

**KANTHAL<sup>®</sup>**

# FIBROTHAL<sup>®</sup> HEATING MODULES AND INSULATION SYSTEMS

PRODUCT OVERVIEW





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# INTRODUCTION

## FEATURES

- Less weight of the insulation
- High insulation properties
- Flexible to use, possible to switch fastly between different processes
- Fast installation and replacement
- Energy savings
- Exact controlling of the process

**Our lightweight construction has become the norm in many industrial furnaces, with the use of ceramic fibers (KF) up to furnace temperatures of 1550°C (2820°F).**

The low thermal mass and thermal conductivity of the ceramic fiber 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 fibers, such as blankets or folding blocks, with electric heating elements. This has led to the product concept which we introduced to the market in 1978 under the trademark Fibrothal®.

Today the Fibrothal® trademark covers a family of products consisting of vacuum-formed ceramic fiber components, with or without electric heating elements.

# FIBROTHAL® HEATING MODULES AND INSULATION SYSTEMS



Fig. 1  
Heating modules with embedded heating elements made of Kanthal alloys for a maximum element temperature of 1150°C (2100°F).



Fig. 2  
RAC tubes with embedded but virtually free-radiating heating element, for a maximum element temperature of 1300°C (2370°F).

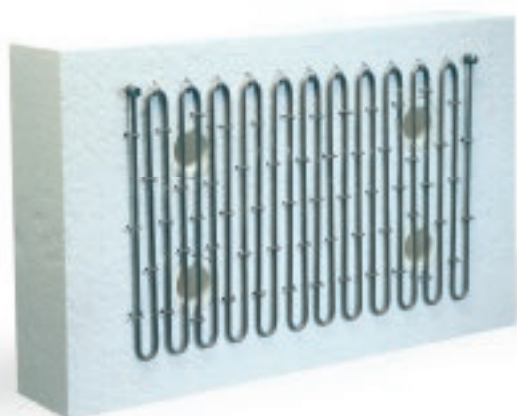


Fig. 3  
Fibrothal® meander II module with free-radiating heating elements for a maximum element temperature of 1300°C (2370°F), mainly for roof heating and tilting furnaces.

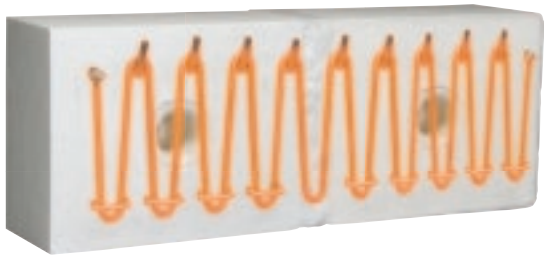


Fig. 4  
ROB with free-radiating heating elements for a maximum element temperature of 1300°C (2370°F), mainly for wall and floor heating.



Fig. 5  
Muffles with embedded heating elements made of Kanthal® alloys for a maximum element temperature of 1150°C (2100°F).



Fig. 6  
Insulation parts of vacuum-formed fiber in the most varied shapes for application temperatures up to 1550°C (2820°F).



Fig. 7  
FibroSiC are unsupported roof insulating parts, which are strengthened by silicon carbide (SiC) tubes.

# TECHNICAL DATA – GENERAL

## KF-MODULES

Chemical properties: 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 fibers themselves. After drying or evaporation the thermal and physical properties are restored. Care must be taken when they are fitted with heating elements because of possible corrosion.

## TECHNICAL DATA OF CERAMIC FIBER MODULES

	F-3/LS	F-17/LS	F-19	F-14	F-BIO
Classification temp. °C (°F)*	1260 (2300)	1400 (2550)	1500 (2730)	1600 (2910)	1300 (2370)
Maximum continuous duty temperature, °C (°F)	1150 (2100)	1300 (2370)	1400 (2550)	1550 (2820)	1000 (1830) (in clean air)**
Density approx. kg/m <sup>3</sup> (lb/ft <sup>3</sup> )	200 (12.48)	200 (12.48)	200 (12.48)	250 (15.61)	180–200 (11.24–12.48)
Linear shrinkage, % (24 hours at max. continuous duty temperature)	3/<1	4.5/<2	4.5	3.5	<2
Guide analysis, %:	Al <sub>2</sub> O <sub>3</sub> 46 SiO <sub>2</sub> 54	50 50	67 33	77 23	CaO+MgO 18–20 70–80 others <3
Thermal conductivity, W/m·K***					
at 200°C (390°F)	0.07	0.07	0.07	–	0.08
at 400°C (750°F)	0.10	0.10	0.10	0.09	0.10
at 600°C (1110°F)	0.14	0.14	0.14	0.13	0.14
at 800°C (1470°F)	0.21	0.21	0.20	0.19	0.21
at 1000°C (1830°F)	0.28	0.29	0.28	0.24	0.28
at 1200°C (2190°F)	–	0.41	0.39	0.35	–
at 1300°C (2370°F)	–	0.49	0.46	0.39	–
at 1400°C (2550°F)	–	–	0.54	0.46	–
at 1500°C (2730°F)	–	–	–	0.54	–
at 1600°C (2910°F)	–	–	–	–	–

\* Classification temperature of the fibers used

\*\* The max. cont. duty temp. is reduced to 1000°C (1830°F) furnace temp. in H<sub>2</sub> atmosphere (also contents of it)

\*\*\* Measuring method: calorimeter

Fiber free versions see Modutha™ brochure

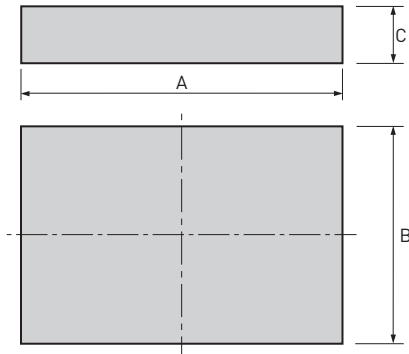
For F-Bio products it is absolutely necessary to know the final application. Please contact our technical sales office for advice.

## TOLERANCES

### MODULE DIMENSIONS

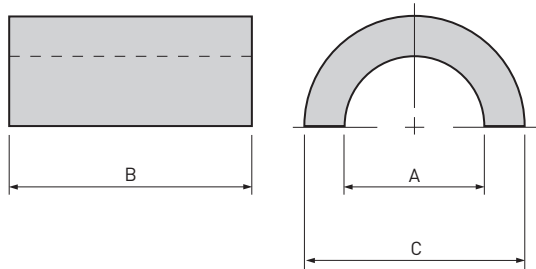
The following tolerances apply to the vacuum-formed insulation with or without heating element.

Electrical resistance:  $R_k \pm 5\%$



### FIBROTHAL® PANELS

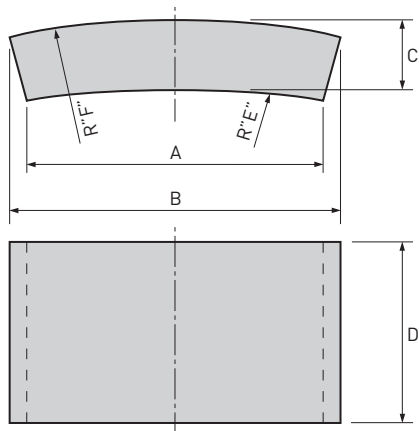
MODULE DIMENSION	A AND B		C, WITH MACHINING ON			
			ONE SURFACE		TWO SURFACES	
	MM	IN	MM	IN	MM	IN
≤700 mm (≤27.6 in)	±3	±0.12	±5	±0.20	±3	±0.12
>700 mm (>27.6 in)	±5	±0.20	+5/-10	+0.20/-0.39	±3	±0.12



### FIBROTHAL® HALF-CYLINDERS

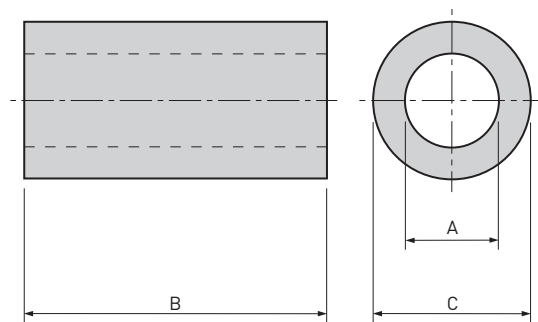
MODULE DIMENSION	A		B		C	
	MM	IN	MM	IN	MM	IN
≤200 (≤7.9)	+4	+0.16	±3	±0.12	±5	±0.20
200–350 (7.9–3.8)	+6	+0.24			±5	±0.20
>350 (>13.8)	+10	+0.39			±10	±0.39





**FIBROTHAL® SHELLS**

MODULE DIMENSION	A, B AND D		C		R "E" AND R "F"	
	MM	IN	MM	IN	MM	IN
≤700 mm (≤27.6 in)	±3	±0.12	±5	± 0.20	±5	± 0.20
>700 mm (>27.6 in)	±5	±0.20			±10	± 0.39



