KANTHAL SUPER

Electric Heating Elements for use up to 1900°C

KANTHAL®

Kanthal

Kanthal Super is an electric heating element material for use in industrial and laboratory furnaces. It can be used in air to heat furnaces to a temperature as high as 1850°C, *3360°F*. and may also be used in all the usual protective gases. Furthermore it has the very useful property of not increasing in resistance with use, whereas the lives of metallic and silicon carbide elements are limited by continuous oxidation of the materials.

Kanthal Super elements at 1200°C, 2200°F. Maximum temperature in air is 1900°C, 3450°F.

Kanthal Super is unique. It comprises molybdenum disilicide, $MoSi_2$, and a component that forms a dense protective layer of glass around it at the working temperature. This protective layer is the key to the superior properties of Kanthal Super, and to its usefulness to the furnace user.

The elements are manufactured to fit all types of industrial and laboratory furnaces and equipment.

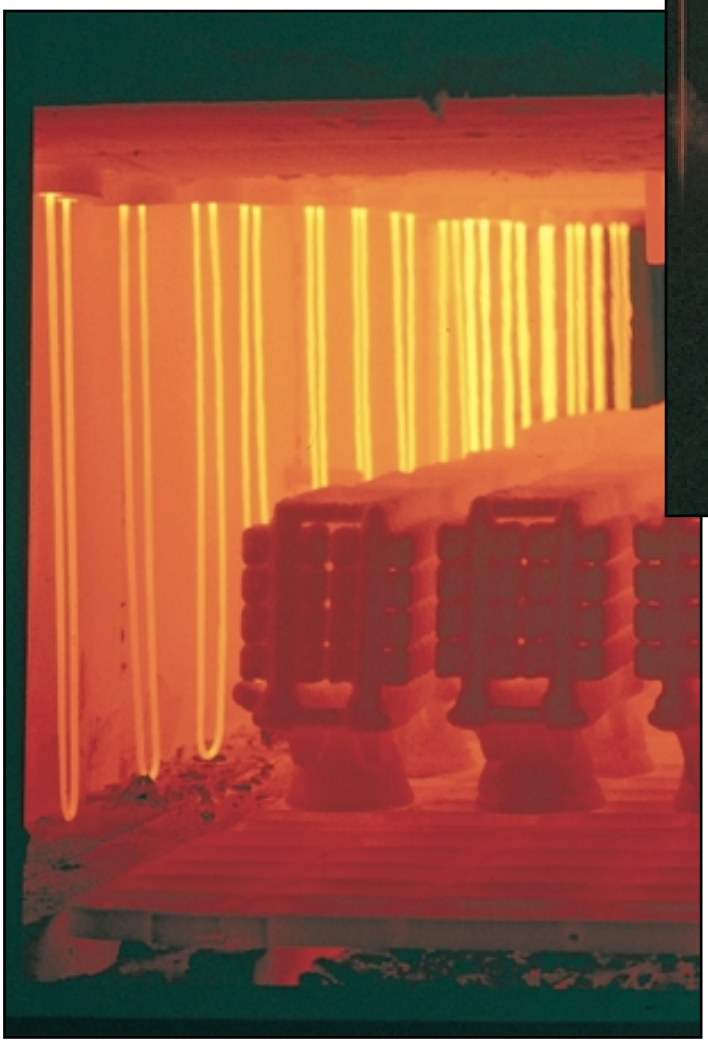
Super

Reliable production; low maintenance costs

No other electric heating element can match the life of Kanthal Super. It is not unusual for Kanthal Super elements to last 3–6 years or even longer, depending on circumstances. Such durability naturally means a notably troublefree furnace.

Users can count on almost continuous furnace availability, with virtually no stoppages for unscheduled replacement of elements. This is, of course, an ideal situation for production managers. And the benefits are also seen in the maintenance budget.

Since the elements do not age, i.e. they retain their electrical characteristics, it is also possible to connect existing and new elements in series without any problems. There is no need to match resistances or adjust voltage.



Wall mounted Kanthal Super elements in a pusher furnace for sintering and burn-out of moulds at 1050°C, 1920°F.

Flexibility

The wide temperature range at which the elements can be used – from 500 to 1850°C, *930 to 3360°F* – enhances the flexibility and usefulness of a furnace. Elements can be used for a variety of processes, and at different temperatures, while extended operation at very high temperatures has minimal effect on the life of the elements. Flexibility is further enhanced by the ability of the elements to being exposed to many of the protective atmospheres used in practice.

The Kanthal Super elements are used directly without protection tubes in the atmosphere in many heat treatment furnaces, as in this sealed quench type.

High productivity

Elements can be used at high surface loadings and arranged in groups to give wall loadings in excess of 100 kW/m^2. This makes it possible to design furnaces having rapid heating rates, and large throughputs. The retrofit of a furnace with Kanthal Super elements is therefore an attractive alternative to the purchase of an additional furnace, when a higher output is required.

Nothing but

Downtime minimized

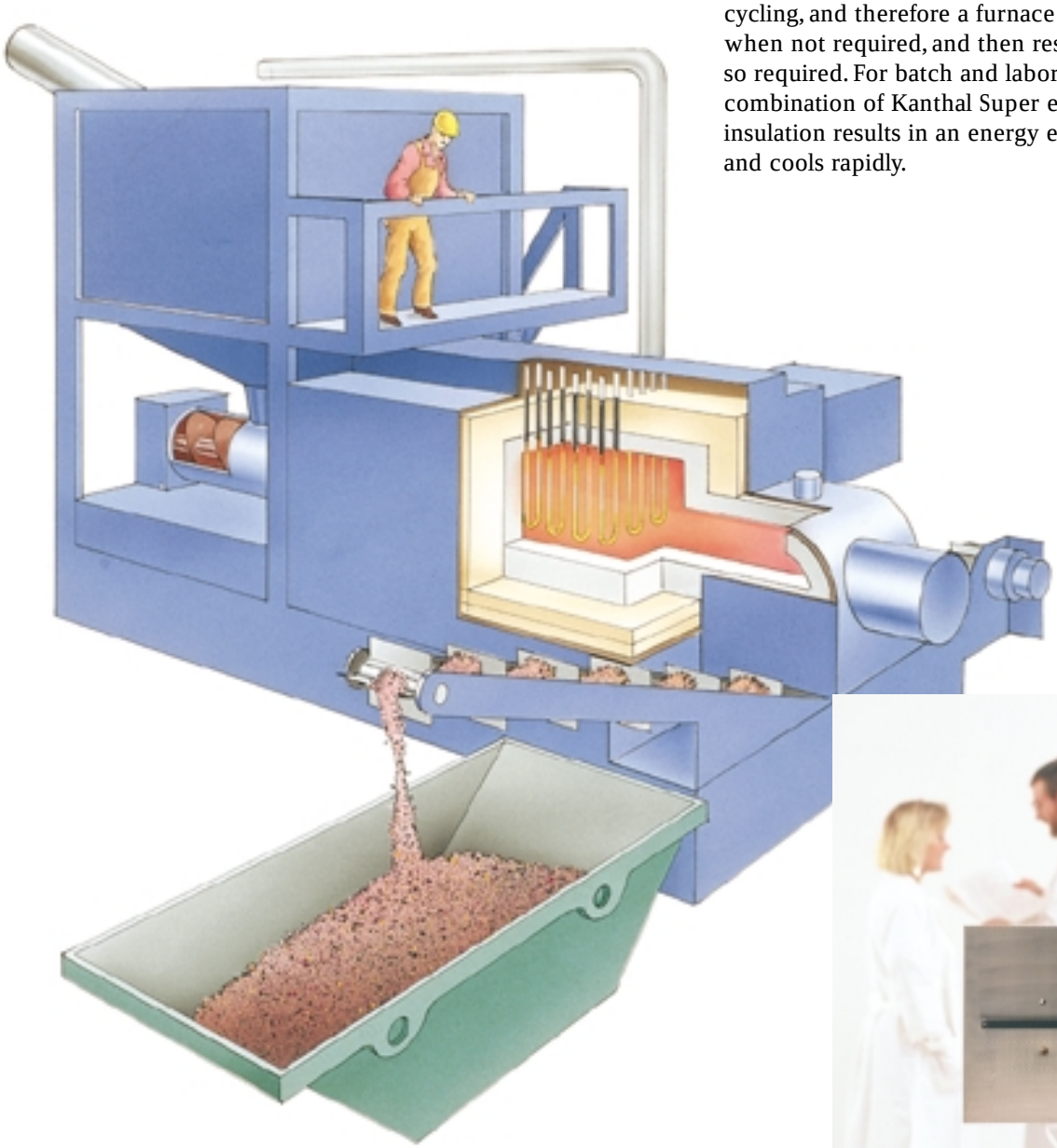
Although Kanthal Super elements do not age, it may become necessary to replace on that has been broken mechanically. As, in most cases, elements can be removed and replaced while the furnace is at temperature, the downtime needs not exceed about half an hour; giving one the advantage of little or no production loss. The choice of the Kanthal Super element is therefore ideal where output is critical.

