

Fibrothal™ **Heating modules and insulation systems**



KANTHAL

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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

Kanthal® is the heating brand within Sandvik. 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.



To get in contact with you local representative visit www.kanthal.com or show this QR-code to your smartphone.

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) | 1200 (2190) (in clean air)** | |
| Density approx. kg/m ³ (lb/ft ³) | 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 ₂ O ₃ SiO ₂ | 46 54 | 50 50 | 67 33 | 77 23 | CaO+MgO 18–20 70–80 others <3 |
| Thermal conductivity, W/mK*** | | | | | | |
| 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 H₂ atmosphere (also contents of it)

*** Measuring method: calorimeter

Fiber free versions see Moduthal™ brochure

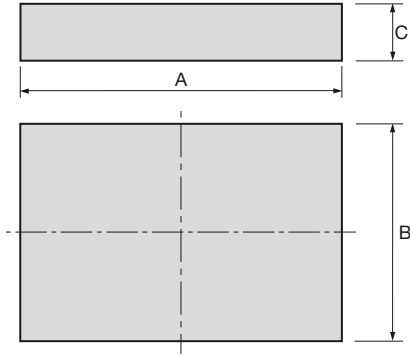
For F-Bio products it is absolutely necessary to know the final application. Please contact our technical sales office for advice.

Tolerances

Module dimensions

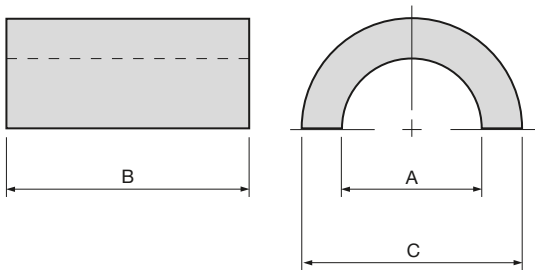
The following tolerances apply to the vacuum-formed insulation with or without heating element.

Electrical resistance: $R_k \pm 5\%$



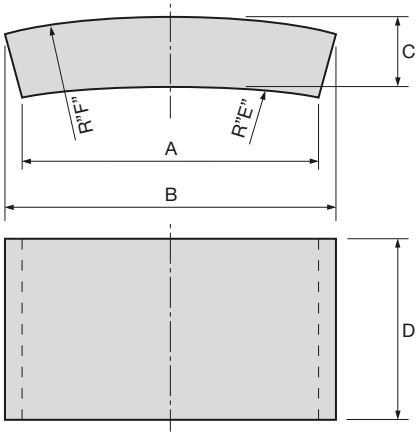
Fibrothal™ panels

| Module dimension | A and B | | C, with machining on | | | |
|--------------------|---------|-------|----------------------|--------------|--------------|--------|
| | mm | in | one surface | | two surfaces | |
| | | | 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 |



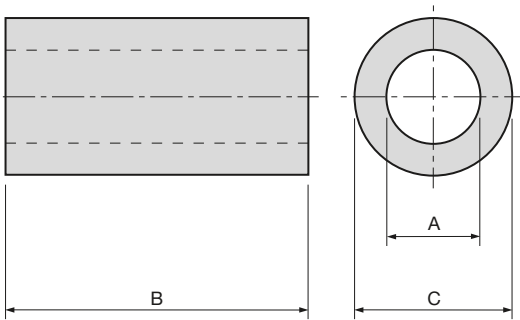
Fibrothal half-cylinders

| 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

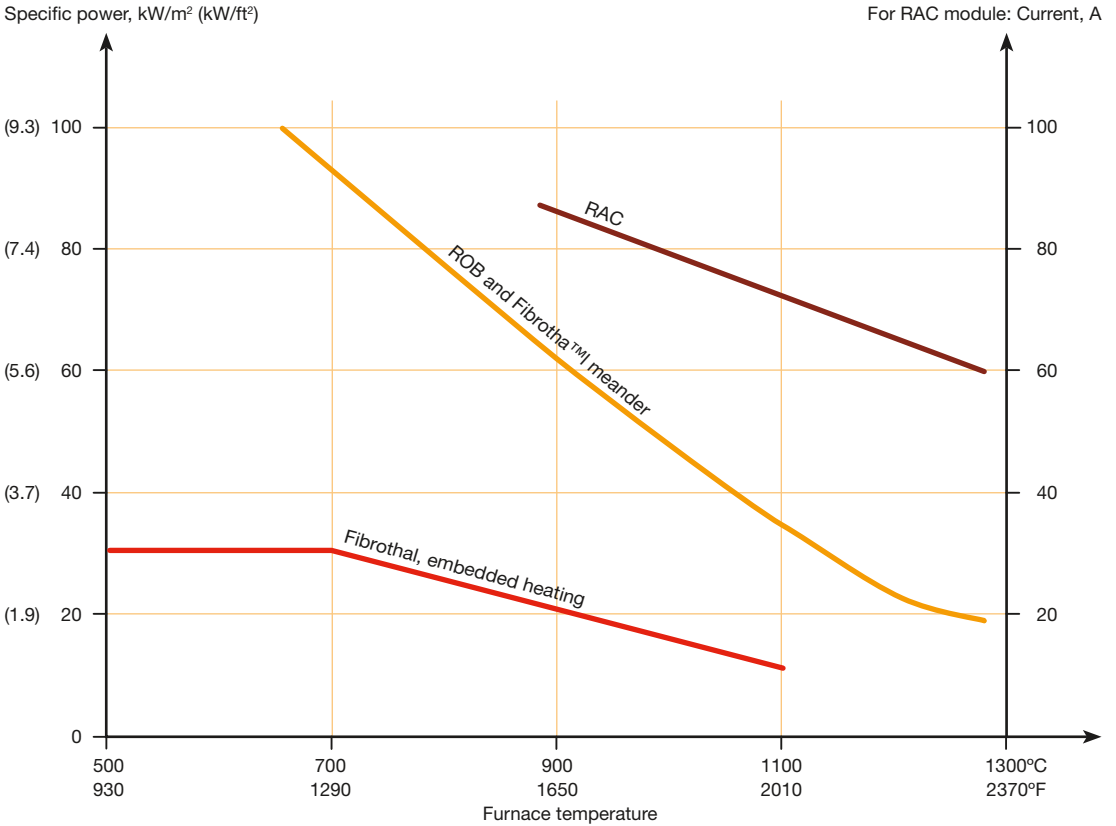
Maximum permissible element temperatures in various furnace atmospheres