**FIBROTHAL® TUBES**

A		B		C	
MM	IN	MM	IN	MM	IN
+8/-2	+0.31/-0.08	+10/-5	+0.39/-0.20	±10	±0.39

## ATMOSPHERES

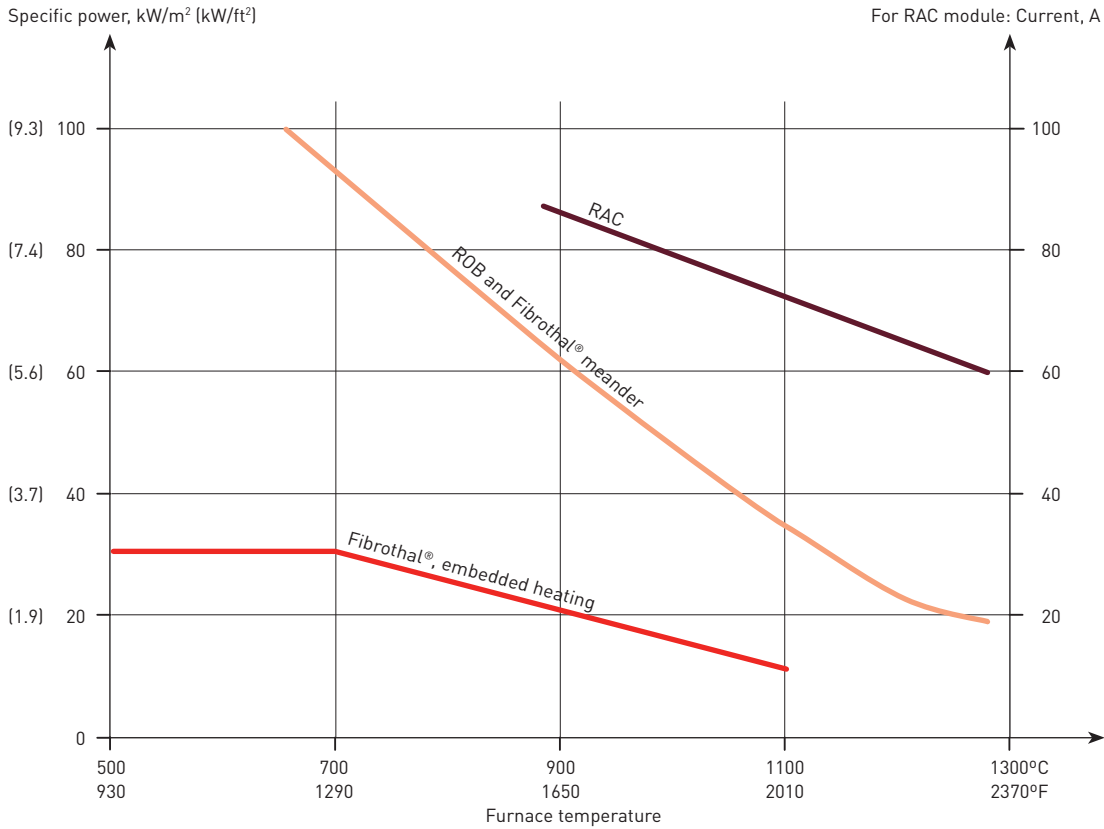
### MAXIMUM PERMISSIBLE ELEMENT TEMPERATURES IN VARIOUS FURNACE ATMOSPHERES

FURNACE ATMOSPHERE	MAX. ELEMENT TEMPERATURE		REMARKS
	KANTHAL® HEATING ELEMENTS	FIBROTHAL® HEATING ELEMENTS	
H <sub>2</sub>	1400°C (2550°F)	1000°C (1830°F)	H <sub>2</sub> increases heat throughput of Fibrothal® 3-4 times.
N <sub>2</sub>	1200°C (2190°F) preoxidized	1150°C (2100°F) preoxidized	Fibrothal® heating modules without heating elements up to maximum duty temperature.
Endogas	1050°C (1920°F) preoxidized	1050°C (1920°F) preoxidized	Pay attention to carbon deposition! Better with gas-tight muffle.
Exogas	1150°C (2100°F) preoxidized	1050°C (1920°F) preoxidized	Pay attention to carbon deposition! Better with gas-tight muffle.
Sulphur	approx. 1000°C (1830°F)	—	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 (1650°F).
Vacuum < 10 <sup>-3</sup> mbar	1150°C (2100°F) preoxidized	800 – 850°C (1470 – 1560°F)	Vacuum higher than 10 <sup>-3</sup> mbar will take too long to evacuate the fiber block. Better with vacuum-tight muffle.
Pressurized	1400°C (2550°F)	1250°C (2280°F)	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 (112 mph). Pay attention to butt joints with ceramic fiber blankets.

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## POWER LIMITATION

### MAXIMUM RECOMMENDED LOAD IN RELATION TO THE FURNACE TEMPERATURE FOR THE VARIOUS HEATING MODULE DESIGNS



#### RULE OF THUMB

To install a voltage of 230 V with a free radiating wire (ROB, Fibrothal® meander) an area of 1 m<sup>2</sup> (10.8 ft<sup>2</sup>) is needed.

To install a voltage of 230 V with an embedded element (Fibrothal®) an area of 0.25 m<sup>2</sup> (2.7 ft<sup>2</sup>) is needed.



# TECHNICAL DATA – STANDARD RANGE

## HEATING MODULES

Fibrothal® standard heating modules are manufactured with embedded heating elements, two principles being followed.

### PRINCIPLE I

With this method the Kanthal® A-1 heating wires (diameter < 3.5 mm (0.14 in)) are embedded in the ceramic fiber module made of F3 fiber. The maximum element temperature is 1150°C (2100°F).

This design is protected by patent.

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

### FOR OPTIMUM HEAT RADIATION:

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

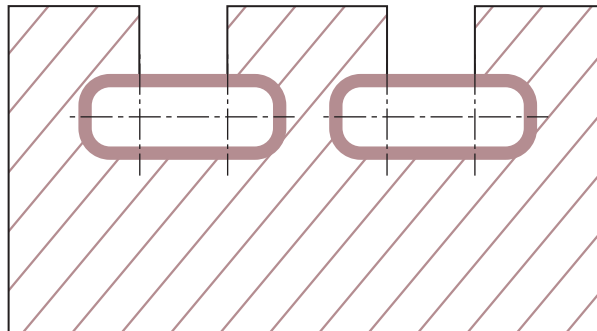


Fig. 8 Embedding principle.

## PRINCIPLE II

With this method – used exclusively for heating tubes – a heating wire of Kanthal® A-1/Kanthal APM™ (diameter 5 mm (0.20 in)) is formed to fit into a ceramic fiber module of F17 fiber 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 (2370°F) (1350°C (2460°F) for Kanthal APM).

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

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

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 Power limitation).

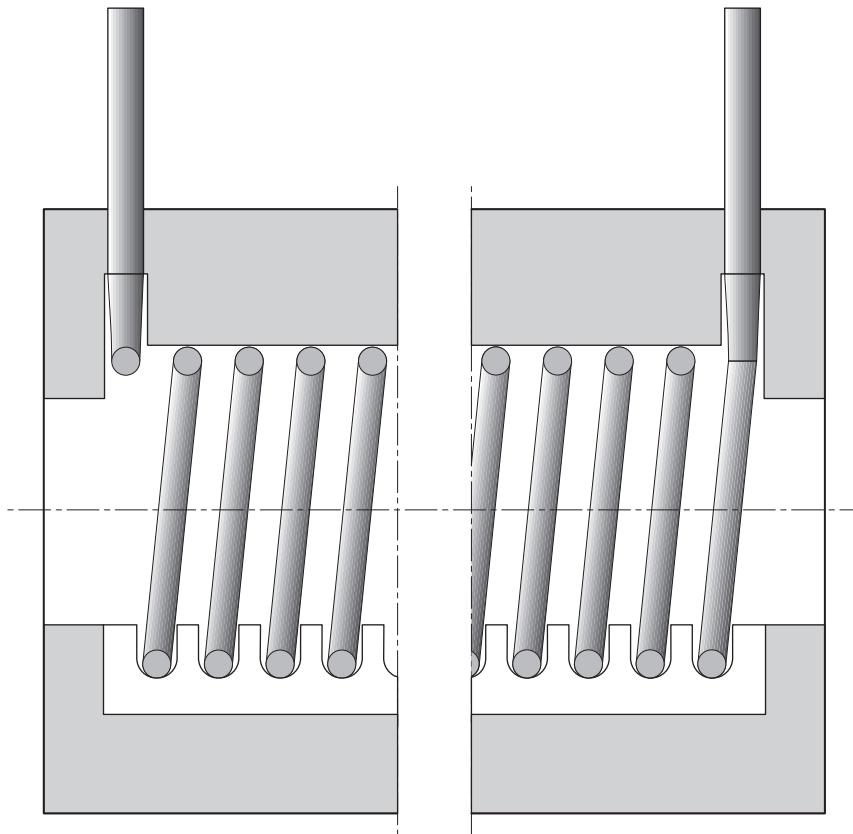


Fig. 9 RAC forming principle.

## PANELS

The heating surface is the surface which accommodates 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 (41.4 in).

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 (4.92 in) 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 (2.95 in) long at the back of the module. Other connection designs are available on request, e. g. flexible leads (see Accessories).

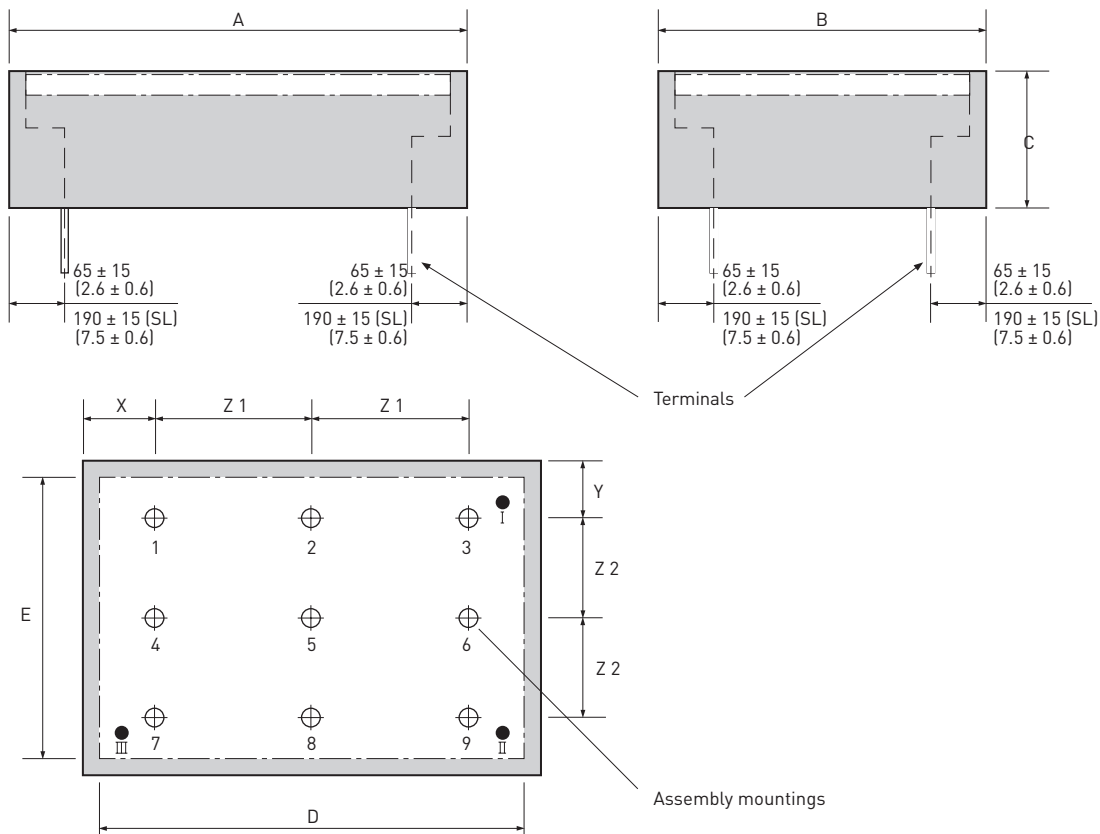


Fig. 10 Fibrothal® standard panels.