High, consistent quality

A well designed furnace heated by Kanthal Super elements will give a high yield, as the elements are easy to control, with rapid response and uniformity of heating. The rapid response results from the low thermal mass of the elements, which are manufactured from bars of only 3 to 12 mm diameter. Wherever reliability and accurate temperature control are of primary importance, the Kanthal Super elements exhibit their superiority.

Energy saving

Kanthal Super elements will withstand repeated cycling, and therefore a furnace can be shut down safely when not required, and then restarted – automatically, if so required. For batch and laboratory furnaces, the combination of Kanthal Super elements and ceramic fibre insulation results in an energy efficient furnace that heats and cools rapidly.



The destruction of hazardous waste is a new application area for Kanthal Super. Here the material is melted and granulated. The elements are working directly in the furnace atmosphere.

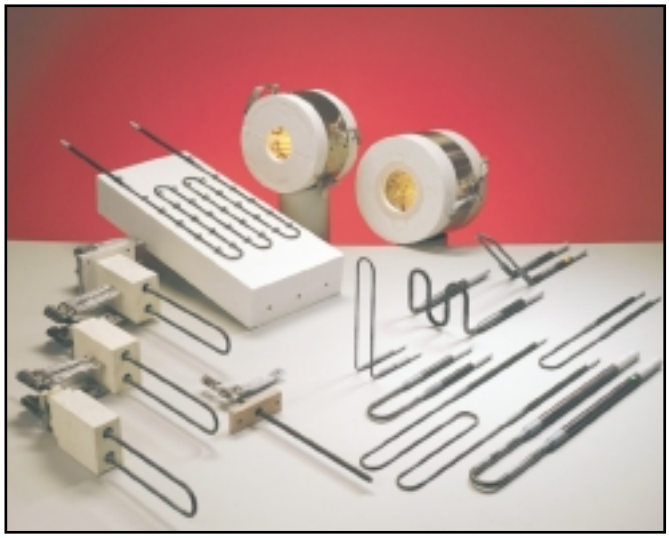
Kanthal Super are standard elements in most laboratory furnaces. In combination with ceramic fibre insulation they result in an extremely fast and versatile furnace.

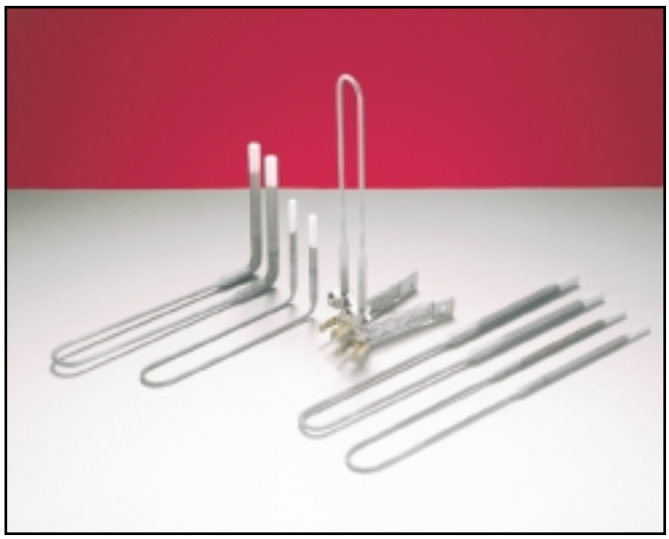
advantages ...

Wide product range

Kanthal Super elements are available in a variety of qualities and forms. The normal form is a U shape for free vertical suspension, but Superthal Modules, comprising a Kanthal Super element mounted in a ceramic fibre shape, are also available. Whatever the chosen form, delivery times are short, as Kanthal Subsidiaries hold stocks and carry out final fabrication.

Kanthal Super heating elements sheathed by Kanthal extruded tubes, make an ideal long-life heating package for aluminium melting and holding furnaces, and other heat treatment furnaces. The mazimum operating temperature for the tube is 1300°C, 2370°F.





Kanthal Super elements are manufactured in different sizes and element forms and as Superthal ready-to-install heating units.

Dependable service and technical support

Kanthal has been making Kanthal Super since the early 1960's, and tens of thousand of furnaces, in a veriety of industries, have been equipped with elements made from this material. Kanthal's Engineers are therefore able to give highly qualified advice on the choice and design of elements, furnace building, installation etc.

The Glass

Feeder forehearths and forebays

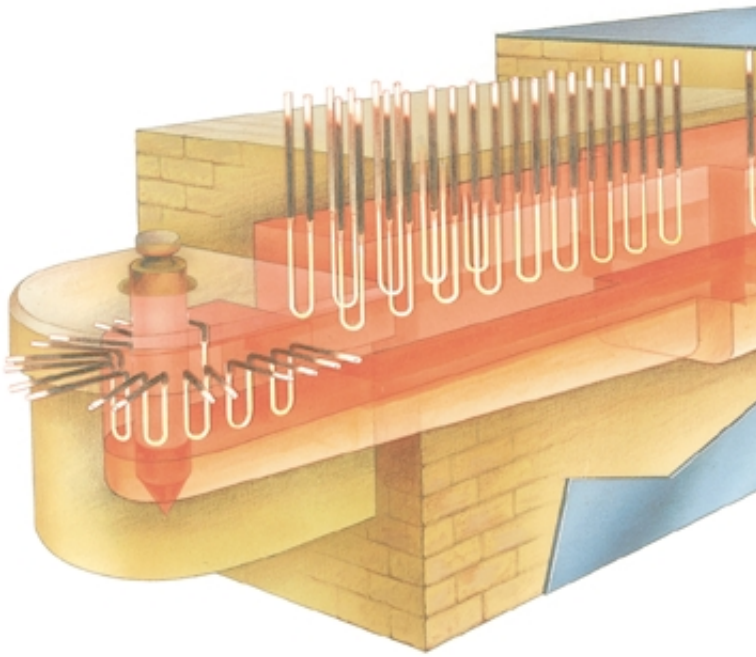
Kanthal Super is well-adapted to give precise control of the temperature and atmosphere inside the feeder. The uniform temperature and viscosity of the glass throughout the process results in better quality. There is no contamination of the glass by combustion products from fossile fuels and there are no substances on the glass surface to evaporate in the gas flame, which could adversely affect glass quality and the environment.

The advantages of using molybdenum disilicide elements are their long life and the constant resistance of the elements – no ageing. One example of a modern Kanthal Super heated feeder forehearth is from a German glass company. The feeder has now been in operation for five years and enough data has been collected to allow a through analysis of the process.

The feeder has produced 5 tonnes of 24 per cent lead crystal glass per day. Compared with gas heating, electricity has resulted in 25 per cent savings in energy costs, and greatly improved glass quality and working conditions. The combination of Kanthal Super elements and fibre insulation has increased efficiency to 80 per cent. What's more, none of the original Kanthal Super elements has been replaced after five years of operation!

Today some 60 molybdenum disilicide heated feeder forehearths are in operation for the production of lead crystal glass, soda-lime glass, optical glass and various special types of glass.

The heating of forebays containing glass for hand forming has proved to be excellent with Kanthal Super elements. Kanthal Super can be used for all working temperatures and for different glass qualities.



