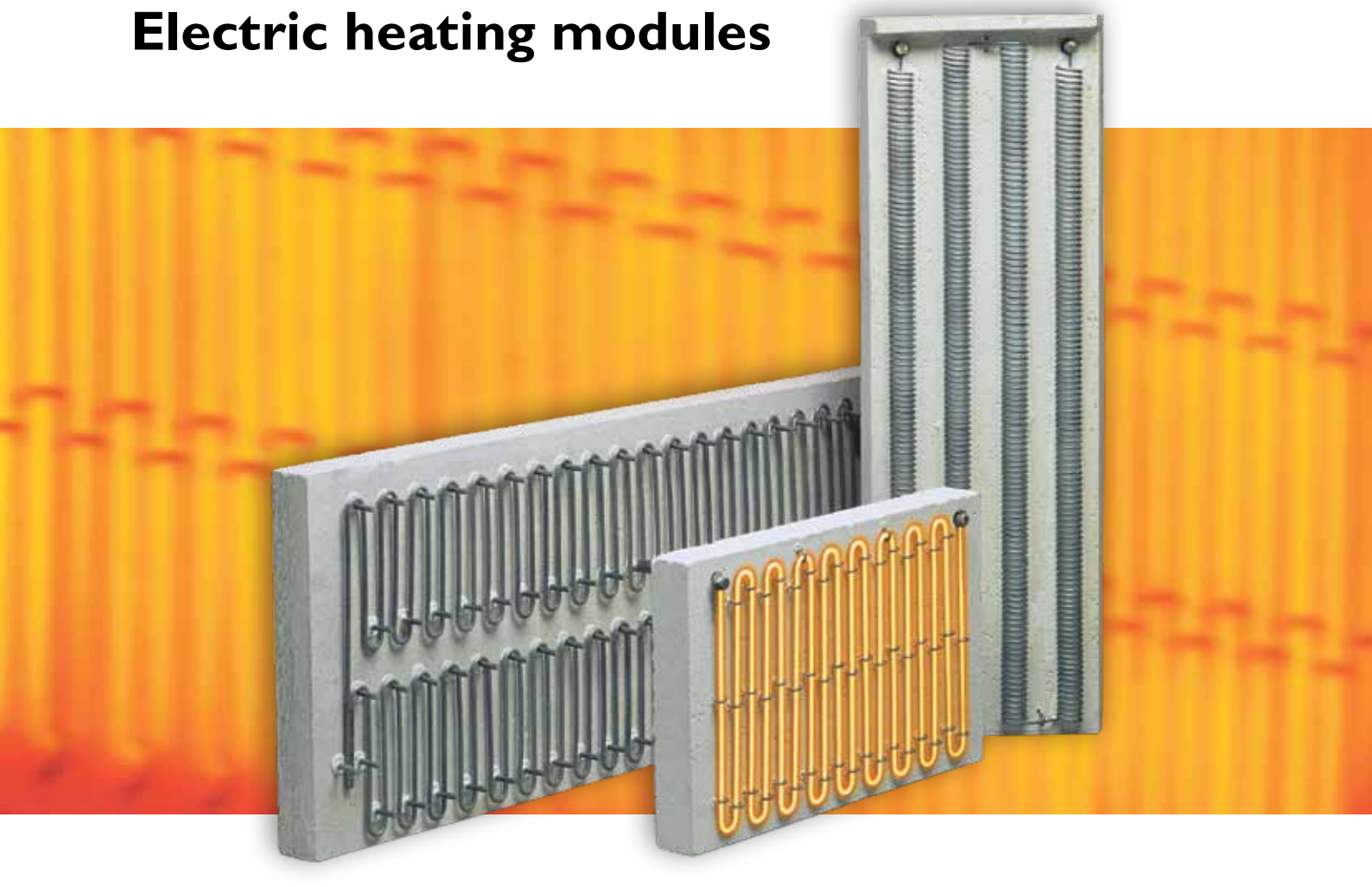
Moduthal™
Electric heating modules



KANTHAL

Moduthal™ heating modules

Kanthal® is the heating technology brand within Sandvik and we have been in the market since 1931, when our first heating wire was introduced. Today, we offer many types of heating elements and systems for laboratory furnaces, industrial furnaces and processes.

Moduthal are prefabricated radiant heating modules designed to suit a wide range of thermal processing applications at element temperatures up to 1350°C (2460°F).