| Furnace atmosphere | Max. element temperature | | Remarks |
|--------------------------------|--|--|--|
| | Kanthal® heating elements | Fibrothal™ heating elements | |
| H ₂ | 1400°C (2550°F) | 1000°C (1830°F) | H ₂ increases heat throughput of Fibrothal 3–4 times. |
| N ₂ | 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 ⁻³ mbar | 1150°C (2100°F) preoxidized | 800–850°C (1470–1560°F) | Vacuum higher than 10 ⁻³ 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. |

Please contact our technical sales office for the use of F-Bio

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 m² (10.8 ft²) is needed.

To install a voltage of 230 V with an embedded element (Fibrothal) an area of 0.25 m² (2.7 ft²) 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.

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

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

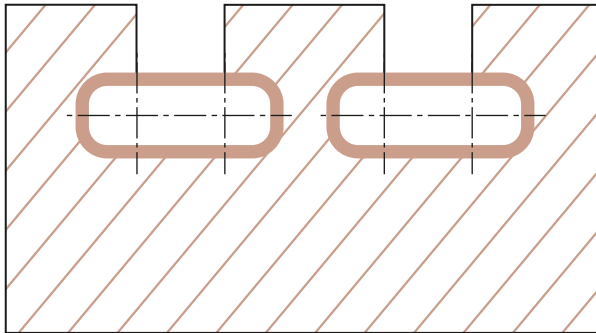


Fig. 8 Embedding principle.

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).

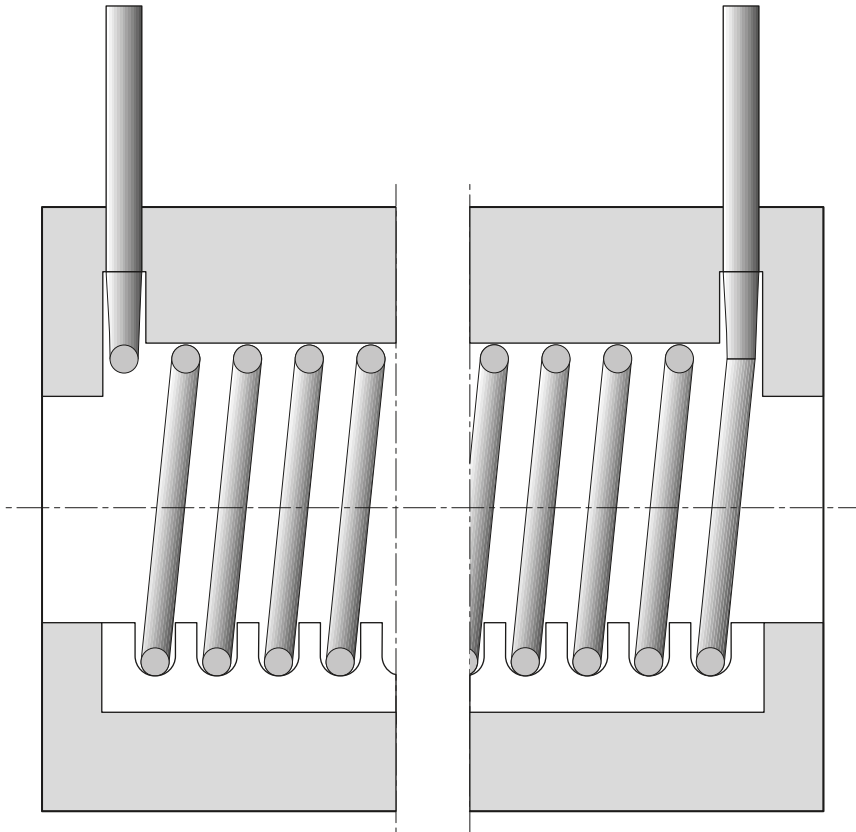


Fig. 9 RAC forming principle.

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).