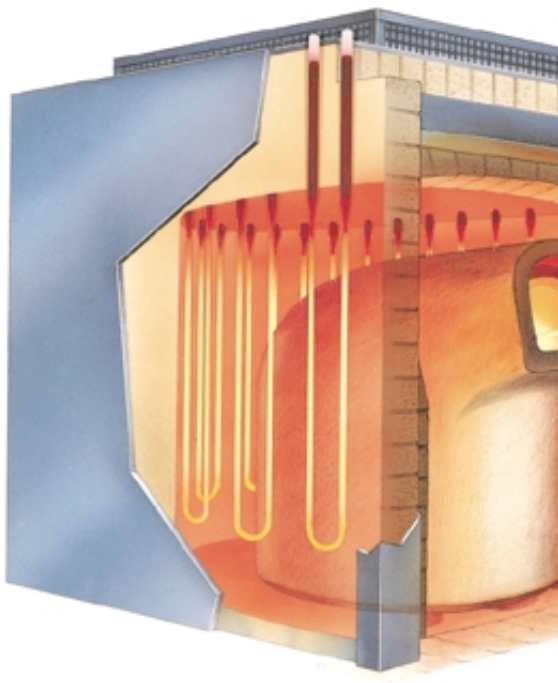
Melting pot furnaces

The first Kanthal Super heated pot furnace was installed in 1960. It was of the open-pot type with brick insulaltion and 28 Kanthal Super 9/18 elements dissipating 180 kW. The furnace still operates continuously in a program-regulated 24-hour cycle with overnight melting.

The basic design was spread around the world and several hundred brick-lined Kanthal Super heated furnaces have been installed.

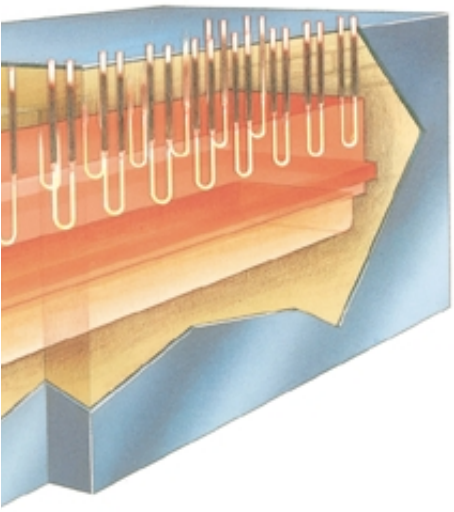
The first fibre-lined pot furnace was built in the beginning of the 80's and the combination of Kanthal Super elements and fibre proved to be a considerable advantace.

A modern Kanthal Super pot furnace is insulated with a stable fibre instead of bricks. In addition to the much lower power needed (some 30–50%) this also results in a more flexible furnace – it is easier to control the temperature and to change the temperature very quickly. The pot is often of a semi-open type and the furnace is usually operating on a 24-hour cycle.

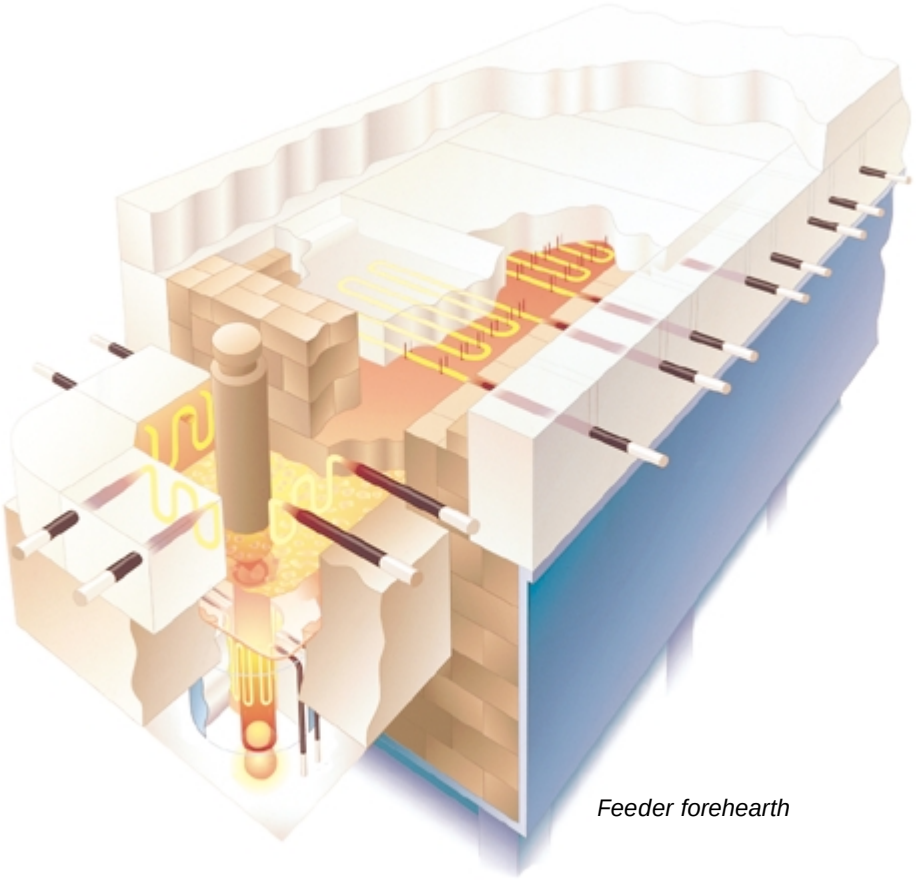


The temperature control is simple and accurate and is preset by an ordinary programmer for at typical 24-hour cycle, enabling unmanned automatic overnight operation. The quality of the glass is high and fully predictable. The element life is on an average 3–5 years.

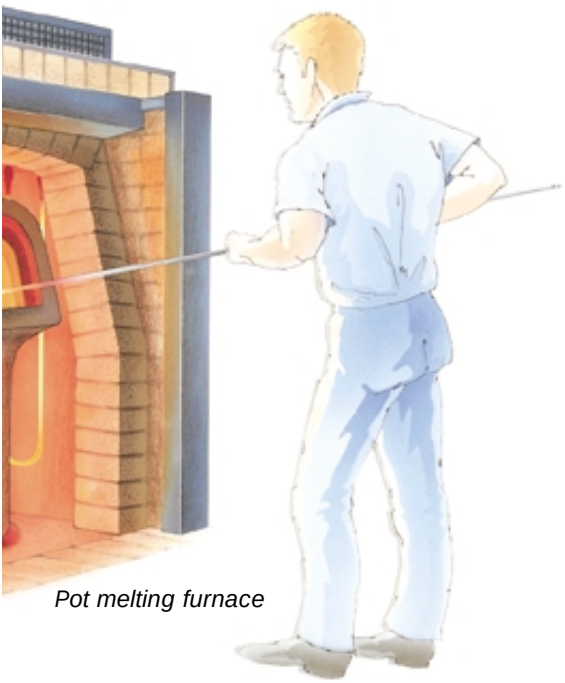
Industry



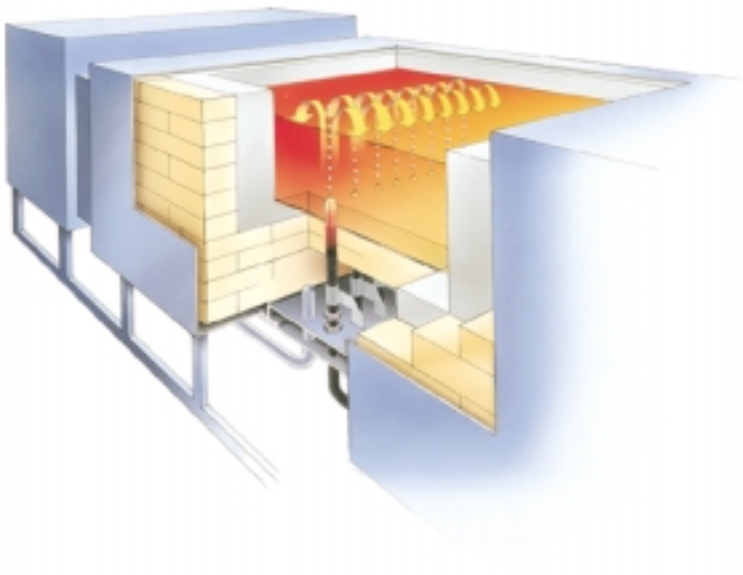
Feeder forehearth



Feeder forehearth



Pot melting furnace



Bubbler tubes

Bubbler tubes

Bubbler tubes of Kanthal Super material are used to produce an even melt temperature in the melting tank, by introducing an air current into the molten glass. If the glass solidifies in the tube, it can be cleared by connecting the tube to an adjacent electrode.