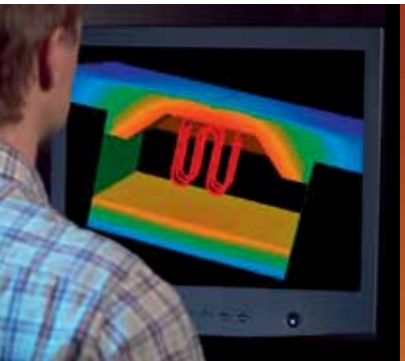
To optimize performance, all resistance material is fabricated primarily from Kanthal® A-1 and Kanthal AF resistance alloys, given each application. The element coils are held in place in a non-electrically conductive, high quality ceramic, to form a Moduthal heating module.

The elements may be fully embedded, semi-embedded or free radiating. The construction method ensures accurate positioning of the coils and eliminates the distortion or other problems connected to the conventional open coil elements in grooves or on tubes. A fiber-free version of Moduthal is available up to 1250°C (2280°F).

The high thermal conductivity of Moduthal refractory panel acts as a diffuser to distribute heat energy evenly from the elements. This provides improved heat distribution as compared with exposed element coils. To provide sophisticated temperature uniformity within a furnace, multiple zones can be used. Without altering the furnace characteristics, individual units are easily replaced, due to the modular construction.

With the introduction of fully embedded, semi embedded and free radiating elements in Moduthal heating modules, Sandvik has taken a major step forward. The exclusive manufacturing process results in e.g. excellent temperature capability, superior element support, and a long life, these being just a few examples of Sandvik high quality reliable workmanship. The result is a heating module which possesses many features.

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




LOOK AT SANDVIK AS YOUR PARTNER

We can solve most industrial heating problems from 0 to 2000°C (32 to 3630°F).

The problem – facts
We collect all the facts and requirements, previous experiences and limitations.

Design and calculations
Our sales engineers analyze the facts, make the basic element and furnace calculations and prepare a preliminary recommendation.

Test
A prototype is manufactured and tested at one of our technical centers.

Simulation
The recommended solution is tested in special, digital simulation programs.

Follow-up
Our sales engineers keep in touch to monitor and evaluate the system performance.

The solution – delivery and installation
We often work as project leader with the responsibility for the whole project including complementary products, like insulation and power supply, training and instruction and the actual installation.

FEATURES OF MODUTHAL HEATING MODULES

- Fully interchangeable modules
- Superior element support
- Long life
- Easy to install
- High surface load
- Excellent heat distribution
- Customized design

Reference applications

Moduthal™ heating modules have been successfully used in these well-established applications.

Crucible furnace
Melting or holding aluminum and copper-based alloys. With the fully embedded type of Moduthal heating modules some protection is given to the element against metal splashes and fluxes. Moduthal heating modules permits high wall loadings, gives uniform temperature around the crucible and can be easily replaced.

Billet heating furnace
Pre-heating of steel, copper, brass and aluminum billets prior to rolling or forging.

Glass toughening and bending furnace
Toughening glass for cooker doors and similar products. Operating for an eight-hour day five days per week at 650°C (1200°F) in an air atmosphere.

Brass melting furnace
Moduthal high-temperature panels in roof and walls operating at element temperatures up to 1350°C (2460°F).

Tundish pre-heating
For casting aluminum. Moduthal heating modules gives accurate and even temperature control in a compact design.

Wire annealing furnace
For multi-strand annealing. Moduthal panels are mounted in the hearth, roof and walls, operating in the range 800–1050°C (1470–1920°F) both continuously and intermittently.

Fluidized bed furnace
Interlinked circular muffles (embedded for protection against bed materials) operating typically at 900–1000°C (1650–1830°F).

Crystal growing
Low-temperature crystal growing using a Moduthal heating module at 950–1000°C (1740–1830°F) in air.

Billet holding furnace
Arch-shaped Moduthal heating module with fully embedded element for billet holding at temperature after induction heating. Intermittent operation at 750–800°C (1380–1470°F).

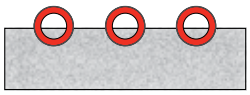
Types and maximum temperature

Moduthal™ cast refractory element modules can be supplied as one of the following individual types of heating module.

