7	13	–	15	20	A38E
TAP	025-45-13	B	45	13	26	–	18	30	A42P
TAP	025-60-15	B	60	15	30	–	18	40	A42P

Dimensional tolerances according DIN 40680 norms
Bold stock standards

Table 9. Ceramic Insulators & plugs

Assembly

For relatively small furnaces, such as tube furnaces with RAC modules, FIBROTHAL half-cylinders or third cylinders and muffle or chamber furnaces with FIBROTHAL panel modules, usually no special measures are necessary for the mounting or fixing of the FIBROTHAL modules, because they are self-supporting and/or self-stabilising inside the furnace body.

Attaching the FIBROTHAL modules

For attaching the FIBROTHAL modules in larger furnace installations, we recommend the FIBROTHAL mounting (see Accessories). For certain furnace designs it is possible to use a minimum of mountings, sometimes even none, because the modules support each other in a similar way as the blocks of a vault.

Examples of this are shown in Figs. 27, A to C. With this assembly it is essential that the modules can be assembled or inserted from the outside or from above. To reduce the assembly times and therefore costs, we can supply completely pre-assembled module rings.

If the design makes assembly of the modules from the furnace interior necessary, we recommend the tried and tested module combination as per Fig. 27, D.

This design consists of the module types A+B, in which the modules "B" are held by the modules "A". In most cases it is sufficient to fix the modules "A" with the mountings.