Heat Treatment,

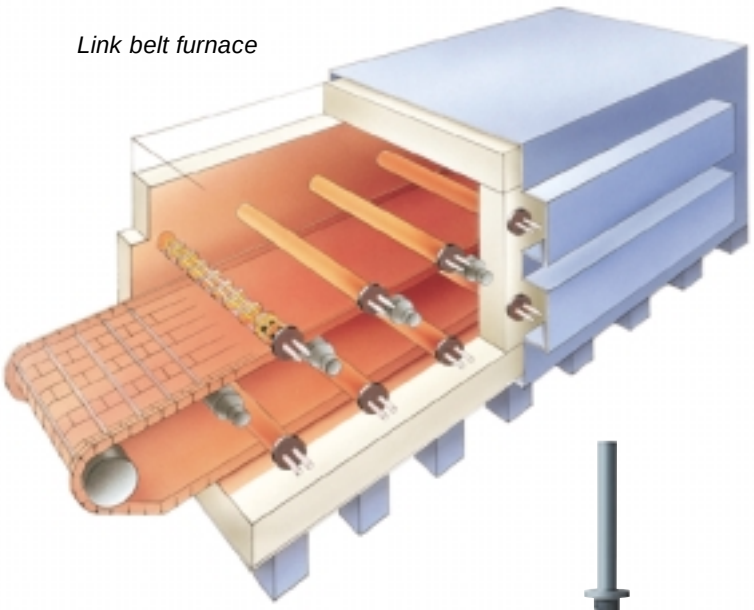
Batch furnaces

Kanthal Super elements are ideal for the electric heating of batch furnaces such as, chamber, elevator hearth and sealed quench types. The elements can often be installed in an endorthermic or ammonia gas atmosphere without being sheathed.

When a sheathed metallic element fails it can often mean a shut down of 1–2 days while the furnace cools, whereas with a Kanthal Super element it can be replaced in about an hour, without loss of production.

Operating conditions remain constant over many years as the elements do not age.

After loading a furnace with a cold batch the recovery time will be reduced because more power is dissipated by the elements when they cool. This results in a reduction in the cycle time, and a higher rate of production.



Link belt furnace

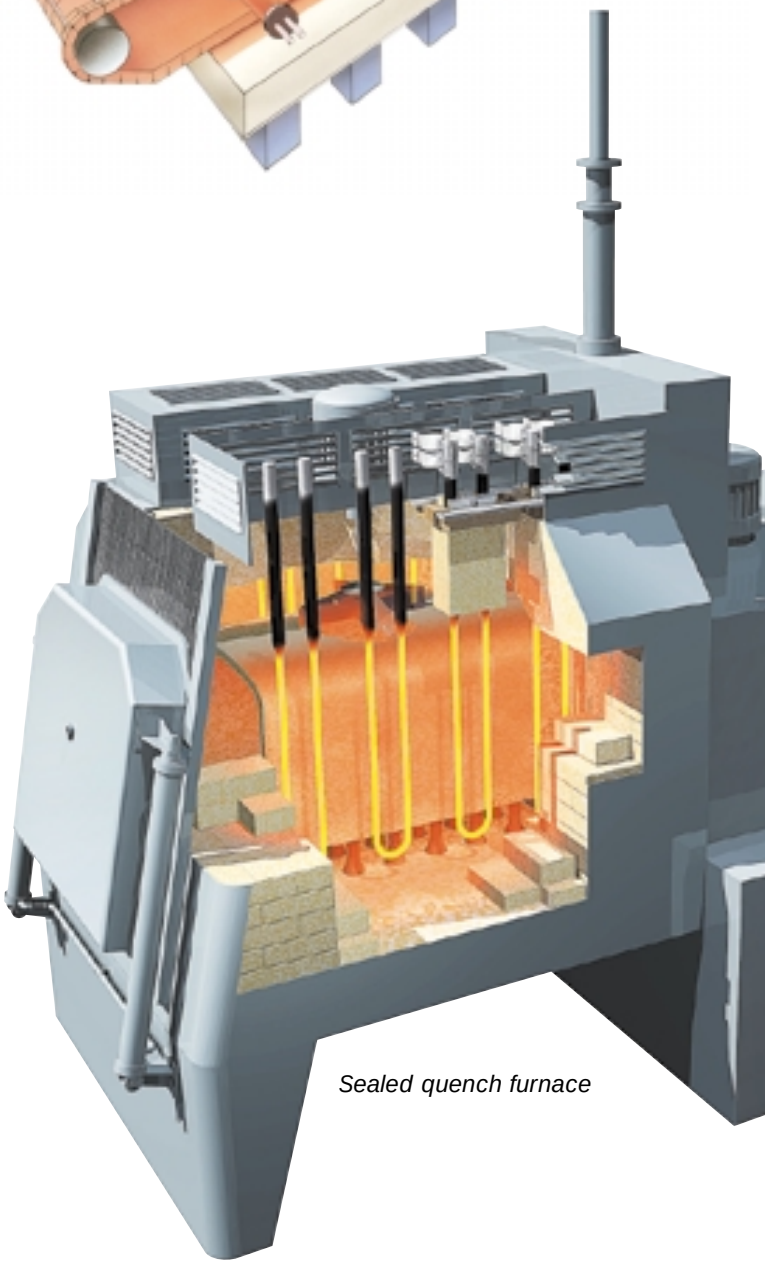
Continuous furnaces

Kanthal Super finds wide spread use in pusher, mesh belt, link belt, roller hearth, walking beam and other types of continuous furnaces.

In many cases the Kanthal Super elements are installed in Kanthal extruded tubes in order to protect the elements from mechanical damage.

By using radiant tubes, the elements can also be installed horizontally. The element life in radiant tubes can be up to 6–10 years or more. The maintenance costs are therefore extremely low and the reliability very high. The life of the radiant tubes is also increased because of the even temperature from the elements.

The elements are easy to control and to use with computerized programs and, because of their non-ageing properties, they will perform consistently, to give the same temperature profile.