Moduthal heating module – fully embedded
Maximum element temperature 1100°C (2010°F)

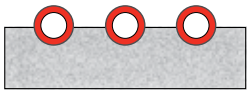
Although being a fully embedded panel, most of the heating element is covered with a thin layer of refractory allowing the element to radiate more efficiently than a standard fully embedded panel. Moduthal fully embedded heating panels are also available in a fiber free version.

Moduthal heating module – semi embedded
Maximum element temperature 1150°C (2100°F)



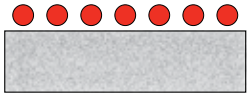
A conventionally designed panel which offers a cost effective solution to applications that do not require the higher temperatures that can be achieved by the open coil elements in Moduthal heating module. Moduthal semi embedded heating panels are also available in a fiber free version.

Moduthal heating module – free radiating
Maximum element temperature 1200°C (2190°F)



Due to the unique Sandvik design, which allows 75 % of the heating element to freely radiate, this element is capable of operating up to 1200°C (2190°F). 1150°C (2100°F) when using fiber free modules.

Moduthal heating module –
free radiating high temperature
Maximum element temperature 1350°C (2460°F)



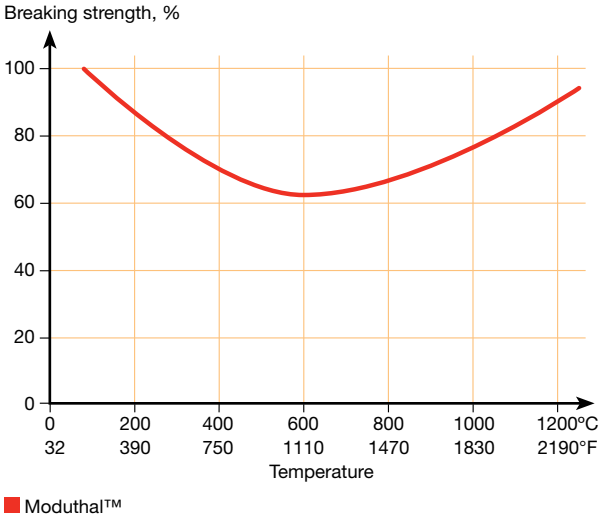
The unique design of Moduthal heating modules combines ceramic casting with freely radiating Kanthal APM™ material elements. Those elements are capable of operating up to 1350°C (2460°F). 1250°C (2280°F) when using the fiber free modules.

Design
The embedded elements in Moduthal heating modules can be designed and manufactured in a variety of shapes and sizes and can also include special features such as thermocouple holes, locating lugs and grooves. The elements in Moduthal heating modules are designed for use in either small furnaces or in multiples to suit larger industrial furnaces or kilns. Each heating panel is typically rated between 1 kW and 10 kW. The mechanical strength of Moduthal at different temperature is shown in a diagram.

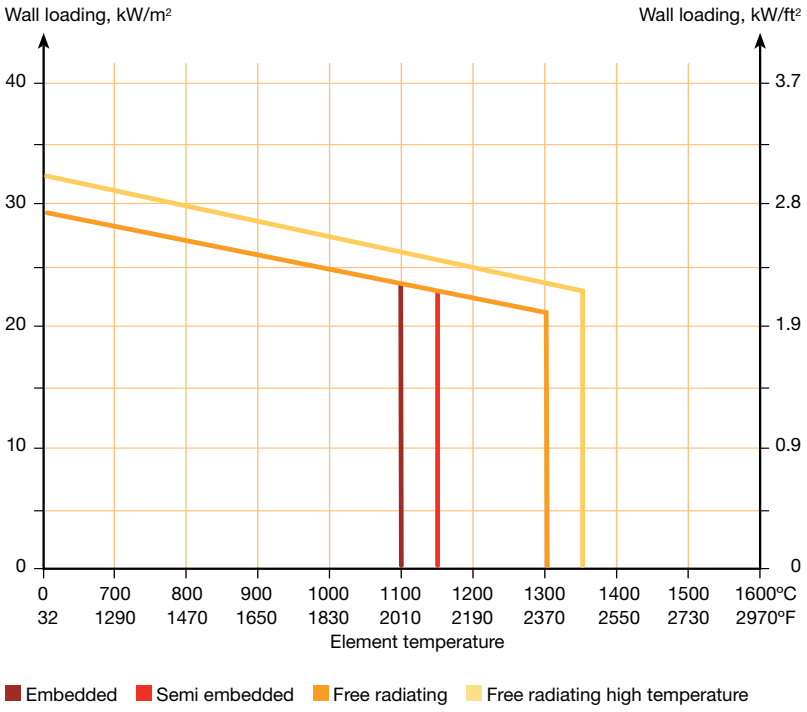
Process atmospheres
The elements in Moduthal heating modules are designed to operate in clean air, but may also be used in process atmospheres within the normal limitations of the heating element alloy. The effect of furnace atmospheres is tabulated on page 11.