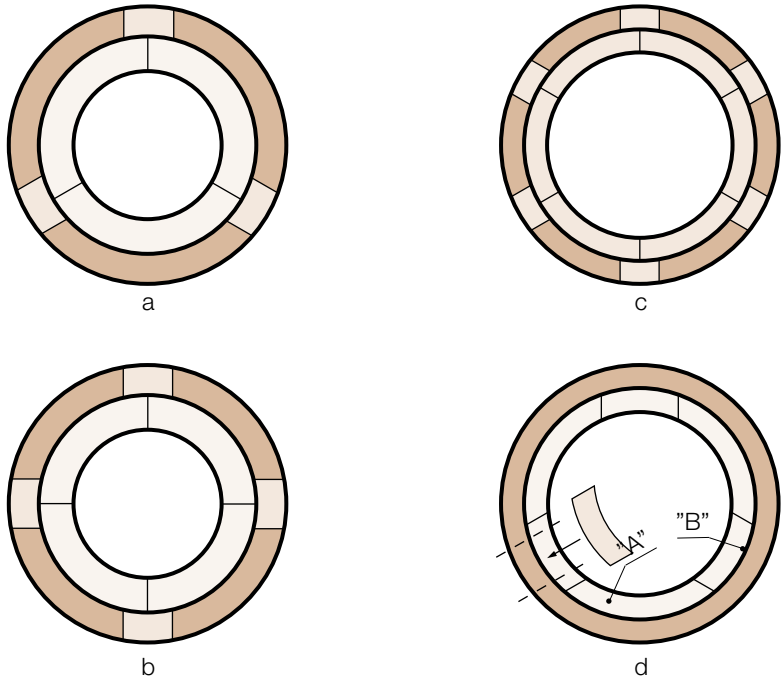


Fig. 27. Module installation situations A-D

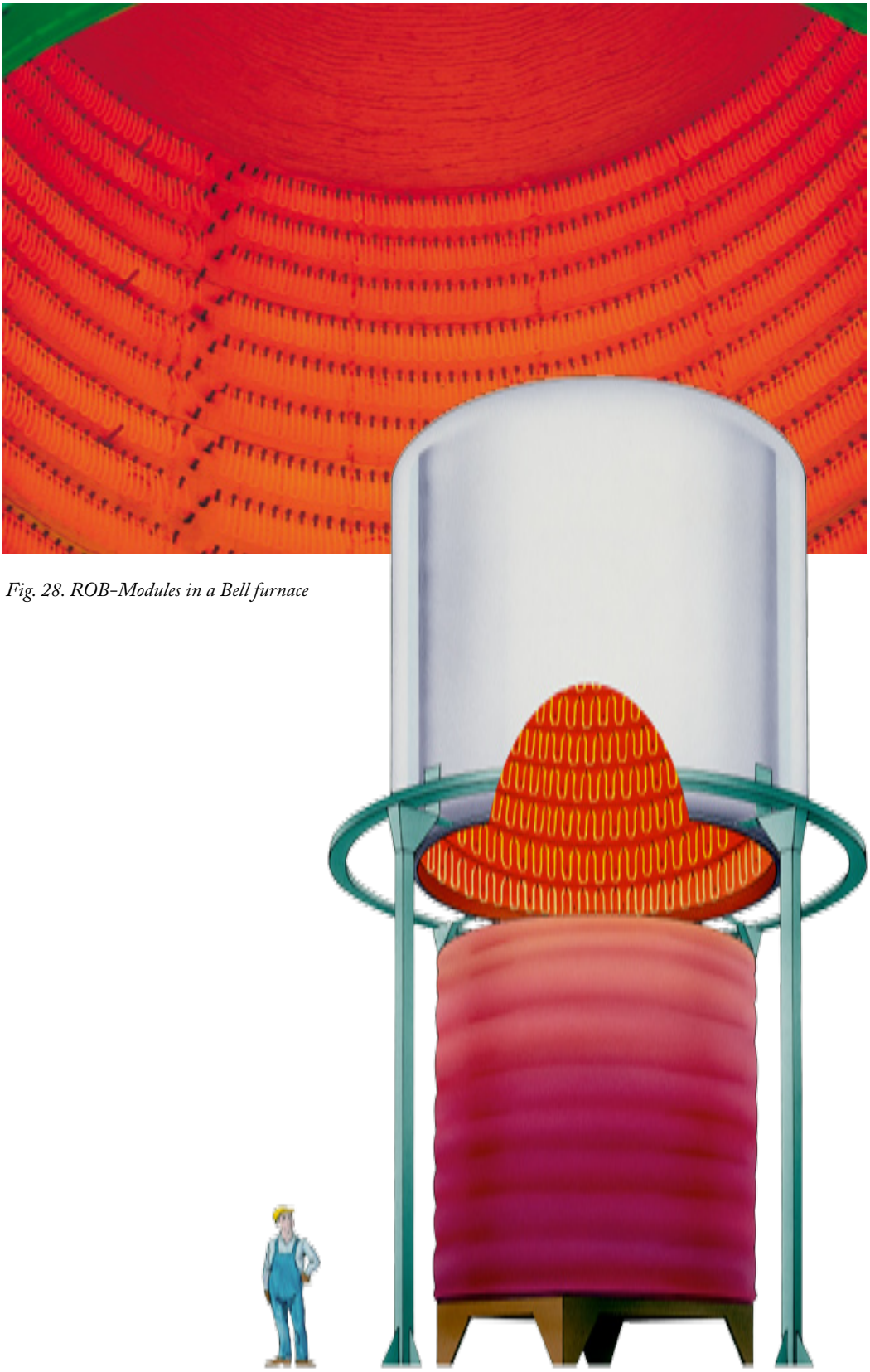


Fig. 28. ROB-Modules in a Bell furnace

Sealing the Joints

To compensate for furnace and module tolerances, and for shrinkage of the module inside, but also to prevent radiation losses through the module gaps, we recommend fitting a double folded layer of ceramic fibre felt (see accessories) between the FIBROTHAL modules. The ceramic fibre felt should project by at least 25 mm from the front of the module. This projection serves to compensate for the thermal module shrinkage.