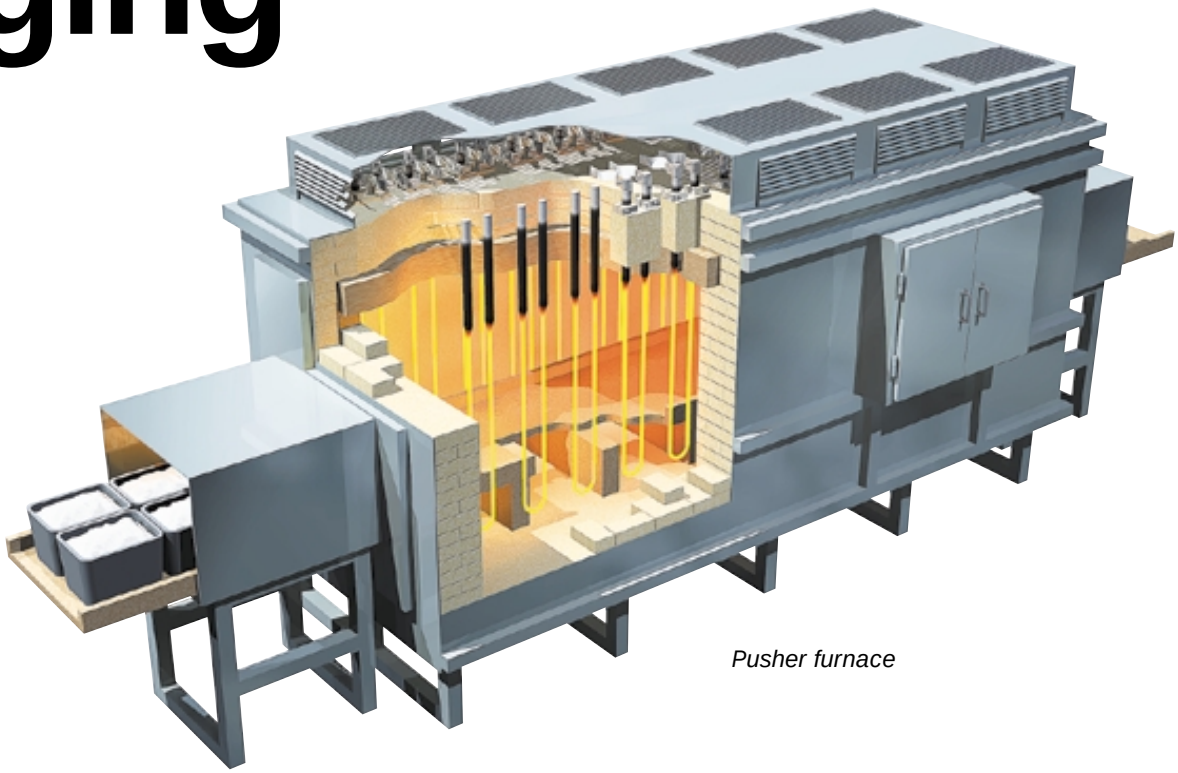
Sealed quench furnace

Forging furnaces

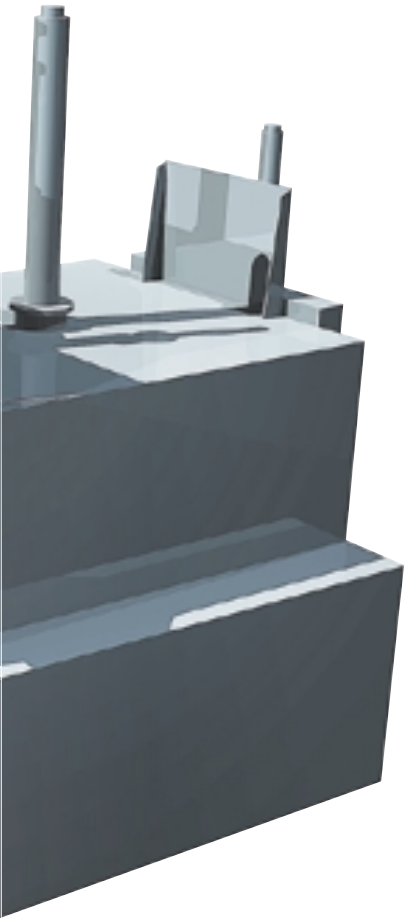
When Kanthal Super was introduced to the market in the early sixties, it was installed in a number of different forging furnaces, and since then a large number of such furnaces have been put into operation.

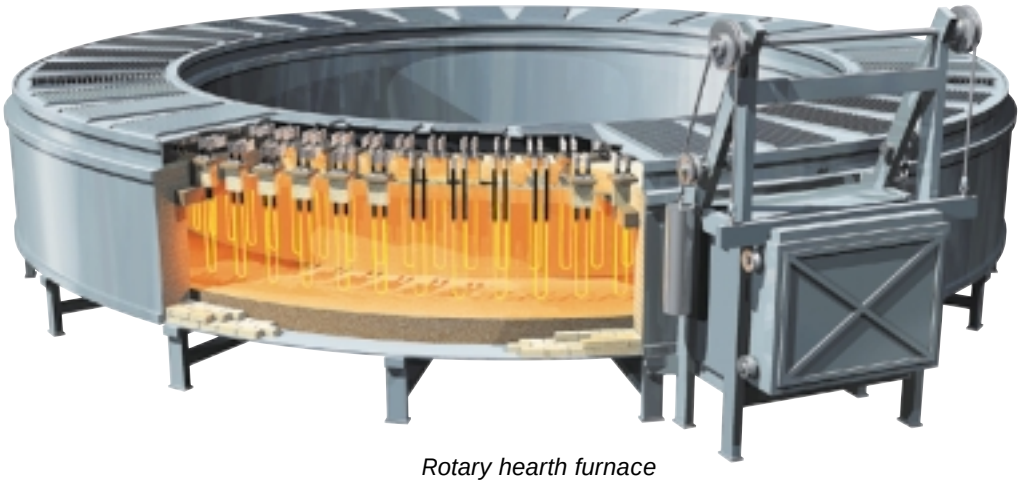
The temperature range of 1150–1300°C is ideal for Kanthal Super and the power needed is easy to obtain by mounting the elements in the roof.

Forging

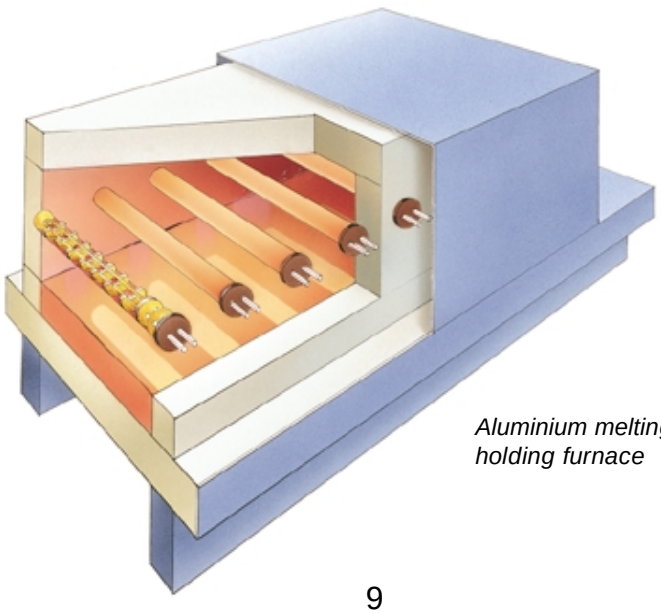


Pusher furnace





Rotary hearth furnace



Aluminium melting and holding furnace

Cera

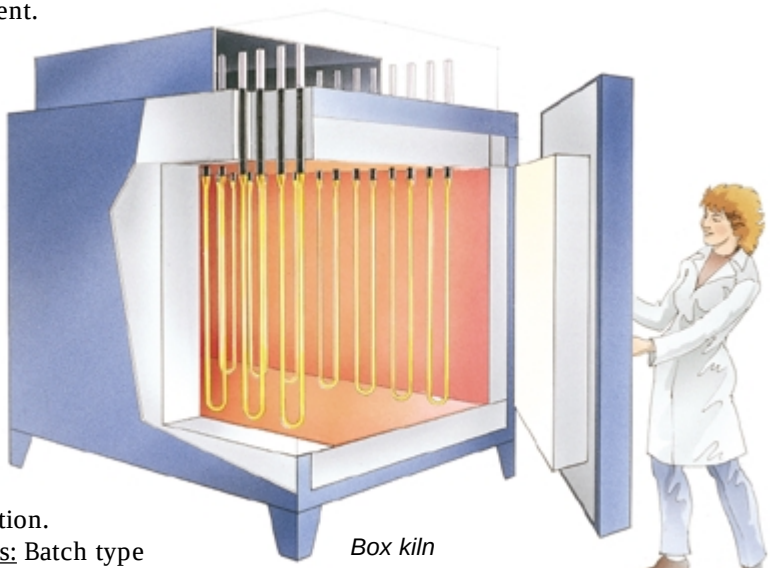
Traditional ceramics

Kanthal Super is used in a number of different kilns in the temperature range 800–1450°C, *1470–2640°F,* e.g. firing porcelain and decoration . . .

Kanthal Super also operates directly in controlled atmosphere kilns, without radiant tubes. The advantages include a completely clean kiln, no dust, no convection phenomena. The kiln may be programmed for extremely diverse operations and products. The atmosphere may be regulated and controlled independently of the heating.