Control equipment
The elements in Moduthal heating modules are normally operated directly from the mains electricity supply and therefore do not require any special power supply equipment. All modules are highly resistant to thermal stress and there is no need to limit the power input during start up conditions, except during the initial firing up when a slower heating rate may be required to expel any residual moisture.

Results of laboratory tests showing the breaking strength of Moduthal heating modules



Maximum recommended wall loading versus furnace temperature for various types of Moduthal™ heating modules (diagram for guidance only)

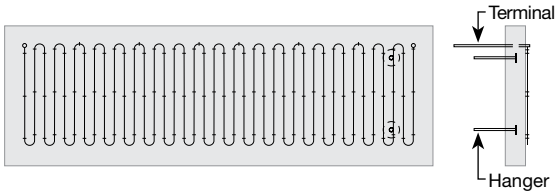


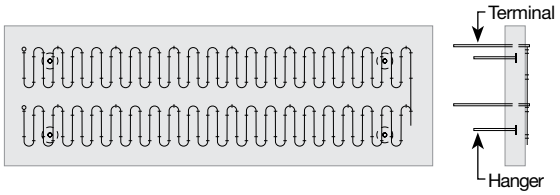
Maximum permissible element temperatures

Type of module	Moduthal™ 3000 module		Moduthal 6000 module		Moduthal FF (fiber free) module	
	°C	°F	°C	°F	°C	°F
Fully embedded (coil)	1100	2010	1100	2010	1100	2010
Semi embedded (coil)	1150	2100	1150	2100	1150	2100
Free radiating (coil)	1200	2190	1200	2190	1150	2100
Free radiating high temperature	1350	2460	1350	2460	1250	2280