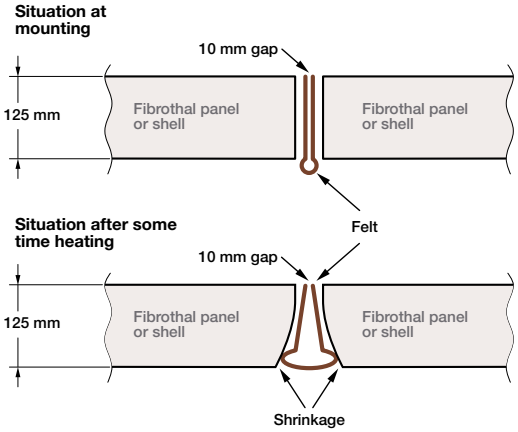


Fig. 29. Fitting of fibre felt (principle)

Welding on the Heating Element

If welding has to be carried out, e.g. between the terminal and the heating element, we recommend using the TIG method. Welding filler is usually not necessary. Please follow our welding instructions.

Fig. 30. Assembly of FIBROTHAL ROB-segments for a vacuum purge furnace

Overview of the Heating Systems

The Table below is intended for quick reference to the various heating systems.

	FIBROTHAL Panels, embedded	FIBROTHAL Shells, embedded	FIBROTHAL Tubes, embedded	RAC	R O B	MEANDERTHAL System II	MEANDERTHAL System III
Vertical installation	X	X	X	X	X	X	X
Horizontal installation	XD	XD	X	X	–	X	O
Floor installation	X	X	n.a.	n.a.	X	X	O
Suitable for round furnaces	O	X	X	X	X	X	X
Element change possible	–	–	–	–	X	–	X
Free-radiating heating	–	–	–	X	X	X	X
Element quality A-1	X	X	X	X	X	X	X
AF	–	–	–	X	X	X	X
APM	–	–	–	X	X	X	X
N80/N60	–	–	–	–	X	X	X
Max. element temp. °C A-1, AF, APM	A-1 1150	A-1 1150	A-1 1150	1300	1300	AF 1250 A-1 1300 APM 1400	AF 1250 A-1 1300 APM 1400
Max. element temp. °C N80/N60	–	–	–	–	1100/1050	1100/1050	1100/1050

X = possible
D = pin system recommended in certain circumstances
O = sometimes possible (customer information necessary)
– = not possible
n.a. = not applicable

Table 10. Selection criteria for heating systems

Fig. 31. FIBROTHAL modules in a suspended monorail furnace

Voltage and power conversion for standard modules

Calculation example

Assumption

For a chamber furnace 6 FIBROTHAL heating panels with dimensions 750 × 450 × 125 are necessary. The required furnace should have a power rating of approx. 25 kW.

For this duty the FIBROTHAL heating module PAS 750/450/230 (Table 3) can be chosen. According to the Table the standard data are 5400 Watts at 230 Volts supply voltage with a cold resistance of 9.42 Ohms (hot resistance approx. 4% higher = 9.8 Ohms). 6 heating modules would therefore give a total installed furnace power of 32.4 kW (2 three-phase groups; star connection).

Calculation of the modified power per FIBROTHAL heating panel

$$\text{Power per heating panel (P)} = \frac{\text{required furnace power (P)}}{\text{quantity of Heating Modules}}$$

$$\text{Power per heating panel (P)} = \frac{25\ (\text{kW})}{6} = 4170\ (\text{W})$$

Calculation of the new supply voltage U

$$U = \sqrt{P \times R_w}$$

$$U = \sqrt{4170\ (\text{W}) \times 9.8\ (\Omega)} = 202.15\ (\text{V})$$

U = 202.15 Volts

In this case it is advisable to select 1 three-phase group in delta connection with two heating modules in series, i.e. each module is connected to 200 Volts.

Calculation of the power P per FIBROTHAL Heating Module at 200 volts supply voltage

$$P = \frac{U^2}{R_w}$$

$$\frac{200^2\ (\text{V}^2)}{9.8(\Omega)} = 4082\ (\text{W})$$

P = 4082 Watts

The total furnace power is therefore 6 × 4082 Watts = 24489 Watts.

The temperature factor which contributes to the change in the heating resistance can be neglected for the calculation illustrated above, because with the element alloy KANTHAL A-1 it is max. 4%.

$$\text{Power per heating panel (P)} = \frac{\text{required furnace power (P)}}{\text{quantity of Heating Modules}}$$

Fig. 32. FIBROTHAL modules used in a conveyor belt furnace

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