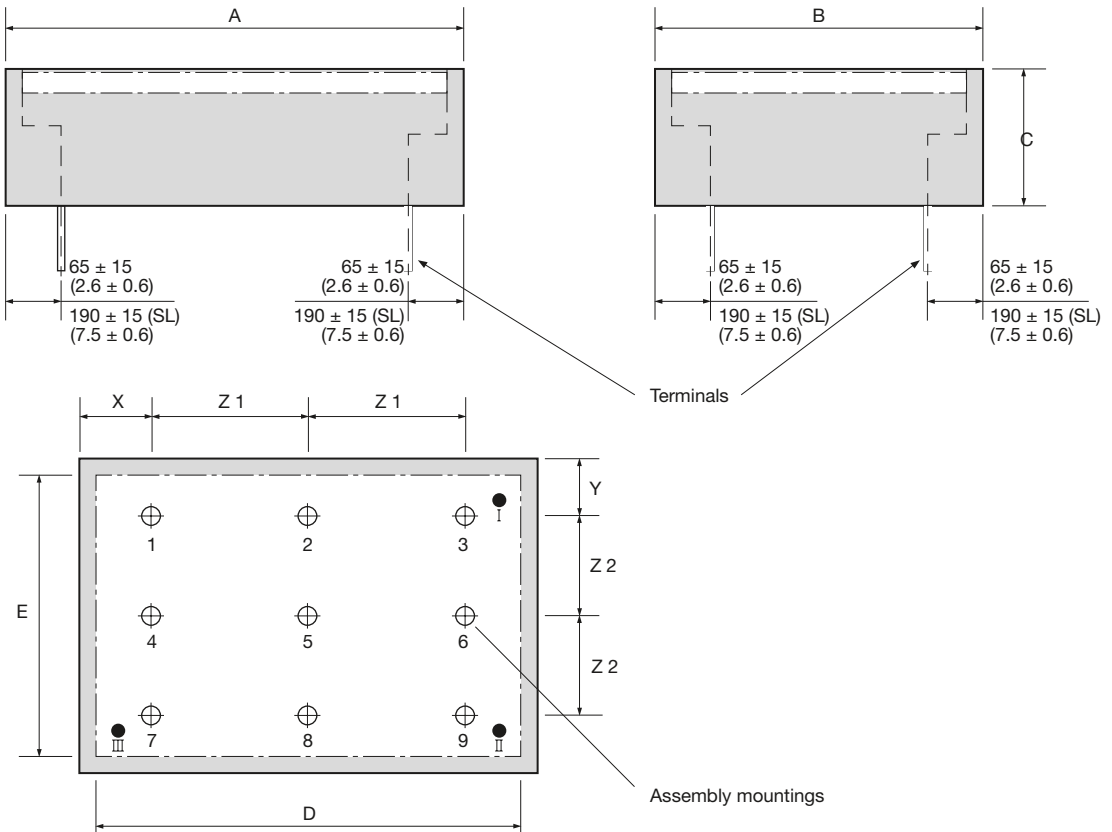


Fig. 10 Fibrothal standard panels.

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.

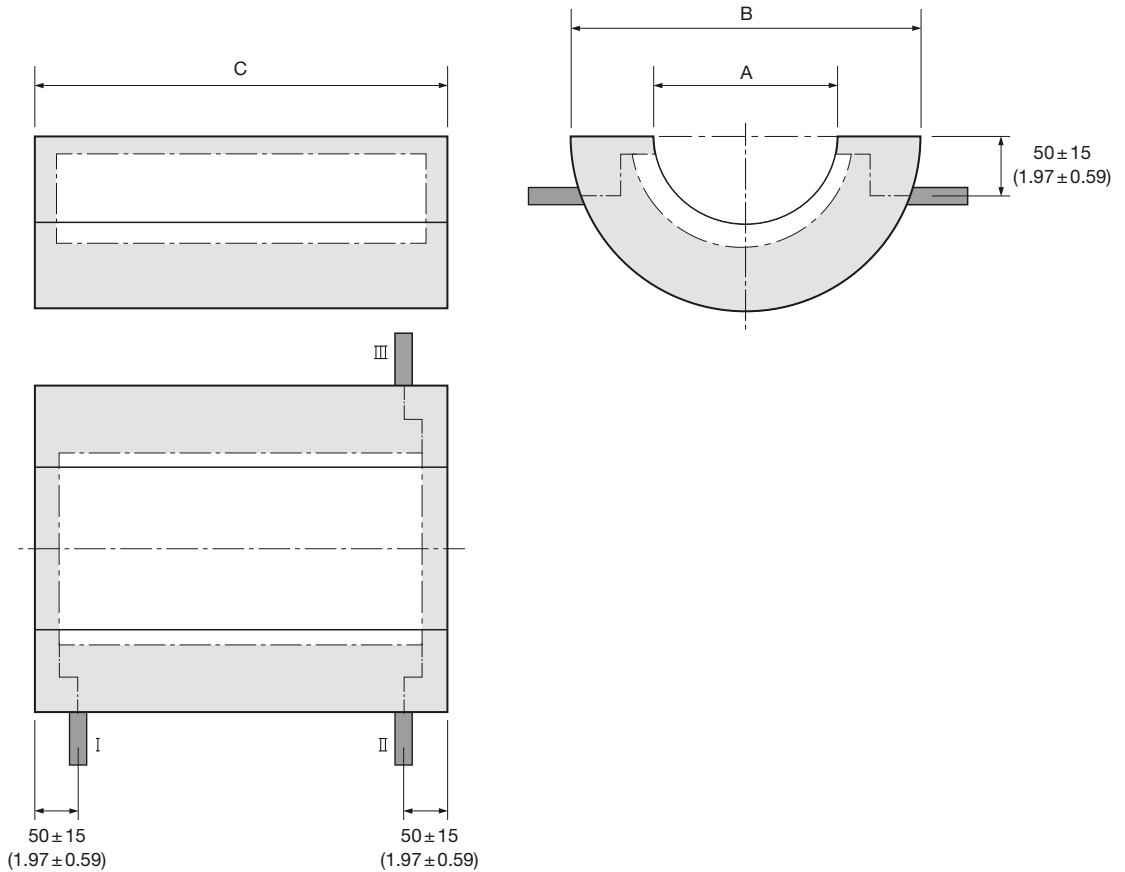


Fig. 11 Fibrothal™ standard half-cylinders.

Standard Fibrothal™ half-cylinder designs

| Type designation | Part No. | Ø inside diameter A | | Ø outside diameter 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 R20 | Terminal arr. position | Approx. weight | |
|-------------|------|-------|---------|-------------------|------------------------------|-------------------|------|
| mm | in | W | V | Ω | | 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 20×3 mm (0.79×0.12 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.