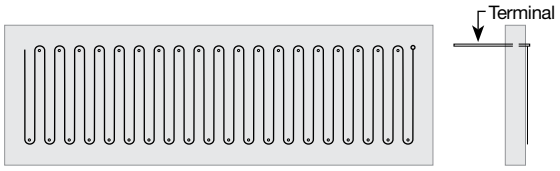
Common panel configurations

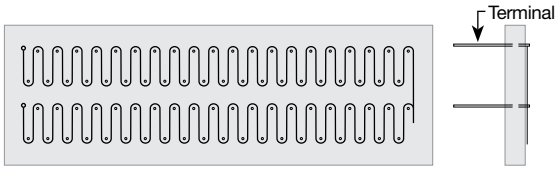
Roof and wall panels



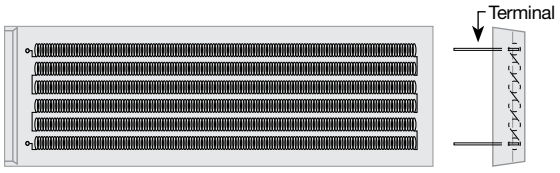


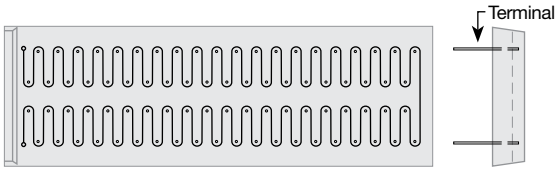
Bottom panels



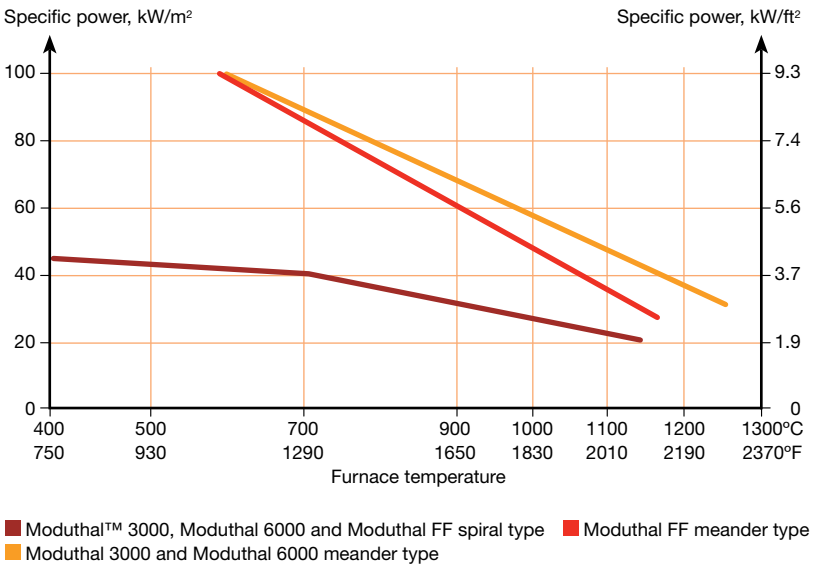


Panels for aluminum crucible furnaces





Power limitation



Moduthal™ 3000, Moduthal 6000 and Moduthal FF spiral type
Moduthal FF meander type
Moduthal 3000 and Moduthal 6000 meander type

Atmospheres

Maximum permissible element temperature in various furnace atmospheres

Furnace atmosphere	Max element temperature						Remarks
	Heating element		Moduthal™ FF		Moduthal 3000 and 6000		
	°C	°F	°C	°F	°C	°F	
H_2	1350	2460	1250	2280	1350	2460	H_2 increases heat conductivity of Moduthal 3–4 times
N_2	1200 preoxidized	2190 preoxidized	1250	2280	1350	2460	
N	don't use		–		–		
Endogas	1050 preoxidized	1920 preoxidized	1050	1920	1050	1920	Pay attention to carbon deposition. Gas tight muffle recommended
Exogas	1150 preoxidized	2100 preoxidized	1150	2100	1150	2100	Pay attention to carbon deposition. Gas tight muffle recommended
Sulphur cont. cycle	approx. 1000	approx. 1830	1000	1830	1000	1830	Gas tight muffle recommended
Sulphur interm. cycle	approx. 1000	approx. 1830	see remarks		see remarks		Gas tight muffle recommended
Vacuum $<10^{-3}$ hPa	1150 preoxidized	2100 preoxidized	1150	2100	1150	2100	Vacuum tight muffle recommended for vacuum $>10^{-3}$ bar
Chlorine, fluorine and alkali	attacks all types of resistant alloys		–		–		
Pressurized	1400	2550	1250	2280	1350	2460	Moduthal can be used in gas or air-tight furnaces only
Scale	see remarks		see remarks		see remarks		Spray scale from heat-resistant parts is usually satisfactorily tolerated, iron oxide scale attacks Kanthal fit cover
Vapors	see remarks		see remarks		see remarks		Vapors must not form condensates from salts or oxides, otherwise electrical bridges may be formed
Gas velocity	see remarks		see remarks		see remarks		Moduthal withstands high gas velocities up to 50 m/s (164 ft/s). Pay attention to butt joints with ceramic fiber blankets

Module dimensions

Maximum sizes for Moduthal™ 3000 and 6000

	A sizes		B sizes		Standard C sizes	
	mm	in	mm	in	mm	in
Roof and walls	max 500 max 350	max 19.7 max 13.8	< 1100 1100–1500	< 43.3 43.3–59.1	50	1.97
Bottom	max 500 max 400	max 19.7 max 15.7	< 1100 1100–1500	< 43.3 43.3–59.1	50	1.97

Dimensional tolerances: A ± 5 mm (0.20 in)
B ± 5 mm (0.20 in)
C ± 2 mm (0.08 in)

Maximum sizes for Moduthal FF

	A sizes		B sizes		Standard C sizes	
	mm	in	mm	in	mm	in
Roof and walls	max 400 max 350	max 15.7 max 13.8	< 900 900–1100	< 35.4 35.4–43.3	50	1.97
Bottom	max 500 max 400	max 19.7 max 15.7	< 1100 1100–1400	< 43.3 43.3–55.1	50	1.97

Dimensional tolerances: A ± 5 mm (0.20 in)
B ± 5 mm (0.20 in)
C ± 2 mm (0.08 in)

Note: Tighter tolerances may be possible, consult Sandvik if required.

Maximum temperature

Accessories

Flexible bead-insulated and connecting leads.