**STANDARD FIBROTHAL® HEATING PANEL DESIGNS**

TYPE DESIGNATION	PART NO.	STANDARD DIMENSIONS		HEATED AREA	
		A × B × C		D × E	
		MM	IN	MM	IN
PAS 300/225/57.5	DF830004	300 × 225 × 125	11.8 × 8.9 × 4.9	270 × 195	10.6 × 7.7
PAS 300/225/57.5 S/D	DF830007	300 × 225 × 125	11.8 × 8.9 × 4.9	270 × 195	10.6 × 7.7
PAS 300/225/57.5 SL	DF830011	550 × 225 × 125	21.7 × 8.9 × 4.9	270 × 195	10.6 × 7.7
PAS 300/225/57.5 SB	DF830012	300 × 475 × 125	11.8 × 18.7 × 4.9	270 × 195	10.6 × 7.7
PAS 375/225/57.5	DF830016	375 × 225 × 125	14.8 × 8.9 × 4.9	335 × 195	13.2 × 7.7
PAS 375/225/57.5 S/D	DF830019	375 × 225 × 125	14.8 × 8.9 × 4.9	335 × 195	13.2 × 7.7
PAS 375/225/57.5 SL	DF830021	625 × 225 × 125	24.6 × 8.9 × 4.9	335 × 195	13.2 × 7.7
PAS 375/225/57.5 SB	DF830022	375 × 475 × 125	14.8 × 18.7 × 4.9	335 × 195	13.2 × 7.7
PAS 450/300/100	DF830026	450 × 300 × 125	17.7 × 11.8 × 4.9	410 × 250	16.1 × 9.8
PAS 450/300/100 S/D	DF830029	450 × 300 × 125	17.7 × 11.8 × 4.9	410 × 250	16.1 × 9.8
PAS 450/300/100 SL	DF830031	700 × 300 × 125	27.6 × 11.8 × 4.9	410 × 250	16.1 × 9.8
PAS 450/300/100 SB	DF830032	450 × 550 × 125	17.7 × 21.7 × 4.9	410 × 250	16.1 × 9.8
PAS 450/300/115	DF830036	450 × 300 × 125	17.7 × 11.8 × 4.9	410 × 250	16.1 × 9.8
PAS 450/300/115 S/D	DF830039	450 × 300 × 125	17.7 × 11.8 × 4.9	410 × 250	16.1 × 9.8
PAS 450/300/115 SL	DF830041	700 × 300 × 125	27.6 × 11.8 × 4.9	410 × 250	16.1 × 9.8
PAS 450/300/115 SB	DF830042	450 × 550 × 125	17.7 × 21.7 × 4.9	410 × 250	16.1 × 9.8
PAS 450/300/133	DF830046	450 × 300 × 125	17.7 × 11.8 × 4.9	410 × 250	16.1 × 9.8
PAS 450/300/133 S/D	DF830049	450 × 300 × 125	17.7 × 11.8 × 4.9	410 × 250	16.1 × 9.8
PAS 450/300/133 SL	DF830051	700 × 300 × 125	27.6 × 11.8 × 4.9	410 × 250	16.1 × 9.8
PAS 450/300/133 SB	DF830052	450 × 550 × 125	17.7 × 21.7 × 4.9	410 × 250	16.1 × 9.8
PAS 450/375/115	DF830056	450 × 375 × 125	17.7 × 14.8 × 4.9	410 × 325	16.1 × 12.8
PAS 450/375/115 S/D	DF830059	450 × 375 × 125	17.7 × 14.8 × 4.9	410 × 325	16.1 × 12.8
PAS 450/375/115 SL	DF830061	700 × 375 × 125	27.6 × 14.8 × 4.9	410 × 325	16.1 × 12.8
PAS 450/375/115 SB	DF830062	450 × 625 × 125	17.7 × 24.6 × 4.9	410 × 325	16.1 × 12.8
PAS 450/375/133	DF830066	450 × 375 × 125	17.7 × 14.8 × 4.9	410 × 325	16.1 × 12.8
PAS 450/375/133 S/D	DF830069	450 × 375 × 125	17.7 × 14.8 × 4.9	410 × 325	16.1 × 12.8
PAS 450/375/133 SL	DF830071	700 × 375 × 125	27.6 × 14.8 × 4.9	410 × 325	16.1 × 12.8
PAS 450/375/133 SB	DF830072	450 × 625 × 125	17.7 × 24.6 × 4.9	410 × 325	16.1 × 12.8



POWER W	VOLTAGE V	RESISTANCE R20 Ω	TERMINAL ARR. POSITION	ASSEMBLY NOS. PCS./POS.	GRID DIMENSIONS				APPROX. WEIGHT	
					X/Z1		Y/Z2		KG	LB
					MM	IN	MM	IN		
1050	57.5	3.03	I-III	-	-	-	-	-	2.1	4.6
1050	57.5	3.03	I-III	2/1-9	75/150	3.0/5.9	92/42	3.6/1.7	2.1	4.6
1050	57.5	3.03	I-III	-	-	-	-	-	3.5	7.7
1050	57.5	3.03	I-III	-	-	-	-	-	3.9	8.6
1350	57.5	2.35	I-III	-	-	-	-	-	2.7	6.0
1350	57.5	2.35	I-III	2/1-9	75/112	3.0/4.4	92/21	3.6/0.8	2.7	6.0
1350	57.5	2.35	I-III	-	-	-	-	-	4.1	9.0
1350	57.5	2.35	I-III	-	-	-	-	-	5	11.0
2100	100	4.58	I-II	-	-	-	-	-	4.2	9.3
2100	100	4.58	I-II	2/4-6	100/125	3.9/4.9	150/0	5.9/0	4.2	9.3
2100	100	4.58	I-II	-	-	-	-	-	6.1	13.4
2100	100	4.58	I-II	-	-	-	-	-	7	15.4
2100	115	6.06	I-II	-	-	-	-	-	4.2	9.3
2100	115	6.06	I-II	2/4-6	100/125	3.9/4.9	150/0	5.9/0	4.2	9.3
2100	115	6.06	I-II	-	-	-	-	-	6.1	13.4
2100	115	6.06	I-II	-	-	-	-	-	7	15.4
2100	133	8.1	I-III	-	-	-	-	-	4.5	9.9
2100	133	8.1	I-III	2/1-9	100/125	3.9/4.9	131/19	5.2/0.7	4.5	9.9
2100	133	8.1	I-III	-	-	-	-	-	5.9	13.0
2100	133	8.1	I-III	-	-	-	-	-	6.9	15.2
2700	115	4.9	I-II	-	-	-	-	-	4.5	9.9
2700	115	4.9	I-II	2/4-6	100/125	3.9/4.9	187/0	7.4/0	4.5	9.9
2700	115	4.9	I-II	-	-	-	-	-	7.7	17.0
2700	115	4.9	I-II	-	-	-	-	-	8.2	18.0
2700	133	6.3	I-II	-	-	-	-	-	5.3	11.7
2700	133	6.3	I-II	2/4-6	100/125	3.9/4.9	187/0	7.4/0	5.3	11.7
2700	133	6.3	I-II	-	-	-	-	-	7.7	17.0
2700	133	6.3	I-II	-	-	-	-	-	8	17.6

(Cont.)

**STANDARD FIBROTHAL® HEATING PANEL DESIGNS**

TYPE DESIGNATION	PART NO.	STANDARD DIMENSIONS		HEATED AREA	
		A × B × C		D × E	
		MM	IN	MM	IN
PAS 600/450/200	DF830076	600×450×125	23.6×17.7×4.9	550×405	21.7×15.9
PAS 600/450/200 S	DF830079	600×450×125	23.6×17.7×4.9	550×405	21.7×15.9
PAS 600/450/200 D	DF830082	600×450×125	23.6×17.7×4.9	550×405	21.7×15.9
PAS 600/450/200 SL	DF830083	850×450×125	33.5×17.7×4.9	550×405	21.7×15.9
PAS 600/450/200 SB	DF830084	600×700×125	23.6×27.6×4.9	550×405	21.7×15.9
PAS 600/450/230	DF830088	600×450×125	23.6×17.7×4.9	550×405	21.7×15.9
PAS 600/450/230 S	DF830091	600×450×125	23.6×17.7×4.9	550×405	21.7×15.9
PAS 600/450/230 D	DF830094	600×450×125	23.6×17.7×4.9	550×405	21.7×15.9
PAS 600/450/230 SL	DF830095	850×450×125	33.5×17.7×4.9	550×405	21.7×15.9
PAS 600/450/230 SB	DF830096	600×700×125	23.6×27.6×4.9	550×405	21.7×15.9
PAS 750/450/200	DF830100	750×450×125	29.5×17.7×4.9	700×405	27.6×15.9
PAS 750/450/200 S	DF830103	750×450×125	29.5×17.7×4.9	700×405	27.6×15.9
PAS 750/450/200 D	DF830106	750×450×125	29.5×17.7×4.9	700×405	27.6×15.9
PAS 750/450/200 SL	DF830107	1000×450×125	39.4×17.7×4.9	700×405	27.6×15.9
PAS 750/450/200 SB	DF830108	750×700×125	29.5×27.6×4.9	700×405	27.6×15.9
PAS 750/450/230	DF830112	750×450×125	29.5×17.7×4.9	700×405	27.6×15.9
PAS 750/450/230 S	DF830115	750×450×125	29.5×17.7×4.9	700×405	27.6×15.9
PAS 750/450/230 D	DF830118	750×450×125	29.5×17.7×4.9	700×405	27.6×15.9
PAS 750/450/230 SL	DF830119	1000×450×125	39.4×17.7×4.9	700×405	27.6×15.9
PAS 750/450/230 SB	DF830120	750×700×125	29.5×27.6×4.9	700×405	27.6×15.9
PAS 900/600/400	DF830124	900×600×125	35.4×23.6×4.9	825×540	32.5×21.3
PAS 900/600/400 S	DF830127	900×600×125	35.4×23.6×4.9	825×540	32.5×21.3
PAS 900/600/400 D	DF830130	900×600×125	35.4×23.6×4.9	825×540	32.5×21.3
PAS 900/600/400 SL	DF830472	1150×600×125	45.3×23.6×4.9	825×540	32.5×21.3
PAS 900/600/400 SB	DF830131	900×850×125	35.4×33.5×4.9	825×540	32.5×21.3
PAS 900/750/400	DF830135	900×750×125	35.4×29.5×4.9	825×680	32.5×26.8
PAS 900/750/400 S	DF830138	900×750×125	35.4×29.5×4.9	825×680	32.5×26.8
PAS 900/750/400 D	DF830141	900×750×125	35.4×29.5×4.9	825×680	32.5×26.8
PAS 900/750/400 SB	DF830142	900×1000×125	35.4×39.4×4.9	825×680	32.5×26.8