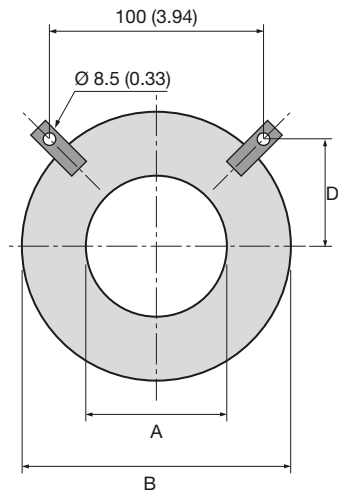
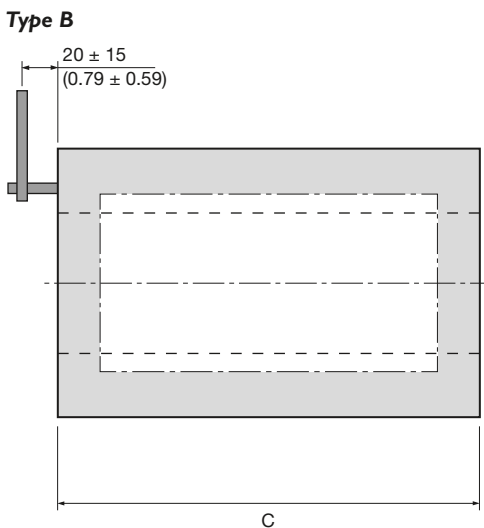
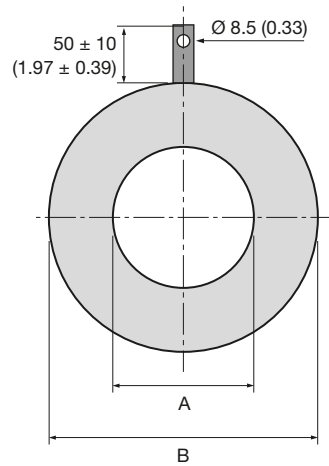
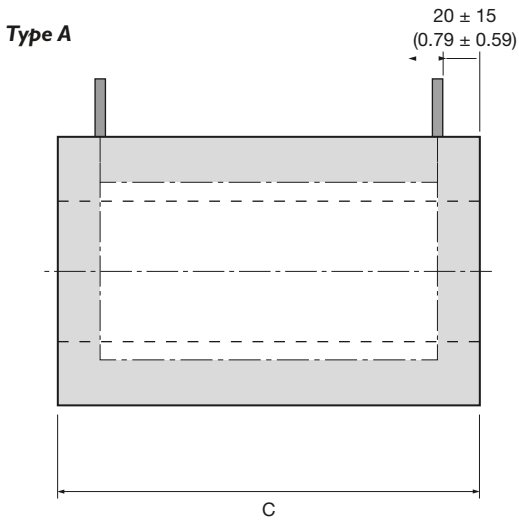


Fig. 12 Fibrothal™ standard tubes.

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 | | |
| | | | | | | | 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 |

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 | | |
| | | | | | | | 15.8 | 19 | 22.5 | | |
| RAC 40/200 | DF830147 | DF830153 | 1.6 | 6.3 | 8.7 | 4.1 | 950 | 1369 | 1909 | 0.253 | 3.5 |
| | | | | | | | 40 | 48 | 56.7 | | |
| RAC 40/500 | DF830158 | DF830164 | 1.6 | 6.3 | 20.5 | 4.1 | 2398 | 3455 | 4818 | 0.639 | 8.4 |
| | | | | | | | 25 | 30 | 35.5 | | |
| RAC 70/200 | DF830169 | DF830175 | 2.8 | 9.4 | 8.7 | 5.3 | 1500 | 2161 | 3014 | 0.4 | 6.4 |
| | | | | | | | 63.1 | 75.8 | 89.5 | | |
| RAC 70/500 | DF830180 | DF830186 | 2.8 | 9.4 | 20.5 | 5.3 | 3786 | 5454 | 7608 | 1.008 | 15.2 |
| | | | | | | | 34.1 | 41 | 48.4 | | |
| RAC 100/200 | DF830191 | DF830197 | 3.9 | 10.6 | 8.7 | 5.9 | 2049 | 2952 | 4117 | 0.546 | 7.9 |
| | | | | | | | 86.2 | 103.5 | 122.2 | | |
| RAC 100/500 | DF830202 | DF830208 | 3.9 | 10.6 | 20.5 | 5.9 | 5170 | 7450 | 10391 | 1.377 | 18.7 |
| | | | | | | | 49.4 | 59.3 | 70.1 | | |
| RAC 150/200 | DF830213 | DF830219 | 5.9 | 13.8 | 8.7 | 8.5 | 2963 | 4269 | 5955 | 0.789 | 12.2 |
| | | | | | | | 127 | 152.5 | 180.2 | | |
| RAC 150/500 | DF830224 | DF830230 | 5.9 | 13.8 | 20.5 | 8.5 | 7620 | 10979 | 15314 | 2.03 | 27.6 |
| | | | | | | | 64.6 | 77.6 | 91.7 | | |
| RAC 200/200 | DF830235 | DF830241 | 7.9 | 17.7 | 8.7 | 9.4 | 3878 | 5587 | 7793 | 1.033 | 17.0 |
| | | | | | | | 163.1 | 195.8 | 231.4 | | |
| RAC 200/500 | DF830246 | DF830252 | 7.9 | 17.7 | 20.5 | 9.4 | 9787 | 14101 | 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.

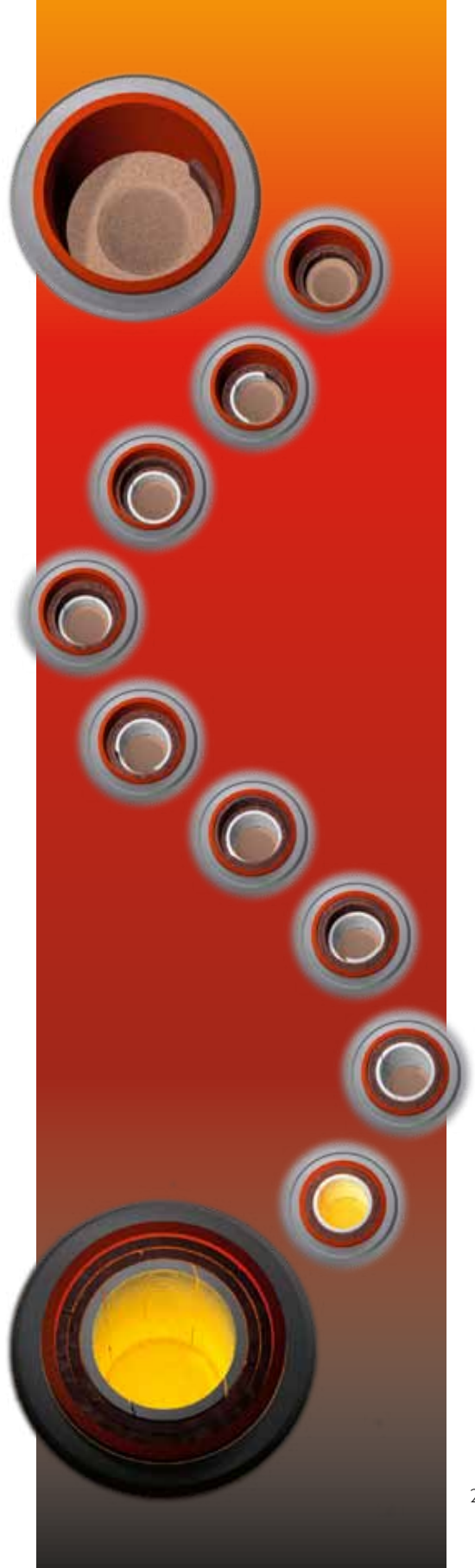
For special designs a portion of the mould costs may be charged.