The firing cost is relatively low and automation minimizes the manning requirement.

The net results are economy and a very high product quality.



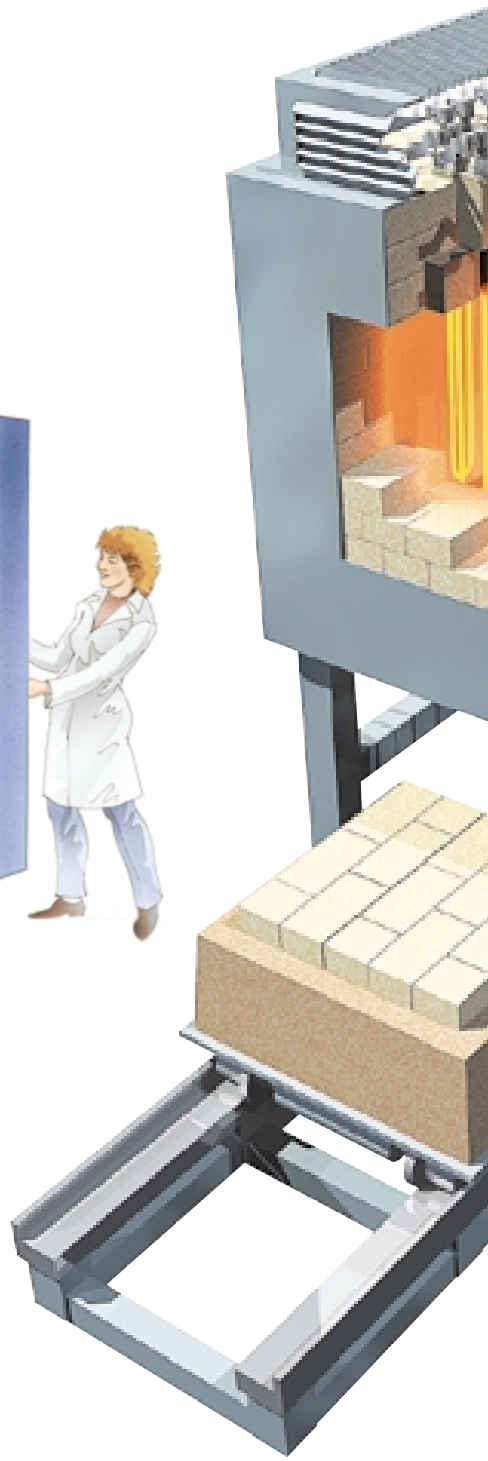
Box kiln

Advanced ceramics

Numerous applications have been found for molybdenum disilicide heating elements in the advanced ceramics industry, ranging from small R & D test furnaces to pilot plant units and large production furnaces for both batch and continuous operation.

Batch type industrial furnaces: Batch type production furnaces can be regarded as a scaling up of R & D furnaces. The furnace types include different types of box production furnaces for use up to 1700°C, *3100°F,* and elevator bottom furnaces; also for use to 1700°C, *3100°F*.

Continuous industrial furnaces: Kanthal Super elements are often used to heat large continuous furnaces, such as those used for firing advanced ceramics and the sintering of ferrites, where control is particularly critical. Large pusher type tunnel furnaces may be heated by horizontally mounted W-shaped elements, or, for the higher temperature range, by standard 2-shank elements installed vertically for free radiation.



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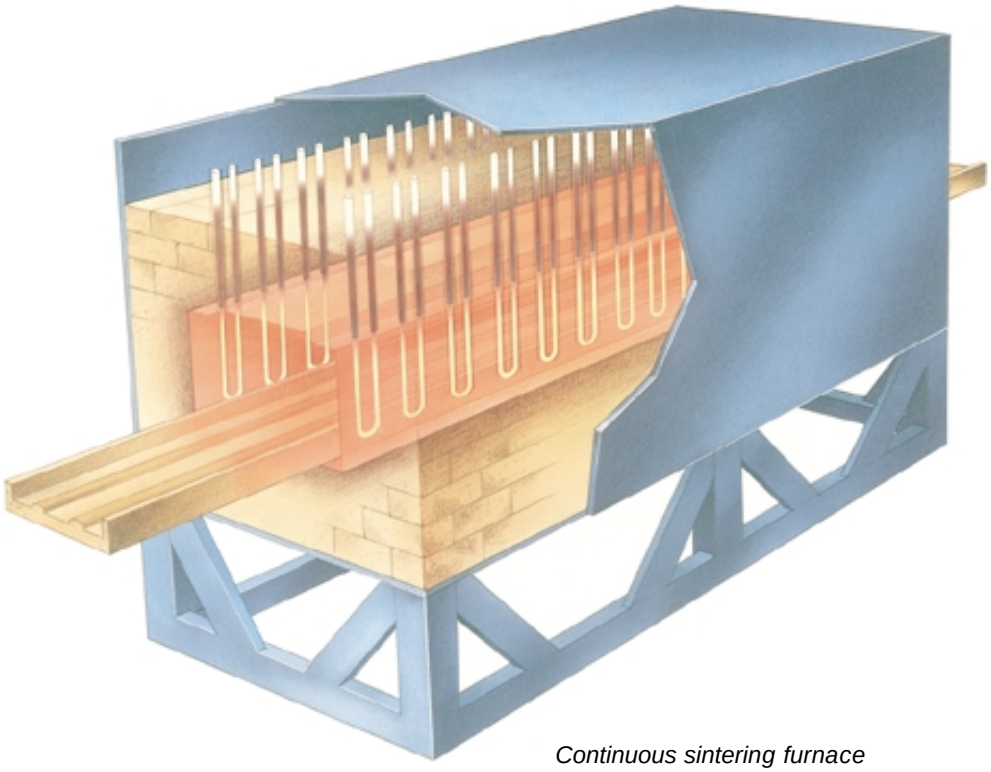
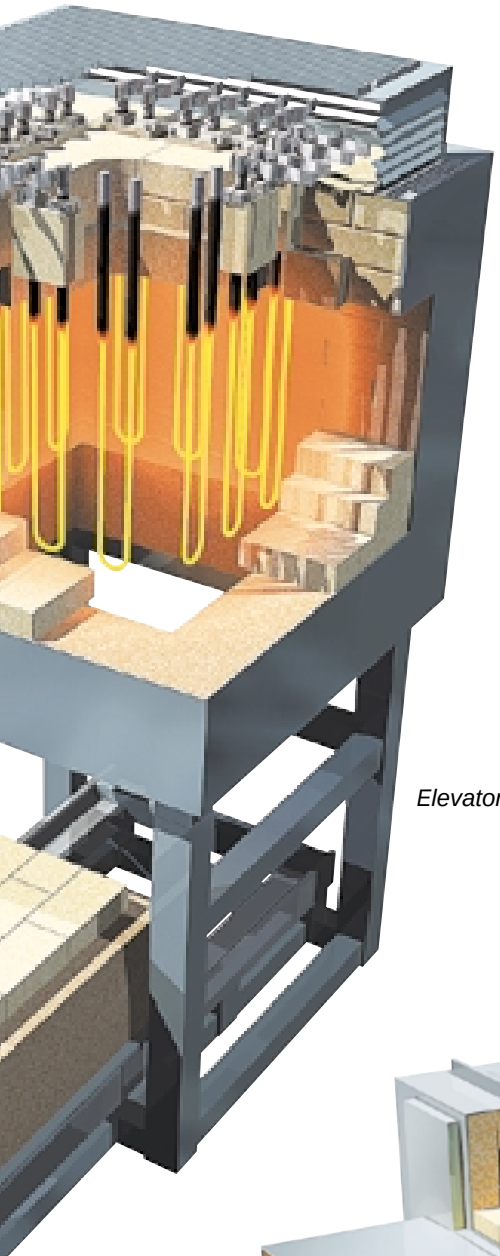
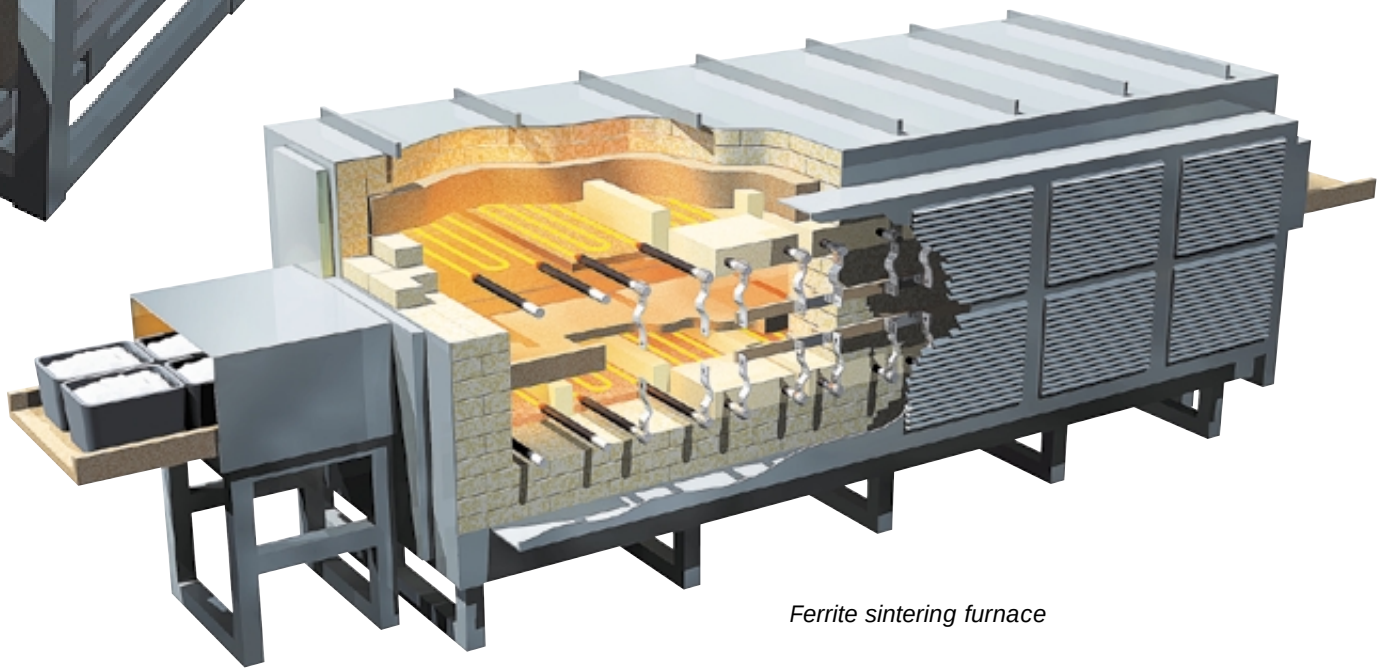