POWER W	VOLTAGE V	RESISTANCE R20 Ω	TERMINAL ARR. POSITION	ASSEMBLY NOS. PCS./POS.	GRID DIMENSIONS				APPROX. WEIGHT	
					X/Z1		Y/Z2		KG	LB
					MM	IN	MM	IN		
4200	200	9.16	I-II	-	-	-	-	-	8.7	19.2
4200	200	9.16	I-II	2/4-6	150/150	5.9/5.9	225/0	8.9/0	8.7	19.2
4200	200	9.16	I-II	4/1-3-7-9	150/150	5.9/5.9	100/125	3.9/4.9	8.7	19.2
4200	200	9.16	I-II	-	-	-	-	-	11.5	25.4
4200	200	9.16	I-II	-	-	-	-	-	12.5	27.6
4200	230	12.11	I-II	-	-	-	-	-	8.6	19.0
4200	230	12.11	I-II	2/4-6	150/150	5.9/5.9	225/0	8.9/0	8.6	19.0
4200	230	12.11	I-II	4/1-3-7-9	150/150	5.9/5.9	100/125	3.9/4.9	8.6	19.0
4200	230	12.11	I-II	-	-	-	-	-	11.4	25.1
4200	230	12.11	I-II	-	-	-	-	-	12.3	27.1
5400	200	7.12	I-III	-	-	-	-	-	11.1	24.5
5400	200	7.12	I-III	2/4-6	143/232	5.6/9.1	225/0	8.9/0	11.1	24.5
5400	200	7.12	I-III	6/1-2-3-7-8-9	102/ (294) (252)	4.0/ (11.6) (9.9)	100/125	3.9/4.9	11.1	24.5
5400	200	7.12	I-III	-	-	-	-	-	14	30.9
5400	200	7.12	I-III	-	-	-	-	-	15.8	34.8
5400	230	9.42	I-III	-	-	-	-	-	15.4	34.0
5400	230	9.42	I-III	2/4-6	143/232	5.6/9.1	225/0	8.9/0	15.4	34.0
5400	230	9.42	II-III	6/1-2-3-7-8-9	102/ (294) (252)	4.0/ (11.6) (9.9)	100/125	3.9/4.9	15.4	34.0
5400	230	9.42	I-III	-	-	-	-	-	13.5	29.8
5400	230	9.42	I-III	-	-	-	-	-	15.4	34.0
8400	400	18.32	II-III	-	-	-	-	-	17.4	38.4
8400	400	18.32	II-III	2/4-6	198/252	7.8/9.9	300/0	11.8/0	17.5	38.6
8400	400	18.32	II-III	6/1-2-3-7-8-9	156/294	6.1/11.6	150/150	5.9/5.9	17.4	38.4
8400	400	18.32	II-III	-	-	-	-	-	23	50.7
8400	400	18.32	II-III	-	-	-	-	-	23	50.7
10800	400	14.25	II-III	-	-	-	-	-	22.3	49.2
10800	400	14.25	II-III	2/4-6	198/252	7.8/9.9	375/0	33.0/0	22.3	49.2
10800	400	14.25	II-III	9/1...9	156/294	6.1/11.6	130/245	5.1/9.6	22.3	49.2
10800	400	14.25	II-III	-	-	-	-	-	27.9	61.5



### 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 (2.95 in) long on the back of the module. Other connection designs are available on request, e.g. flexible leads (see Accessories).



We are producing the HAS models to use fiber felt inbetween.

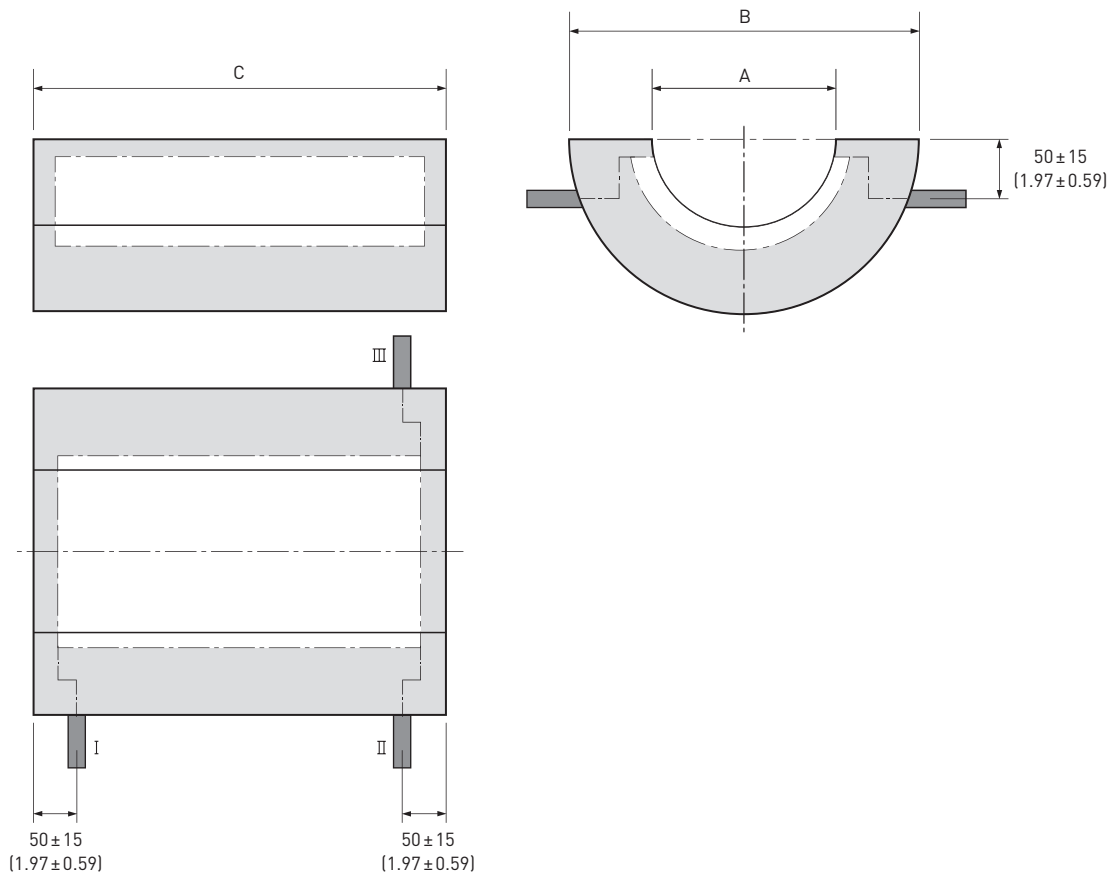


Fig. 11 Fibrothal® standard half-cylinders.

## STANDARD FIBROTHAL® HALF-CYLINDER DESIGNS

TYPE DESIGNATION	PART NO.	Ø INSIDE DIAMETER		Ø OUTSIDE DIAMETER	
		A		B	
		MM	IN	MM	IN
HAS 70/250/57.5	DF830256	70	2.8	220	8.7
HAS 70/500/115	DF830260	70	2.8	220	8.7
HAS 100/250/57.5	DF830264	100	3.9	250	9.8
HAS 100/300/57.5	DF830268	100	3.9	250	9.8
HAS 100/500/115	DF830272	100	3.9	250	9.8
HAS 100/600/115	DF830276	100	3.9	250	9.8
HAS 150/250/57.5	DF830280	150	5.9	300	11.8
HAS 150/300/57.5	DF830284	150	5.9	300	11.8
HAS 150/500/115	DF830288	150	5.9	300	11.8
HAS 150/600/115	DF830292	150	5.9	300	11.8
HAS 200/250/57.5	DF830296	200	7.9	350	13.8
HAS 200/300/57.5	DF830300	200	7.9	350	13.8
HAS 200/500/115	DF830304	200	7.9	350	13.8
HAS 200/600/115	DF830308	200	7.9	350	13.8
HAS 250/375/115	DF830312	250	9.8	450	17.7
HAS 250/400/115	DF830316	250	9.8	450	17.7
HAS 250/750/200	DF830320	250	9.8	450	17.7
HAS 250/750/230	DF830324	250	9.8	450	17.7
HAS 250/800/230	DF830328	250	9.8	450	17.7
HAS 300/375/115	DF830332	300	11.8	500	19.7
HAS 300/400/115	DF830336	300	11.8	500	19.7
HAS 300/750/230	DF830340	300	11.8	500	19.7
HAS 300/800/230	DF830344	300	11.8	500	19.7
HAS 350/500/200	DF830348	350	13.8	600	23.6
HAS 350/500/230	DF830352	350	13.8	600	23.6
HAS 350/600/230	DF830356	350	13.8	600	23.6
HAS 350/750/230	DF830360	350	13.8	600	23.6
HAS 350/800/230	DF830364	350	13.8	600	23.6
HAS 400/500/200	DF830368	400	15.7	650	25.6
HAS 400/500/230	DF830372	400	15.7	650	25.6
HAS 400/600/200	DF830376	400	15.7	650	25.6
HAS 400/600/230	DF830380	400	15.7	650	25.6
HAS 400/750/400	DF830384	400	15.7	650	25.6
HAS 400/900/400	DF830388	400	15.7	650	25.6
HAS 450/600/400	DF830392	450	17.7	700	27.6
HAS 450/900/400	DF830396	450	17.7	700	27.6
HAS 500/600/400	DF830400	500	19.7	750	29.5
HAS 500/900/400	DF830404	500	19.7	750	29.5

LENGTH C		POWER	VOLTAGE	RESISTANCE	TERMINAL	APPROX.	
MM	IN	W	V	R20 Ω	ARR. POSITION	KG	LB
250	9.8	450	57.5	7.06	I-III	1	2.2
500	19.7	900	115	14.13	I-II	1.9	4.2
250	9.8	650	57.5	4.89	I-II	1.2	2.6
300	11.8	750	57.5	4.24	I-III	1.5	3.3
500	19.7	1300	115	9.78	I-II	2.4	5.3
600	23.6	1500	115	8.48	I-III	3	6.6
250	9.8	950	57.5	3.35	I-II	1.7	3.7
300	11.8	1150	57.5	2.76	I-II	2	4.4
500	19.7	1900	115	6.69	I-II	3.4	7.5
600	23.6	2300	115	5.53	I-III	4.1	9.0
250	9.8	1250	57.5	2.54	I-III	2.2	4.9
300	11.8	1500	57.5	2.12	I-II	2.7	6.0
500	19.7	2500	115	5.09	I-III	4.5	9.9
600	23.6	3000	115	4.24	I-III	5.3	11.7
375	14.8	2350	115	5.41	I-II	5.3	11.7
400	15.7	2500	115	5.09	I-II	5.3	11.7
750	29.5	4700	200	8.18	I-III	10.7	23.6
750	29.5	4700	230	10.82	I-III	10.4	22.9
800	31.5	5000	230	10.17	I-II	11	24.3
375	14.8	2800	115	4.54	I-II	6.1	13.4
400	15.7	3000	115	4.24	I-II	6.5	14.3
750	29.5	5600	230	9.08	I-III	13	28.7
800	31.5	6000	230	8.48	I-II	12.9	28.4
500	19.7	4400	200	8.74	I-III	11.5	25.4
500	19.7	4400	230	11.56	I-III	11.5	25.4
600	23.6	5300	230	9.6	I-III	13.5	29.8
750	29.5	6600	230	7.71	I-III	17	37.5
800	31.5	7000	230	7.27	I-III	17.7	39.0
500	19.7	5000	200	7.69	I-III	13	28.7
500	19.7	5000	230	10.17	I-III	13	28.7
600	23.6	6000	200	6.41	I-II	14.8	32.6
600	23.6	6000	230	8.48	I-III	15.2	33.5
750	29.5	7500	400	20.51	I-II	18.5	40.8
900	35.4	9000	400	17.09	I-III	21.7	47.8
600	23.6	6800	400	22.62	I-III	15.8	34.8
900	35.4	10200	400	15.08	I-II	26.1	57.5
600	23.6	7500	400	20.51	I-II	17.1	37.7
900	35.4	11300	400	13.61	I-II	27.3	60.2

## TUBES

For the power connections (strip  $20 \times 3 \text{ mm}$  ( $0.79 \times 0.12 \text{ in}$ )) you can choose between radial (type A) and face variants (type B). Because of the high current levels a flexible wire connection is not possible.