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.

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)

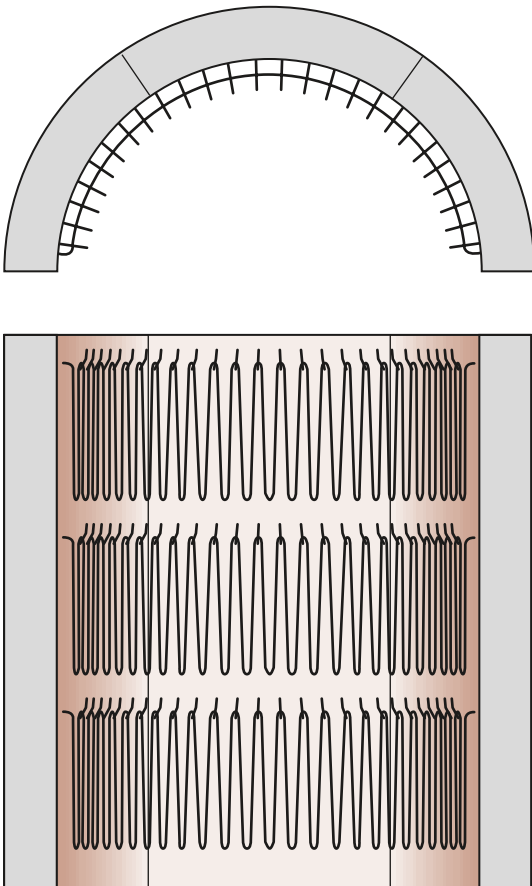


Fig. 13 ROB in panel design.

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

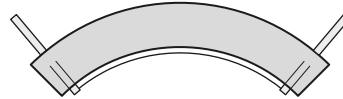
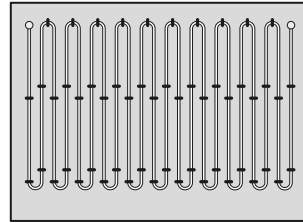
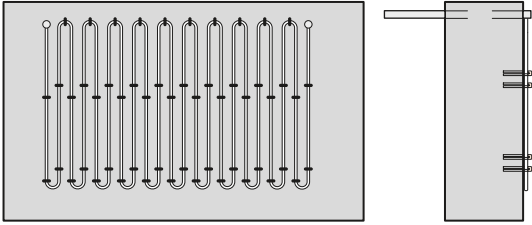


Fig. 14 Fibrothal meander II modules.

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

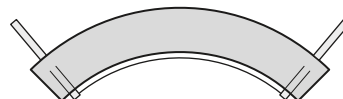
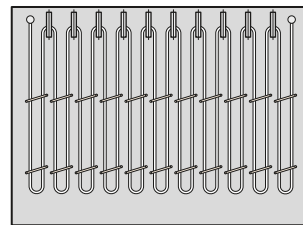
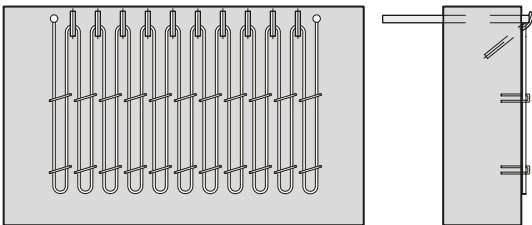


Fig. 15 Fibrothal meander III modules.