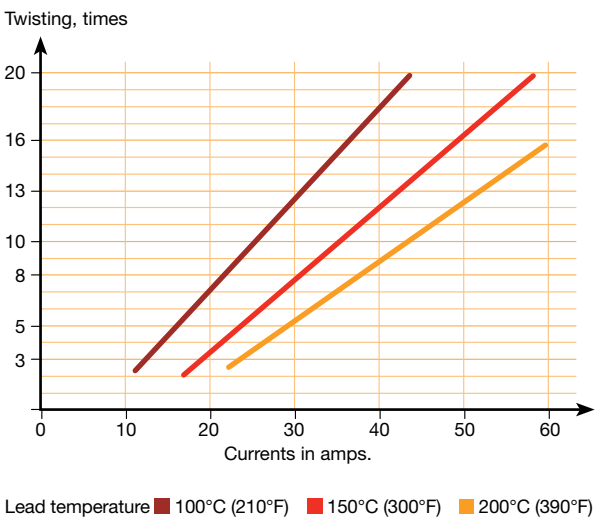
The leads for electrical connections consist of Nikrothal® 40 nickel-chromium wire and are multi-twisted. The choice of the proper cross-section depends on the power consumption of Moduthal™ panels. The diagrams below can be used to select the correct lead dimension. Remember, however, that the temperature at the terminal connection point must never exceed 200°C (390°F).

It is also necessary to note that the temperature of the lead in 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 (see the diagrams below) and the temperature of the insulation.

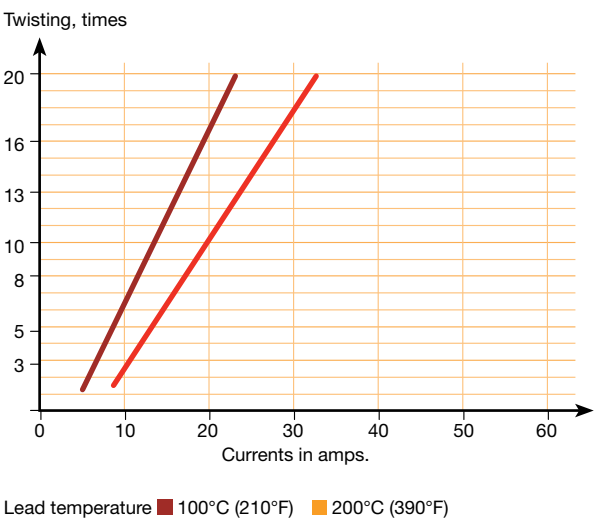
Outer dimensions, depending on number of twists

	Number of twists											
	3 times		5 times		6 times		8 times		10 times		13 times	
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
Outside Ø of the twisted lead	3.5	0.14	4.5	0.18	5	0.2	6.5	0.26	7	0.28	8.5	0.33
Outside Ø of the insulating beads	11	0.43	11	0.43	11	0.43	14	0.55	14	0.55	14	0.55