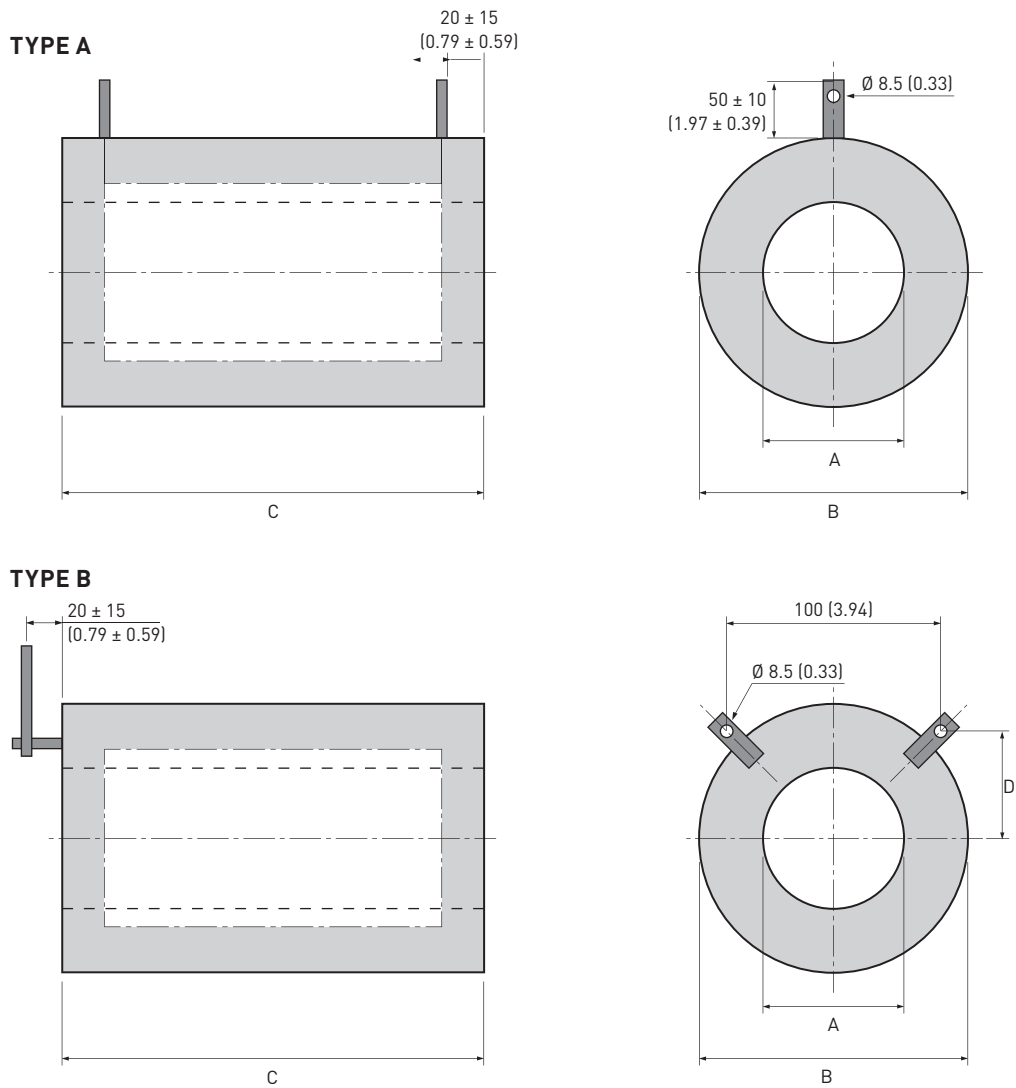


Fig. 12 Fibrothal® standard tubes.



**STANDARD FIBROTHAL® TUBE DESIGNS (METRIC FIGURES)**

TYPE DESIGNATION	TYPE A PART NO.	TYPE B PART NO.	DIMENSIONS		LENGTH C MM	TERM. ARR. D MM	VOLTAGE, V POWER, W			RES. R20 Ω	WEIGHT KG
			Ø I.D. A MM	Ø O.D. B MM			AT 60 A	AT 72 A	AT 85 A		
			RAC 40/200	DF830147			DF830153	40	160		
RAC 40/500	DF830158	DF830164	40	160	520	105	40 2398	48 3455	56.7 4818	0.639	3.8
RAC 70/200	DF830169	DF830175	70	240	220	135	25 1500	30 2161	35.5 3014	0.4	2.9
RAC 70/500	DF830180	DF830186	70	240	520	135	63.1 3786	75.8 5454	89.5 7608	1.008	6.9
RAC 100/200	DF830191	DF830197	100	270	220	150	34.1 2049	41 2952	48.4 4117	0.546	3.6
RAC 100/500	DF830202	DF830208	100	270	520	150	86.2 5170	103.5 7450	122.2 10391	1.377	8.5
RAC 150/200	DF830213	DF830219	150	350	220	215	49.4 2963	59.3 4269	70.1 5955	0.789	5.1
RAC 150/500	DF830224	DF830230	150	350	520	215	127 7620	152.5 10979	180.2 15314	2.03	12.5
RAC 200/200	DF830235	DF830241	200	450	220	240	64.6 3878	77.6 5587	91.7 7793	1.033	7.7
RAC 200/500	DF830246	DF830252	200	450	520	240	163.1 9787	195.8 14101	231.4 19669	2.607	18.7

**STANDARD FIBROTHAL® TUBE DESIGNS (IMPERIAL FIGURES)**

TYPE DESIGNATION	TYPE A PART NO.	TYPE B PART NO.	DIMENSIONS		LENGTH C IN	TERM. ARR. D IN	VOLTAGE, V POWER, W			RES. R20 Ω	WEIGHT LB
			Ø I.D. A IN	Ø O.D. B IN			AT 60 A	AT 72 A	AT 85 A		
			RAC 40/200	DF830147			DF830153	1.6	6.3		
RAC 40/500	DF830158	DF830164	1.6	6.3	20.5	4.1	40 2398	48 3455	56.7 4818	0.639	8.4
RAC 70/200	DF830169	DF830175	2.8	9.4	8.7	5.3	25 1500	30 2161	35.5 3014	0.4	6.4
RAC 70/500	DF830180	DF830186	2.8	9.4	20.5	5.3	63.1 3786	75.8 5454	89.5 7608	1.008	15.2
RAC 100/200	DF830191	DF830197	3.9	10.6	8.7	5.9	34.1 2049	41 2952	48.4 4117	0.546	7.9
RAC 100/500	DF830202	DF830208	3.9	10.6	20.5	5.9	86.2 5170	103.5 7450	122.2 10391	1.377	18.7
RAC 150/200	DF830213	DF830219	5.9	13.8	8.7	8.5	49.4 2963	59.3 4269	70.1 5955	0.789	12.2
RAC 150/500	DF830224	DF830230	5.9	13.8	20.5	8.5	127 7620	152.5 10979	180.2 15314	2.03	27.6
RAC 200/200	DF830235	DF830241	7.9	17.7	8.7	9.4	64.6 3878	77.6 5587	91.7 7793	1.033	17.0
RAC 200/500	DF830246	DF830252	7.9	17.7	20.5	9.4	163.1 9787	195.8 14101	231.4 19669	2.607	41.2

## 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 (4.92 in) or 50 mm (1.97 in); other dimensions are also available.

### FIBROTHAL®, END PIECE RANGE

OUTSIDE DIAMETER		THICKNESS		WEIGHT	
MM	IN	MM	IN	KG	LB
160	6.3	125/50	4.9/2.0	0.5/0.2	1.1/0.4
220	8.7	125/50	4.9/2.0	0.9/0.3	2.0/0.7
240	9.5	125/50	4.9/2.0	1.1/0.4	2.4/0.9
300	11.8	125/50	4.9/2.0	1.2/0.7	2.6/1.5
350	13.8	125/50	4.9/2.0	2.4/1.0	5.3/2.2
450	17.7	125/50	4.9/2.0	3.9/1.6	8.6/3.5
500	19.7	125/50	4.9/2.0	4.9/2.0	10.8/4.4
600	23.6	125/50	4.9/2.0	7.0/3.0	15.4/6.6
650	25.6	125/50	4.9/2.0	8.2/3.3	18.1/7.3
700	27.6	125/50	4.9/2.0	9.6/3.8	21.2/8.4
750	29.5	125/50	4.9/2.0	11.0/4.4	24.3/9.7

# 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 are available for the manufacture of special modules.

For special designs a portion 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 tubes up to 500 mm (19.7 in) diameter and half-cylinders up to 650 mm (25.6 in) diameter. For larger inside diameters, shell modules (1/3, 1/4, 1/6 shells, etc.) are used. The designs correspond to that of the standard panels or half-cylinders. The maximum element temperature is 1150°C (2100°F).

### ADVANTAGES OF THE SYSTEM:

- The heating element is directly incorporated into the module and requires no additional mountings
- Shape, dimensions and electrical data variable within wide limits
- Terminal voltages of the modules correspond to line voltage or fractions of it
- Easy replacement of the modules, if the furnace is suitably designed, even during operation
- 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.

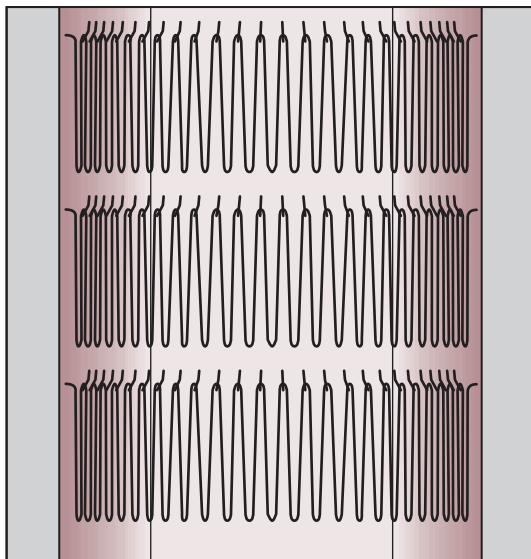
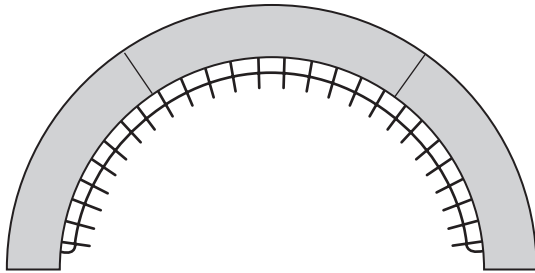


Fig. 13 ROB in panel design.