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

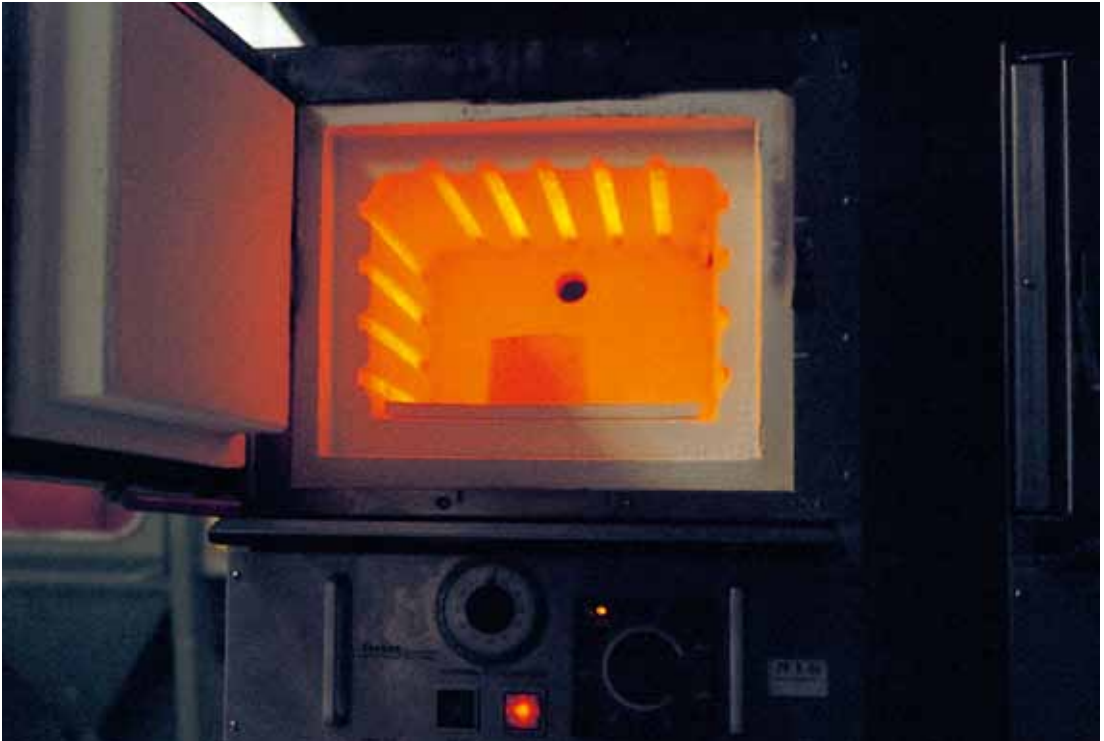


Fig. 17 Fibrothal™ muffle in laboratory furnace.

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°C (2190°F)
- Easy to assemble
- Economic design, since no other roof support is needed

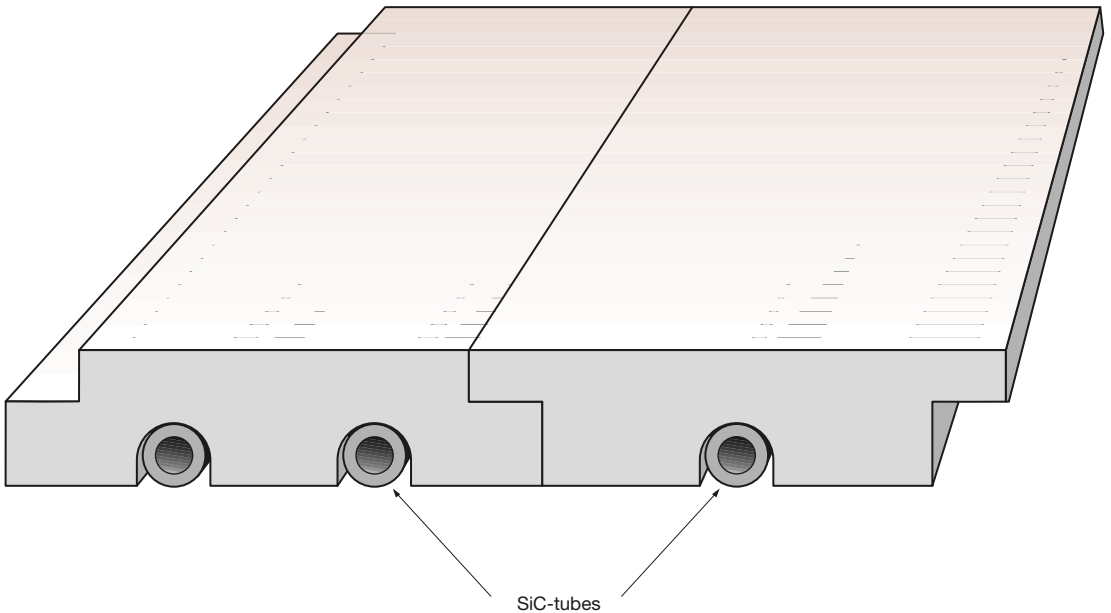


Fig. 18 FibroSiC, unsupported roof modules

Fig. 19 Fibrothal modules in a suspended monorail furnace.



Accessories

Flexible bead-insulated connecting leads

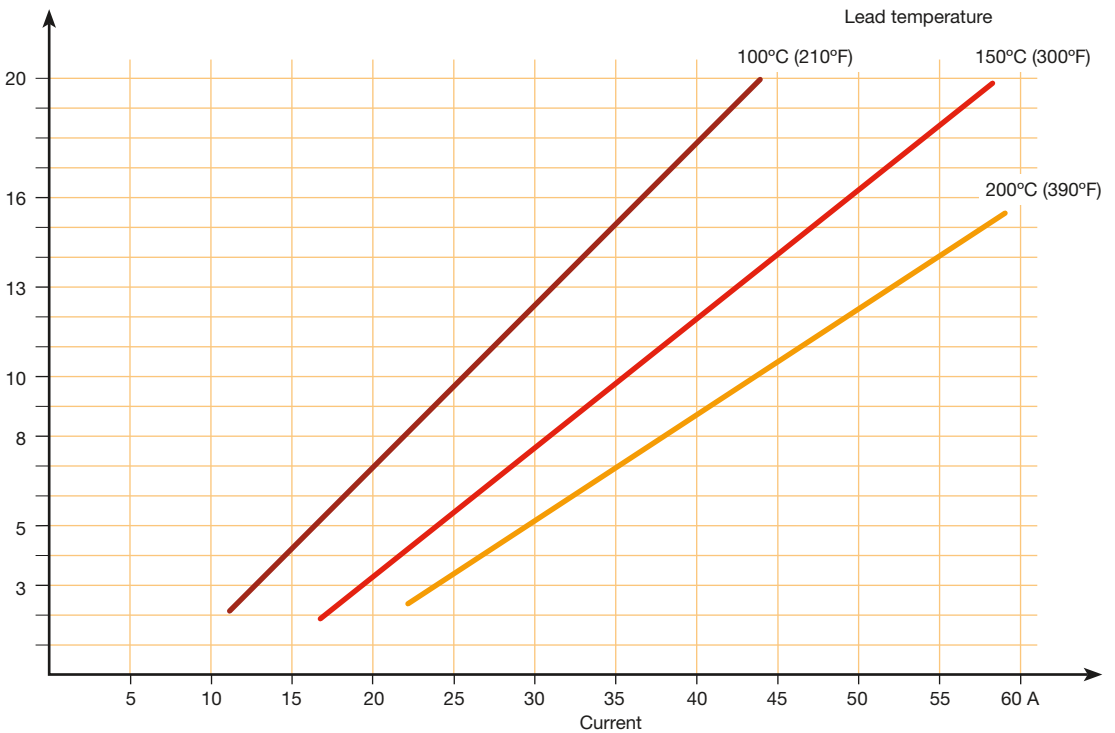
Only for modules with embedded heating!