Continuous sintering furnace



Elevator bottom furnace



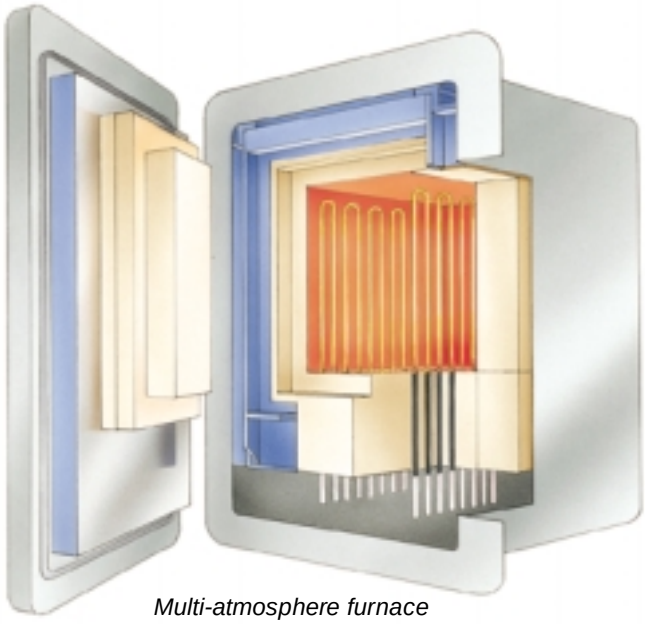
Ferrite sintering furnace

Research &

Because of the intensive development of materials and processes, there is a demand for high temperature Laboratory and Test furnaces having versatility of use and accuracy of control. A chamber furnace, having a ceramic fibre lining and heated by Kanthal Super 1800 or 1900 quality elements, is one of the most common types. Rapid heating to a maximum of 1850°C is possible, and cooling is also fast because of the low thermal mass. It is also possible to design a furnace having a clear space on top, by using elements with bent terminals that pass through the side walls of the furnace.

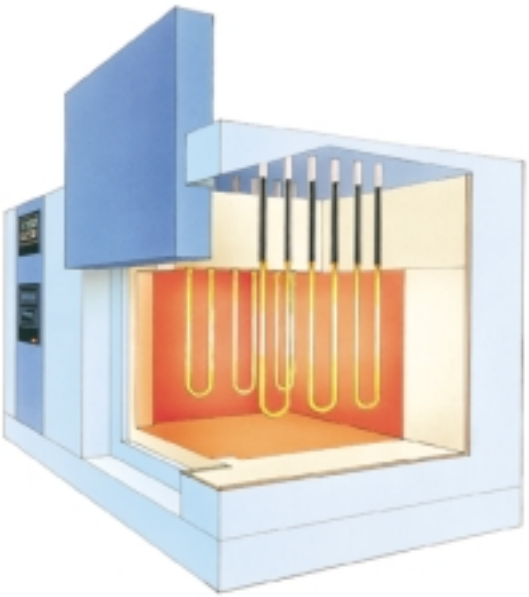
Atmosphere and elevator bottom furnaces are other examples where the Kanthal Super – $MoSi_2$ – elements can be used to advantage.

The Kanthal Superthal heating modules – vacuum formed ceramic fibre shapes with integral Kanthal Super elements – are ideal for a broad range of testing research equipment. The modules may be used as a single unit, in multiples, or in a mixed assembly, to achieve any specific heating pattern required.