### GENERAL ROB ADVANTAGES:

- Free-radiating heating element up to 1300°C (2370°F) element temperature
- Heating element change possible
- Long heating element length over several modules possible, therefore far fewer terminals are required
- Larger heating conductor cross-section can be installed; this results in longer element working life
- High power concentrations can be installed (see Fig. 12)

### FIBROTHAL® MEANDER II

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

#### SPECIFIC ADVANTAGES:

- No limitation on the installation position; also suitable for tilting furnaces
- Variable heating element pitch value
- Also suitable for round furnaces

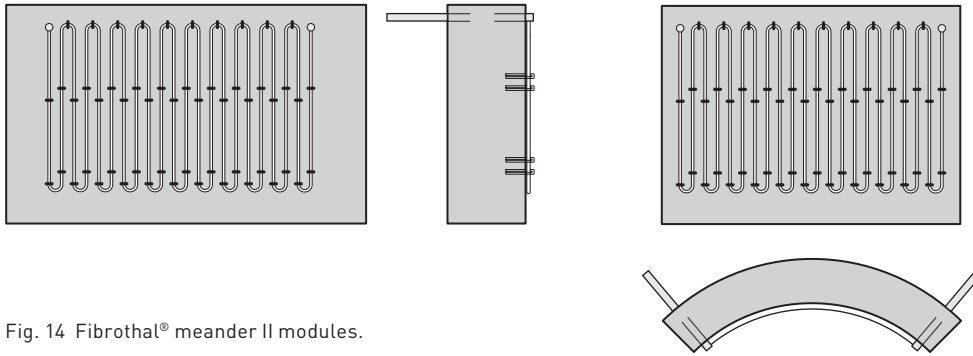


Fig. 14 Fibrothal® meander II modules.

### FIBROTHAL® MEANDER III

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

#### SPECIFIC ADVANTAGES:

- Elements can be replaced
- Tilting of furnace up to 90° is possible
- Also suitable for round furnaces

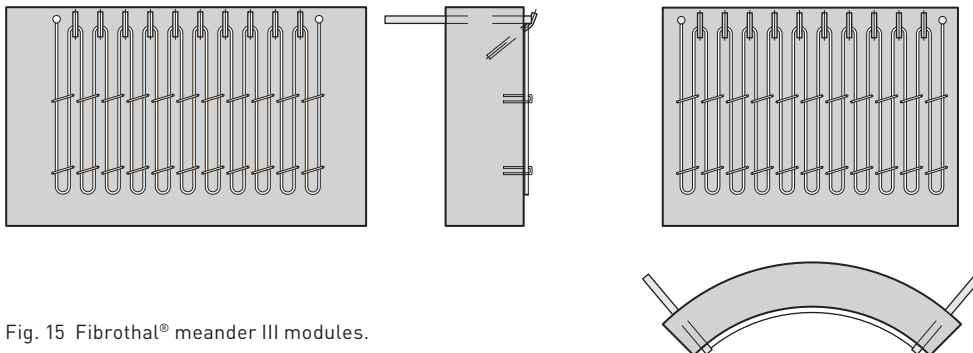


Fig. 15 Fibrothal® meander III modules.

### SPECIAL TUBE MODULES

These modules, usually multi-zone, correspond in their design to the RAC tubes (see Principle II, Fig. 9). The maximum inside diameter is 400 mm (15.7 in); lengths up to approx. 2000 mm (78.7 in) can be manufactured. If required these heating tubes can also be supplied with a sheet metal shell. Depending on the requirements the alloys Kanthal® A-1, AF or Kanthal APM™ are used.

### ADVANTAGES OF THE SYSTEM:

- High temperature uniformity
- Precise temperature profiles can be achieved
- High power concentration
- Can be installed in any position



Fig. 16 Heating cassette (diffusion annealing tube).

## MUFFLES

Monoblock ceramic fiber 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 (2100°F). Matching door modules can be supplied.

### ADVANTAGES OF THE SYSTEM:

- Short assembly times
- Short heating up times
- Uniform temperature distribution in the furnace interior
- Rapidly and easily replaced

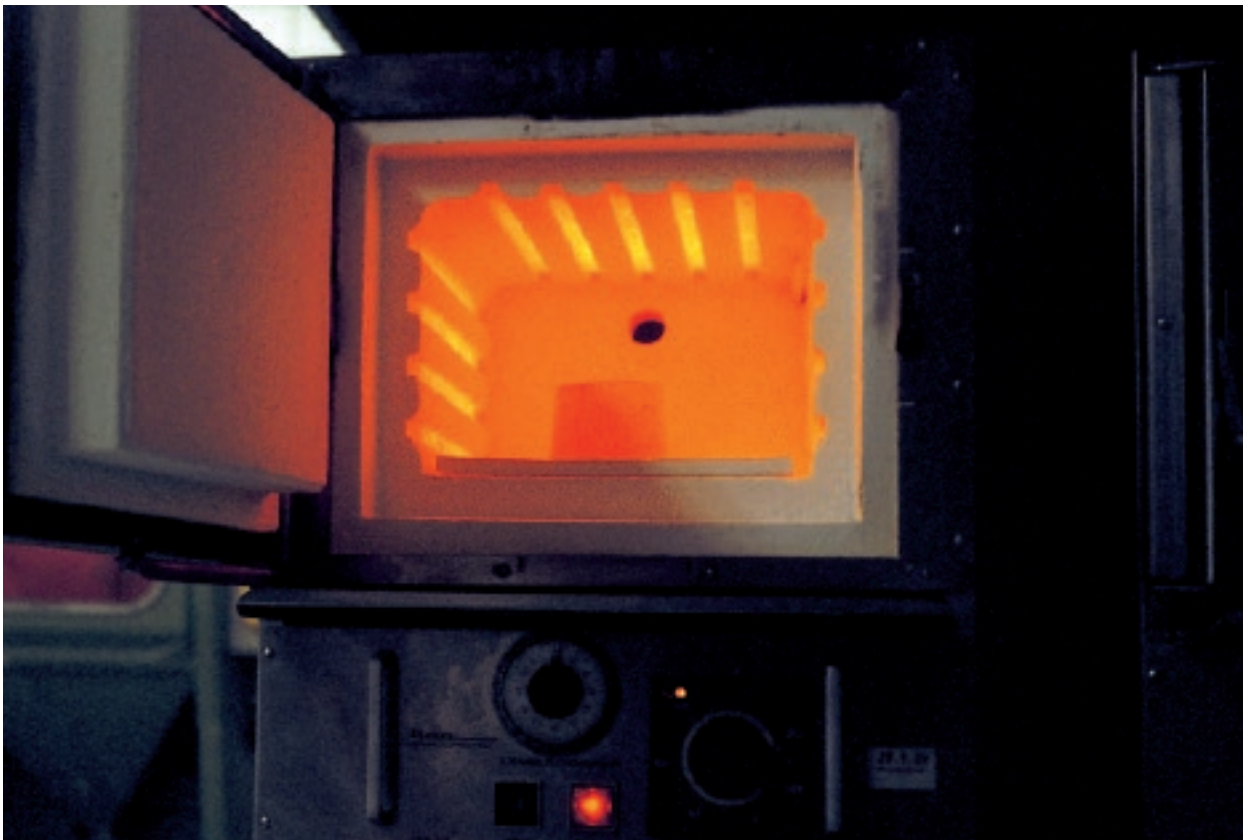


Fig. 17 Fibrothal® muffle in laboratory furnace.

### 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 fiber insulation modules and SiC tubes.

This design, introduced under the type designation FibroSiC, can be used for spans up to 2200 mm (86.6 in) at  $T_f = 1200^\circ\text{C}$  (2190°F).

### ADVANTAGES OF THE SYSTEM:

- Unsupported up to 2200 mm (86.6 in) at furnace temperature  $1200^\circ\text{C}$  (2190°F)
- Easy to assemble
- Economic design, since no other roof support is needed

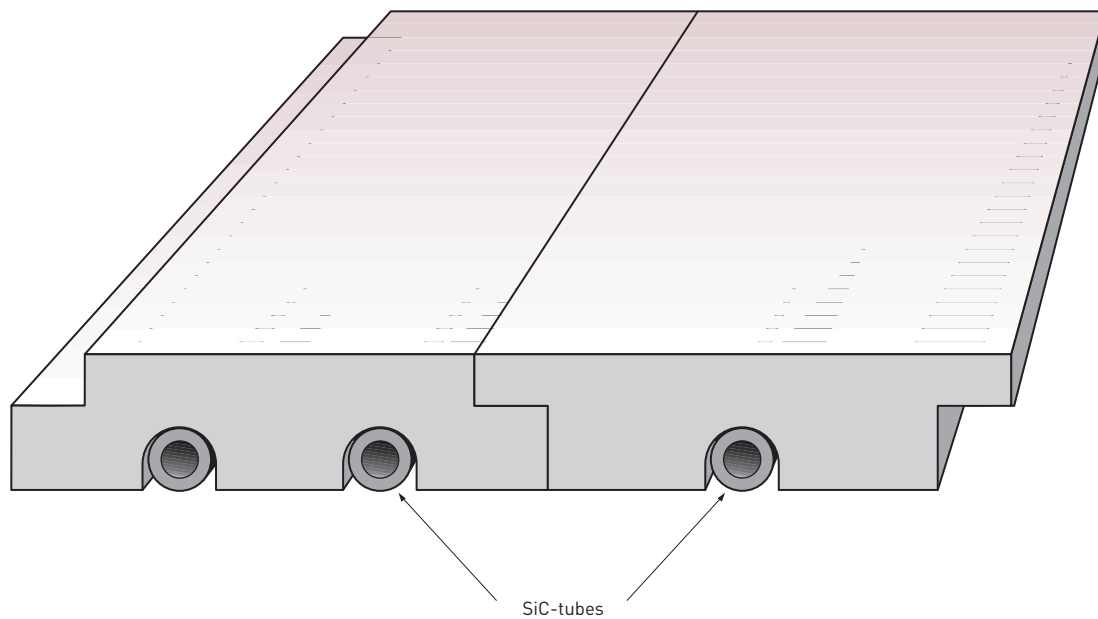


Fig. 18 FibroSiC, unsupported roof modules



Fig. 19 Fibrothal® modules in a suspended monorail furnace.