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

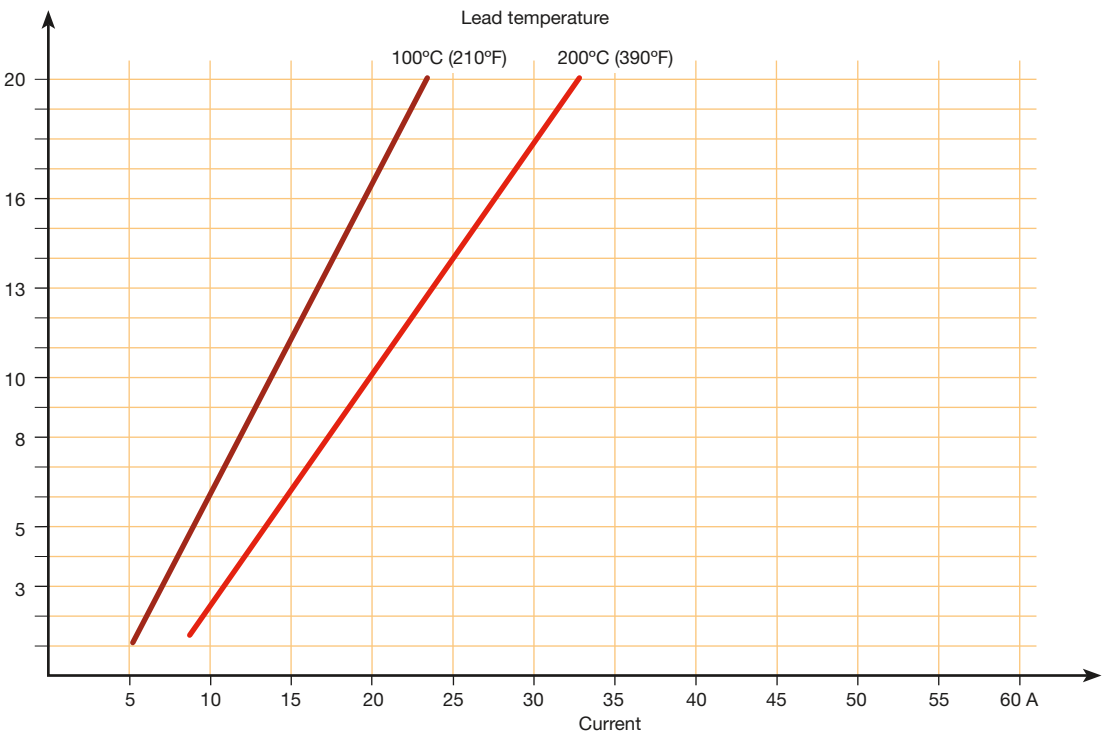


Twisted connecting leads

| 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

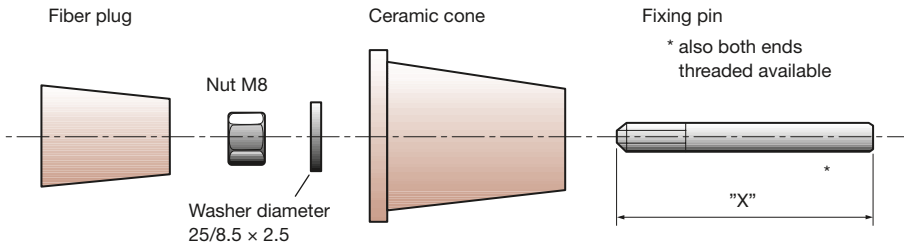
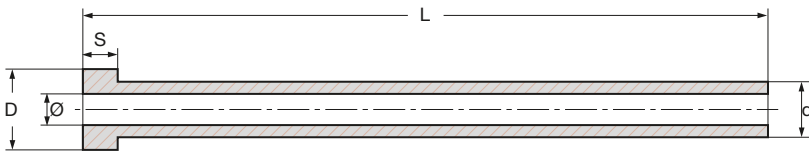


Fig. 20 Mounting of Fibrothal modules.

Ceramic tubes with flange



Ceramic tubes with flange

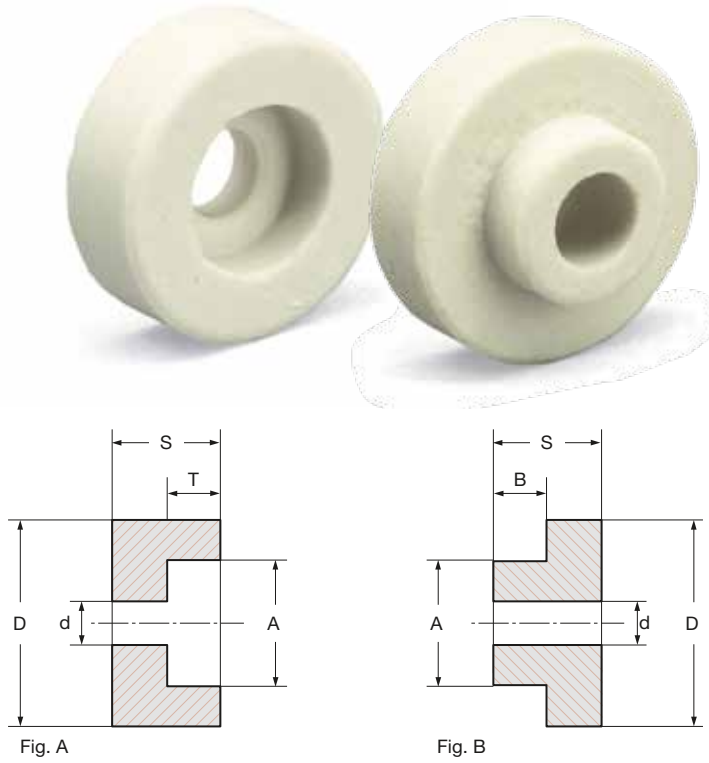
| Ref. | D | | d | | Ø | | S | | L stock | |
|-----------|----|------|----|------|----|------|----|------|-----------------|------------------|
| | mm | in | mm | in | mm | in | mm | in | mm | in |
| TUT-20-10 | 20 | 0.79 | 10 | 0.39 | 6 | 0.24 | 6 | 0.24 | max 300 | max 11.8 |
| TUT-25-15 | 25 | 0.98 | 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



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.