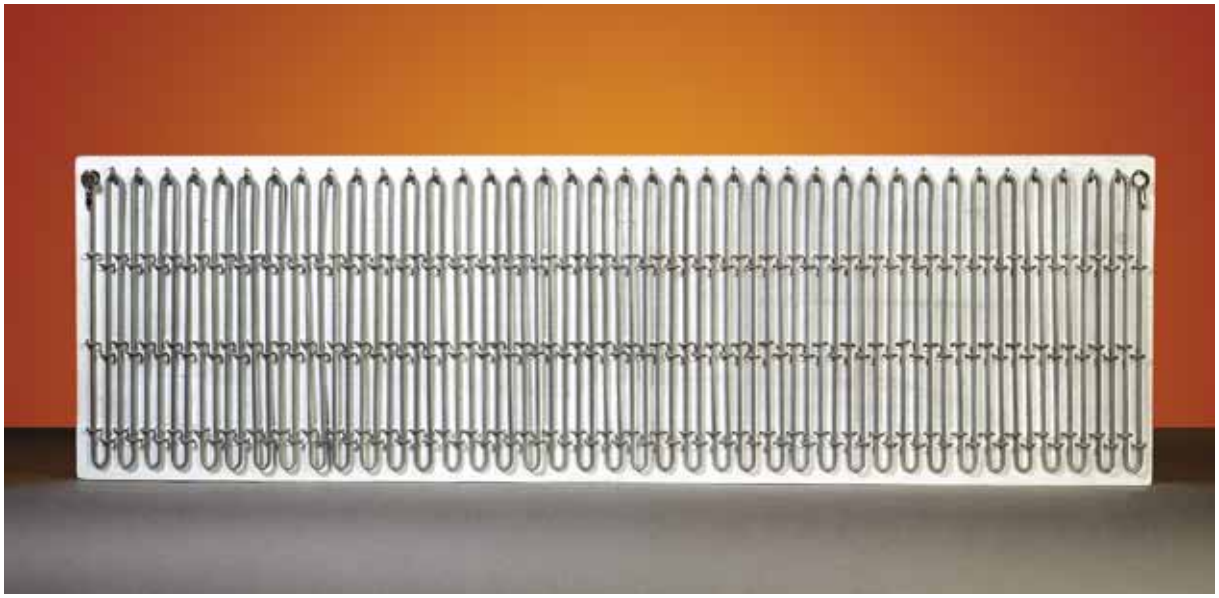
Leads bead-insulated in air



Leads bead-insulated in Moduthal



Technical information



Technical data for Moduthal™ insulation

		Moduthal™ 3000	Moduthal 6000	Moduthal FF
Main component		fiber	fiber	aluminum silicate
Classification temperature		1600°C (2910°F)	1600°C (2910°F)	1400°C (2550°F)
Maximum working temperature		1500°C (2730°F)	1500°C (2730°F)	1250°C (2280°F)
Melting point		1680°C (3060°F)	1680°C (3060°F)	1400°C (2550°F)
Chemical analysis	Al_2O_3 SiO_2 CaO	72–73 12–13 10–11	70–71 13–15 10–11	38–40 27–29 33–35
Density after firing at 1000°C, kg/m³ (at 1830°F, lb/ft³)		1100–1200 (68.7–74.9)	1000 (62.4)	1200 (74.9)
Thermal conductivity, W/mK (W/inF)	110°C (230°F) 800°C (1470°F) 1000°C (1830°F) 1200°C (2190°F) 1350°C (2460°F)	– 80 (1.13) – 117 (1.65) 163 (2.30)	– 63 (0.89) – 92 (1.30) 125 (1.76)	167 (2.36) 146 (2.06) 201 (2.84) – –
Thermal expansion, %	1000°C (1830°F) 1500°C (2730°F)	0.65 1.40	0.60 -1.30	0.65 –
Shrinkage, %	110°C (230°F) 1000°C (1830°F) 1500°C (2730°F)	none 0.10 0.15	none none 1.30	0.10 none –
Compr. strength, MPa (lb/in²)	after firing 700°C (1290°F) 1000°C (1830°F) 1500°C (2730°F)	15.7 (2276) 6.4 (924) 6.6 (953) 8.4 (1223)	15.2 (2204) 5.9 (853) 6.0 (868) 7.3 (1053)	13.7 (1991) 7.8 (1138) 8.3 (1209) –
Drying and firing		firing at 50°C/h (120°F/h) one stop of 5 h at 150°C (300°F)		

Sandvik Group
The Sandvik Group is a global high technology enterprise with 47,000 employees in 130 countries. Sandvik's operations are concentrated on three core businesses: Sandvik Tooling, Sandvik Mining and Construction and Sandvik Materials Technology – areas in which the group holds leading global positions in selected niches.

Sandvik Materials Technology
Sandvik Materials Technology is a world-leading manufacturer of high value-added products in advanced stainless steels and special alloys, and of medical implants, steel belt-based systems and industrial heating solutions.

Kanthal is a Sandvik owned brand, under which world class heating technology products and solutions are offered. Sandvik, Kanthal, Moduthal and Nikrothal are trademarks owned by Sandvik Intellectual Property AB.

Quality management
Sandvik Materials Technology has quality management systems approved by internationally recognized organizations. We hold, for example, the ASME Quality Systems Certificate as a materials organization, approval to ISO 9001, ISO/TS 16949, ISO 17025, and PED 97/23/EC, as well as product approvals from TÜV, JIS and Lloyd's Register.

Environment, health and safety
Environmental awareness, health and safety are integral parts of our business and are at the forefront of all activities within our operation. We hold ISO 14001 and OHSAS 18001 approvals.

Recommendations are for guidance only, and the suitability of a material for a specific application can be confirmed only when we know the actual service conditions. Continuous development may necessitate changes in technical data without notice.

This printed matter is only valid for Sandvik material. Other material, covering the same international specifications, does not necessarily comply with the mechanical and corrosion properties presented in this printed matter.

Sandvik Materials Technology
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