# ACCESSORIES

## FLEXIBLE BEAD-INSULATED CONNECTING LEADS

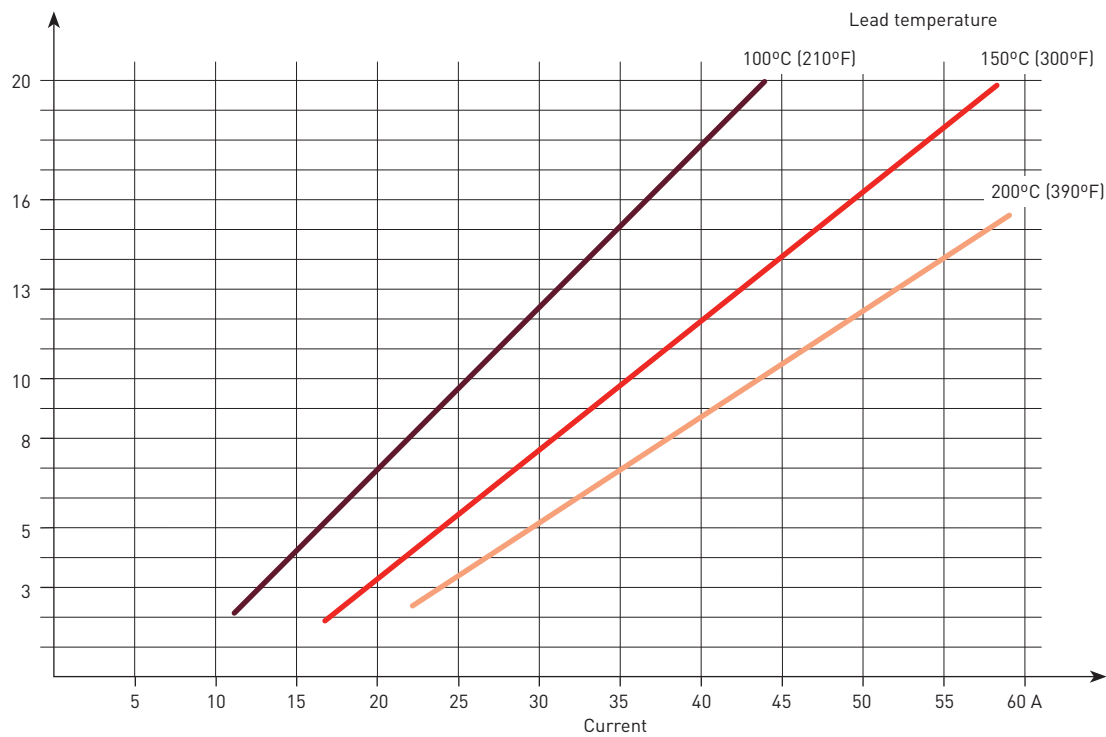
### ONLY FOR MODULES WITH EMBEDDED HEATING!

The lead consists of Nikrothal® 40 (nickel-chromium alloy) 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 (390°F).

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 (1470°F). The lead temperature is due to the combination of inherent heating caused by the passing current and the temperature of the insulation.

## LEADS BEAD-INSULATED IN AIR

Twisting, times

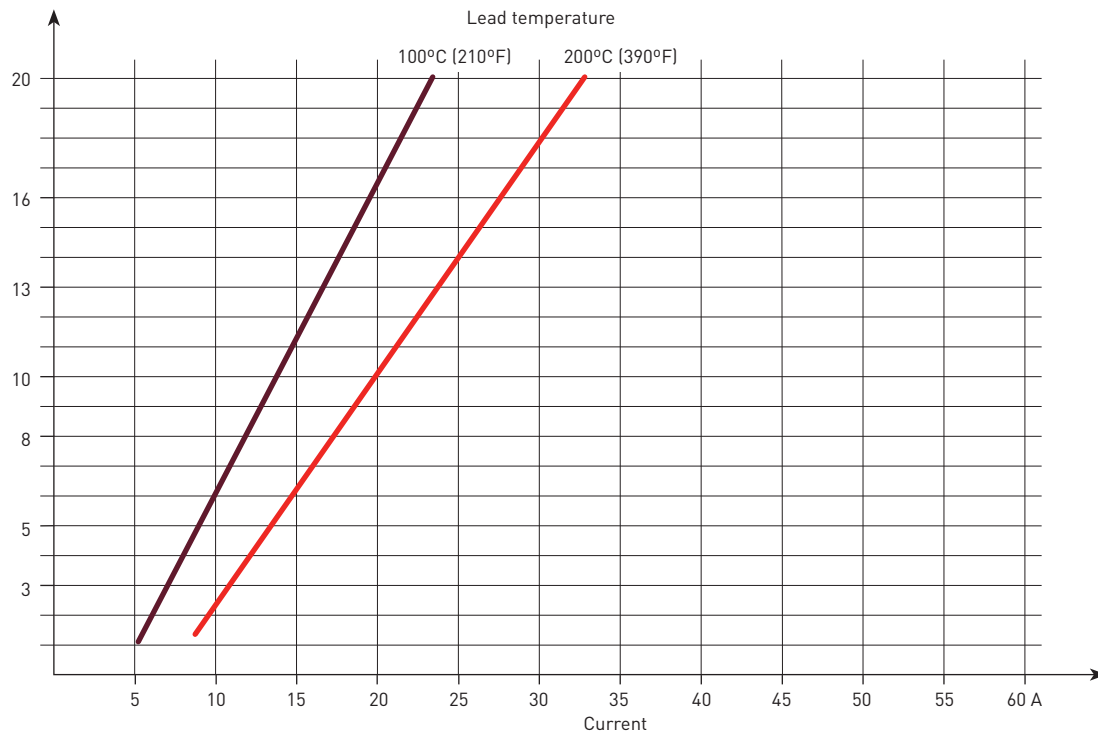


### TWISTED CONNECTING LEADS

OUTSIDE DIAMETER	NUMBER OF TWISTS, X TIMES							
	5.0		8.0		10.0		13.0	
	MM	IN	MM	IN	MM	IN	MM	IN
Twisted lead	4.5	0.18	6.5	0.26	7.0	0.28	8.5	0.33
Insulating beads	11.0	0.43	14.0	0.55	14.0	0.55	14.0	0.55

### LEADS BEAD-INSULATED IN FIBROTHAL® MODULES

Twisting, times



**INSULATING BLANKETS**

For compensating for module and furnace tolerances and shrinkage, dimensions: 6.35 × 300 mm (0.25 × 11.8 in) wide.

**PROTECTION TUBES FOR THERMOCOUPLES**

Diameter 7/5 mm (0.28/0.20 in) × desired length, both ends open.

**GLUE**

For bonding Fibrothal® modules together.

**HARDENER**

For hardening machined surfaces.

**CEMENT**

For patching up damaged Fibrothal® modules.

**REPAIR KIT**

Consisting of: adhesive, hardener, powder, wool and felt.

**MOUNTING OF FIBROTHAL® MODULES**

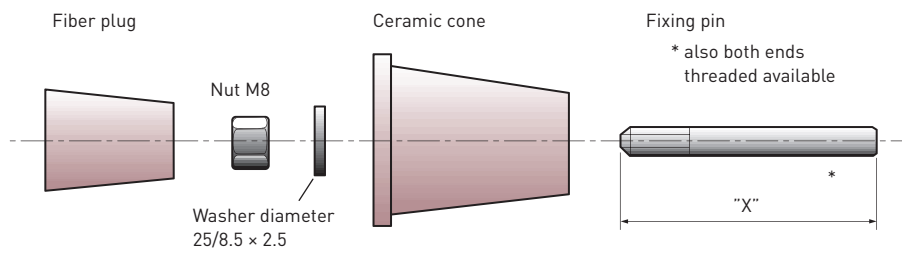
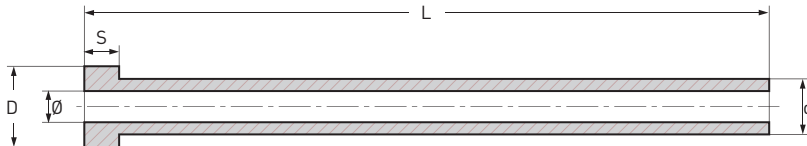


Fig. 20 Mounting of Fibrothal® modules.

## CERAMIC TUBES WITH FLANGE



## CERAMIC TUBES WITH FLANGE

REF.	D		D		∅		S		L STOCK	
	MM	IN	MM	IN	MM	IN	MM	IN	MM	IN
TUT-20-10	20	0.79	10	0.39	6	0.24	6	0.24	max 300	max 11.8
TUT-25-15	25	0.98	15	0.59	9	0.35	10	0.39	100-150-200-300	3.9-5.9-7.9-11.8
TUT-30-20	30	1.18	20	0.79	12	0.47	15	0.59	100-150-200-300	3.9-5.9-7.9-11.8
TUT-35-25	35	1.38	25	0.98	15	0.59	20	0.79	150-200-300	5.9-7.9-11.8
TUT-40-30	40	1.57	30	1.18	15	0.59	20	0.79	200-250-300	7.9-9.8-11.8
TUT-45-35	45	1.77	35	1.38	20	0.79	20	0.79	150-200-300	5.9-7.9-11.8
TUT-50-40	50	1.97	40	1.57	25	0.98	30	1.18	300	11.8

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

## CERAMIC INSULATORS AND PLUGS

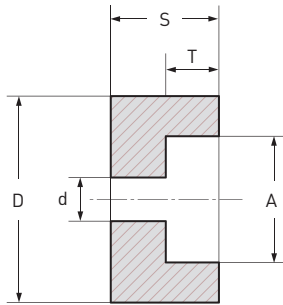


Fig. A

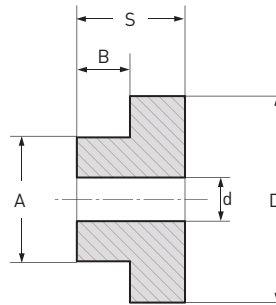


Fig. B

## CERAMIC INSULATORS AND PLUGS

CODE	REF.	FIG.	D		D		A		T		B		S		MAT.
			MM	IN	MM	IN	MM	IN	MM	IN	MM	IN	MM	IN	
ISM	025-16,5-5 M	B	15.5	0.61	5	0.20	10	0.39	-	-	1.5	0.06	6	0.24	Steatite
ISF	025-16,5-5 F	A	15.5	0.61	5	0.20	11	0.43	1.8	0.07	-	-	5	0.20	Steatite
ISM	025-22-6.5 M	B	22.5	0.89	6.5	0.26	11.5	0.45	-	-	4	0.16	10.5	0.41	Steatite
ISF	025-22-6.5 F	A	22.5	0.89	6.5	0.26	12.3	0.48	4.3	0.17	-	-	8	0.31	Steatite
ISM	025-30-8 M	B	30	1.18	8.5	0.33	16	0.63	-	-	7.5	0.30	15	0.59	Steatite
ISF	025-30-8 F	A	30	1.18	8.5	0.33	18	0.71	8.5	0.3	-	-	15	0.59	Steatite
TAP	025-23-7	B	23	0.91	7	0.28	13	0.51	-	-	15	0.59	20	0.79	A38E
TAP	025-45-13	B	45	1.77	13	0.51	26	1.02	-	-	18	0.71	30	1.18	A42P
TAP	025-60-15	B	60	2.36	15	0.59	30	1.18	-	-	18	0.71	40	1.57	A42P

Dimensional tolerances according DIN 40680 norms  
 Bold stock standards

# 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® panels, usually no special measures are necessary for the mounting or fixing of Fibrothal® modules, because they are self-supporting and/or self-stabilising inside the furnace body.

## ATTACHING FIBROTHAL® MODULES

For attaching Fibrothal® modules in larger furnace installations, we recommend mounting of Fibrothal® modules (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. 21, 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. 21, D.