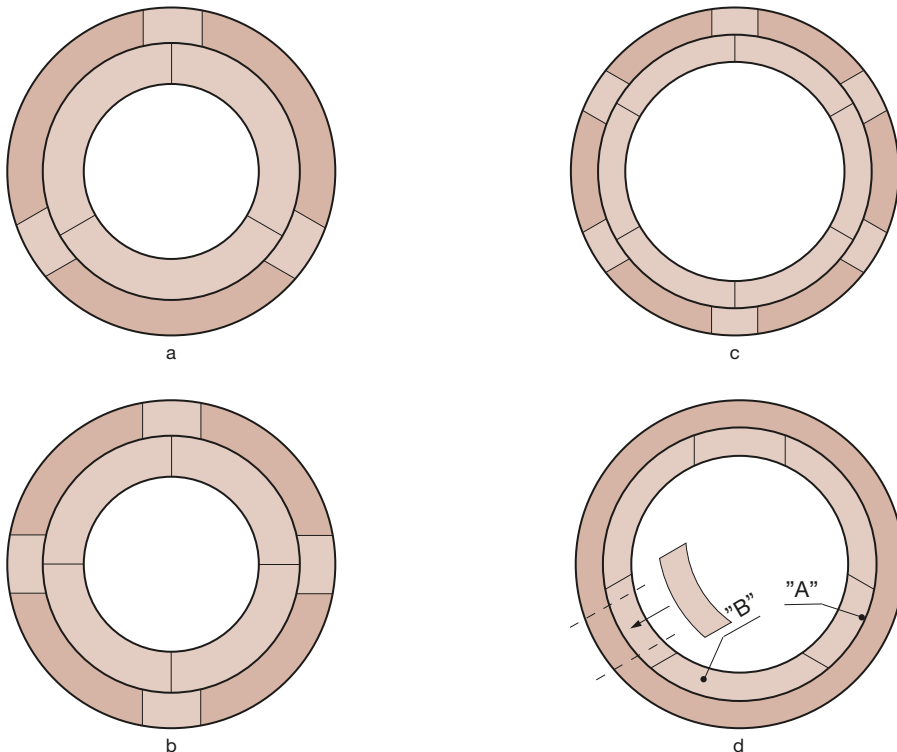
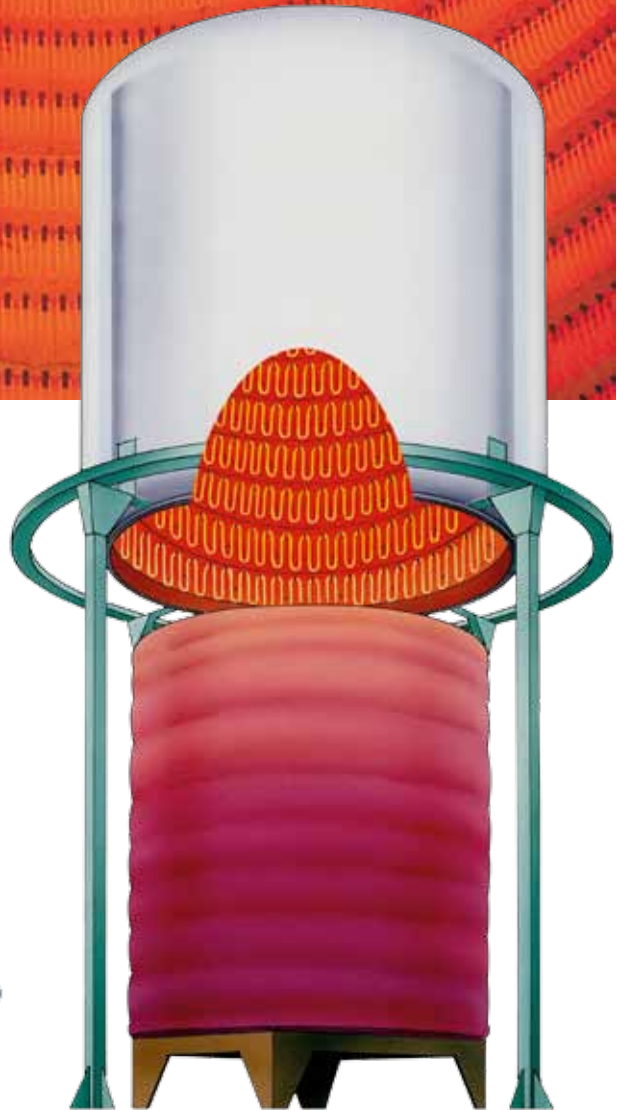


Fig. 21 Module installation situations A–D.



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.

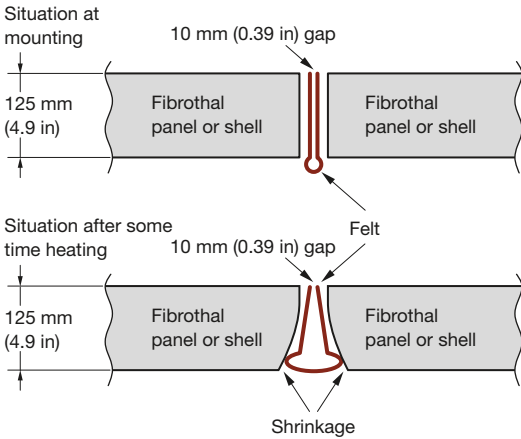


Fig. 23 Fitting of fiber felt (principle).



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 × 4082 W = 24489 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.

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