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

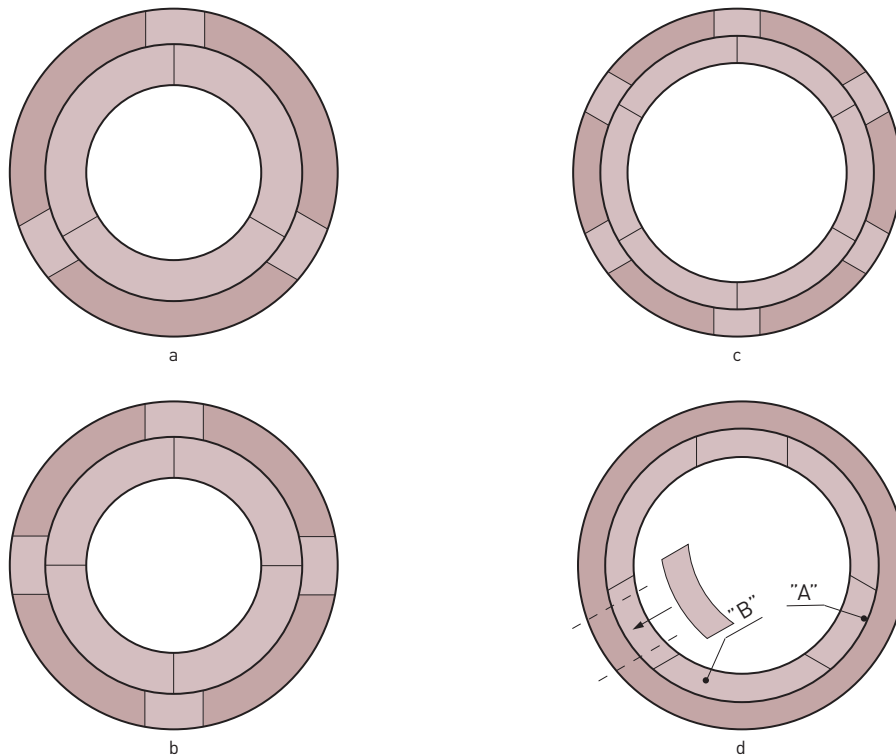


Fig. 21 Module installation situations A–D.

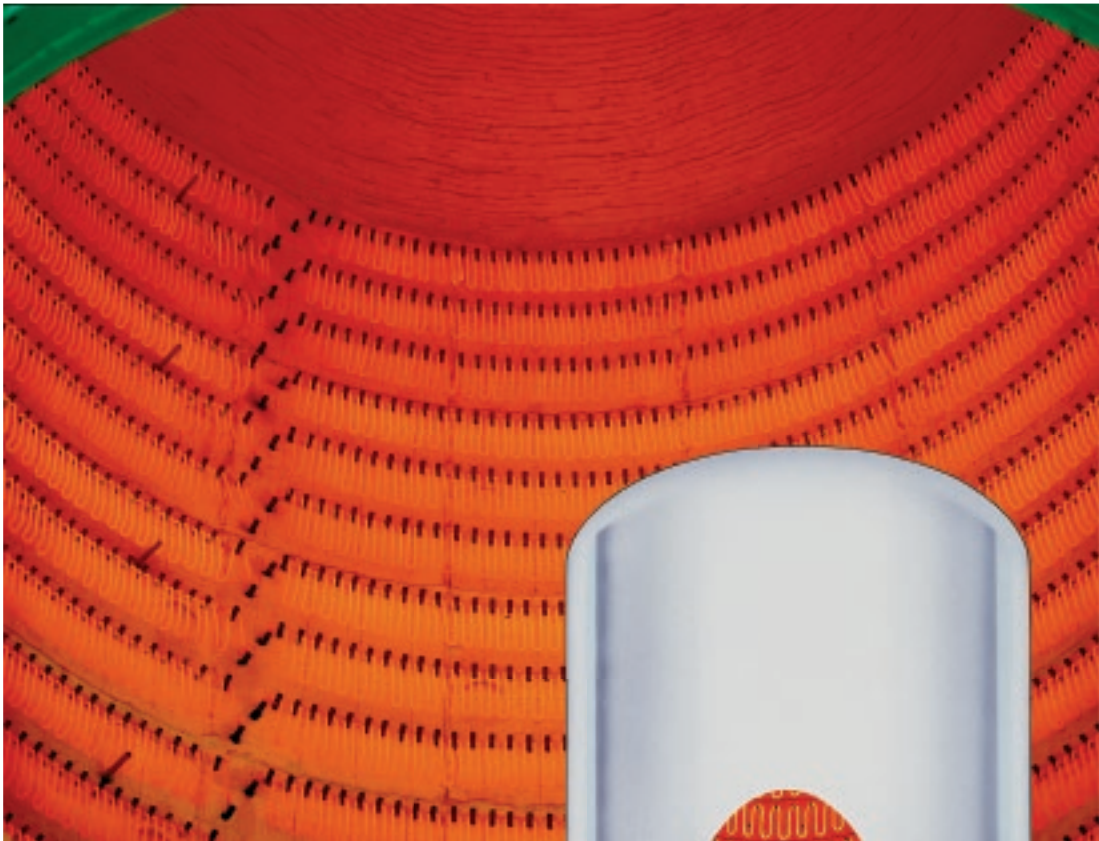
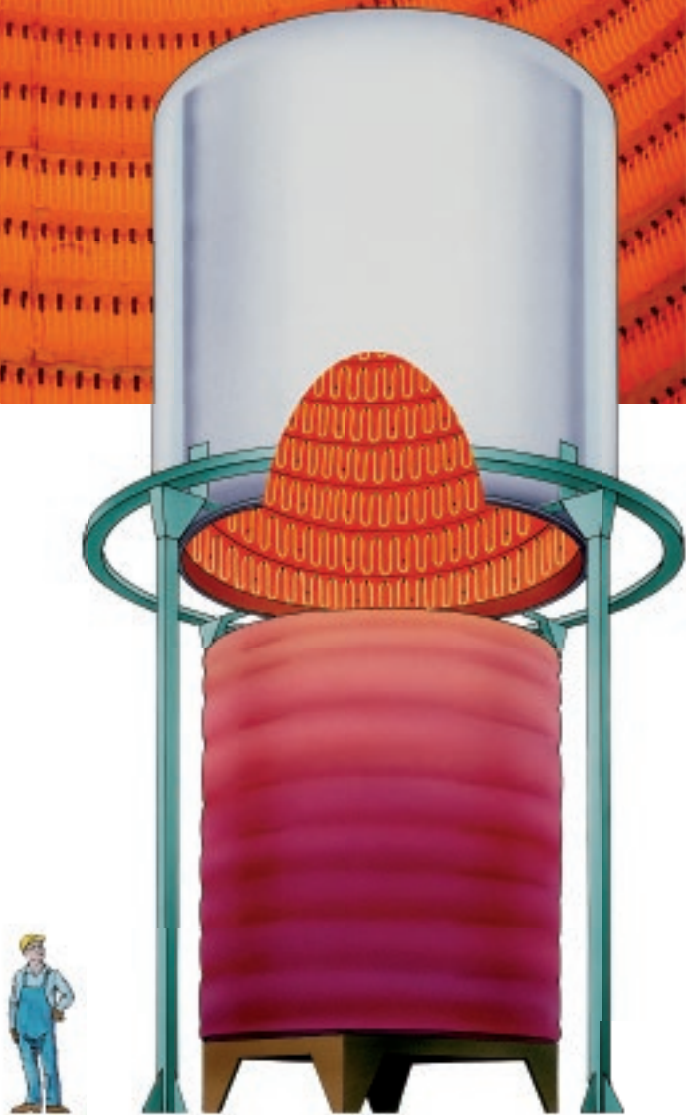


Fig. 22 ROB-modules in a bell furnace.





### 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 fiber felt (see Accessories) between Fibrothal® modules. The ceramic fiber felt should project by at least 25 mm (0.98 in) from the front of the module. This projection serves to compensate for the thermal module shrinkage.

### 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.

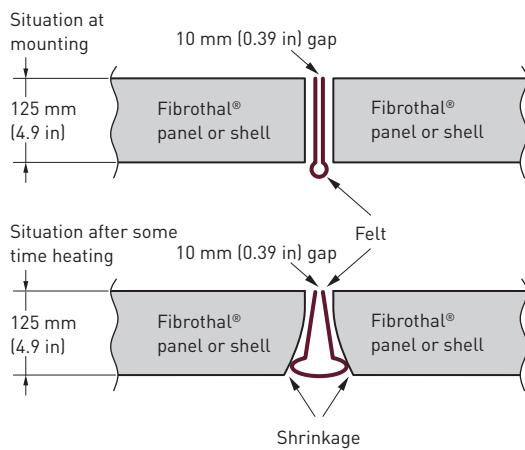


Fig. 23 Fitting of fiber felt (principle).



Fig. 24 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.

## SELECTION CRITERIA FOR HEATING SYSTEMS

	FIBROTHAL® PANELS EMBEDDED	FIBROTHAL® SHELLS EMBEDDED	FIBROTHAL® TUBES EMBEDDED	RAC	R O B	FIBROTHAL® MEANDER SYSTEM II	FIBROTHAL® MEANDER 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 [°F]							
AF				1300 (2370)	1300 (2370)	1250 (2280)	1250 (2280)
A-1	1150 (2100)	1150 (2100)	1150 (2100)	1300 (2370)	1300 (2370)	1250 (2280)	1250 (2280)
APM				1300 (2370)	1300 (2370)	1350 (2460)	1350 (2460)
Max. element temp. °C [°F] N80/N60	-	-	-	-	1100/1050 (2010/1920)	1100/1050 (2010/1920)	1100/1050 (2010/1920)

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

# VOLTAGE AND POWER CONVERSION FOR STANDARD MODULES

## CALCULATION EXAMPLE

### ASSUMPTION

For a chamber furnace six Fibrothal® heating panels with dimensions 750 × 450 × 125 mm (29.5 × 17.7 × 4.9 in) are necessary. The required furnace should have a power rating of approx. 25 kW.

For this duty Fibrothal® heating module PAS 750/450/230 (see Standard Fibrothal® heating panel designs) can be chosen. According to the table the standard data are 5400 W at 230 V supply voltage with a cold resistance of 9.42 Ω (hot resistance approx. 4% higher = 9.8 Ω). 6 heating modules would therefore give a total installed furnace power of 32.4 kW (two 3-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

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

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

$$U = 202.15 \text{ Volts}$$

In this case it is advisable to select one 3-phase group in delta connection with two heating modules in series, i.e. each module is connected to 200 V.

### CALCULATION OF THE POWER P PER FIBROTHAL® HEATING MODULE AT 200 VOLTS SUPPLY VOLTAGE

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

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

$$P = 4082 \text{ Watts}$$

The total furnace power is therefore  $6 \times 4082 \text{ W} = 24489 \text{ W}$ .

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%.



Fig. 25 Fibrothal® modules used in a conveyor belt furnace.