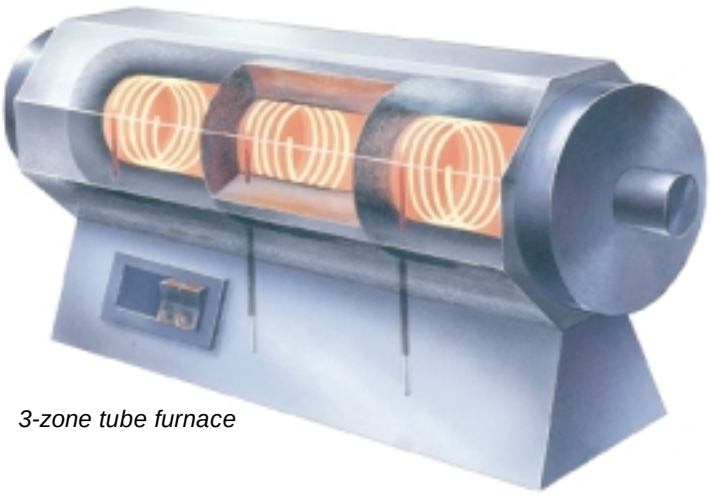


Multi-atmosphere furnace

High temperature melting furnace

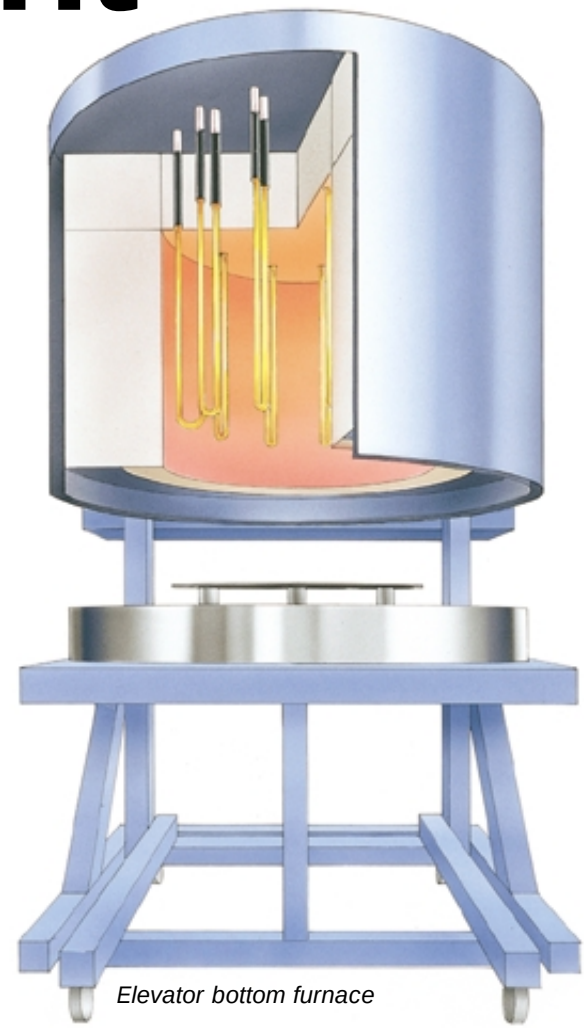


Rapid heating – high temperature furnace



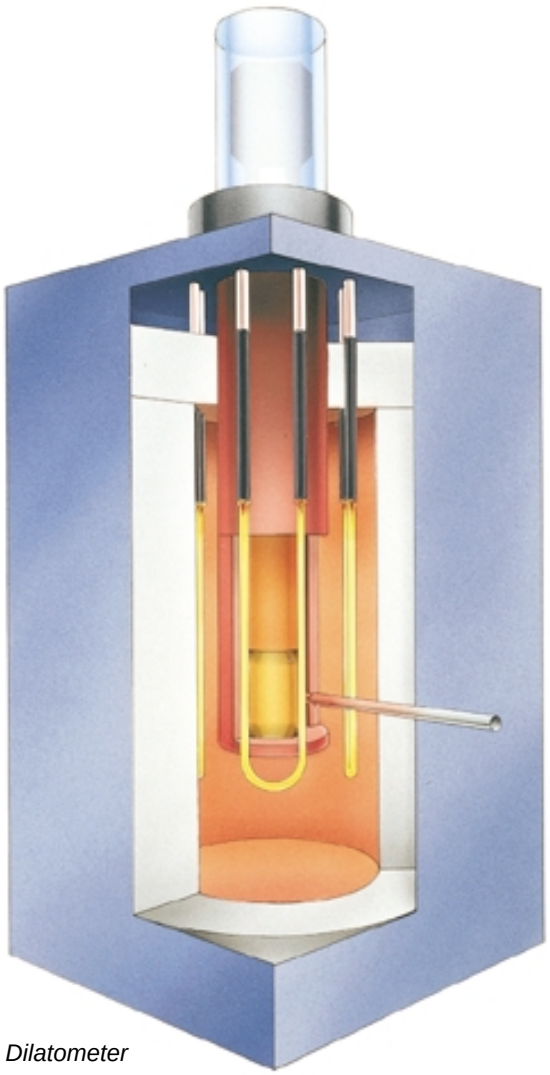
3-zone tube furnace

Development



Material test furnace

Elevator bottom furnace



Dilatometer

Thermal analyser

Technical

Composition

KANTHAL SUPER is a dense cermet material consisting of $MoSi_2$ and an oxide component, mainly a glass phase. KANTHAL SUPER has the ability to withstand oxidation at high temperatures. This is due to the formation of a thin and adhesive protective layer of quartz glass on the surface. When $MoSi_2$ reacts with oxygen in the atmosphere, the layer of quartz glass is formed and under this a thin layer of molybdenum silicide with a lower silicon content Mo_5Si_3.
When KANTHAL SUPER elements are operated at temperatures around 1200 °C *(2190 °F)* the material becomes ductile, whilst at lower temperatures the material is more brittle.
The silica layer possesses the capacity to clean itself from adhering impurities. If the impurities react with silica, the melting point will be lowered. The contaminated layer then flows down the element and drops off. A new silica layer is, however, spontaneously rebuilt.

The unique properties of Kanthal Super elements

- The elements may be used in an oxidizing atmosphere up to an element temperature of 1850°C, *3360°F.*
- Long life combined with ease of replacing failed elements contributes to a high degree of utilization of the furnace and low maintanance costs.
- New and old elements can be series connected.
- High power densities may be applied.
- The elements can be used continuously or intermittently.

Quality and product summary

Type of element	Max. element temperature in air	General applications
Kanthal Super 1700	1700°C (3090°F)	Most types of industrial furnaces for heat treatment, forging, sintering, glass melting and refining and for use in radiant tubes.
Kanthal Super 1800	1800°C (3270°F)	Laboratory furnaces, testing equipment and high temperature sintering production furnaces.
Kanthal Super 1900	1850°C (3360°f)	Laboratory furnaces, testing equipment and high temperature sintering furnaces.
Superthal SMU/SHC	1600°C (2910°F) 1650°C (3000°F) Kanthal Super Excel	Laboratory furnaces, testing equipment, tube furnaces, diffusion furnaces and glass feeders.

Data

Maximum element temperature

Kanthal Super can be used in most furnace atmospheres. Most favourable are oxidizing atmospheres such as air, carbon dioxide and water vapour, but Kanthal Super elements are also operating successfully in neutral, reducing and carburizing atmospheres.

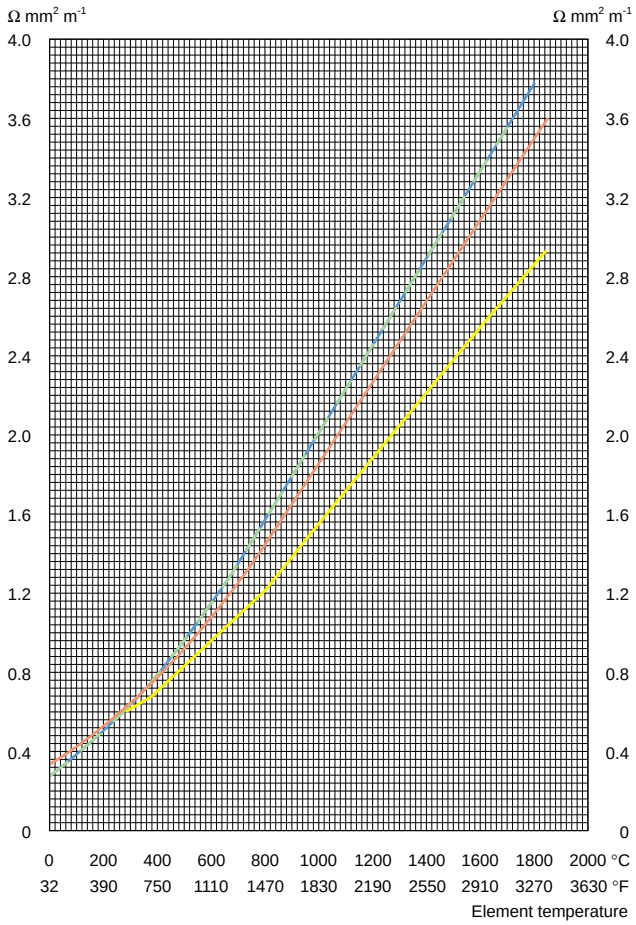
Maximum recommended element temperatures in atmospheres.

KANTHAL SUPER element	1700		1800		1900	
Atmosphere	**°C**	**° F**	**°C**	**°F**	**°C**	**°F**
Air	1700	3090	1800	3270	1850	3360
Nitrogen	1600	2910	1700	3090	1800	3270
Argon, Helium	1600	2910	1700	3090	1800	3270
Dry hydrogen, dewpoint -80 °C *(-112 °F)*	1150	2100	1150	2100	1150	2100
Moist hydrogen, dewpoint 20 °C *(68 °F)*	1450	2640	1450	2640	1450	2640
Endogas (Ex. 40% N_2, 40% H_2, 20% CO)	1400	2550	1450	2640	1450	2640
Cracked and partially burnt ammonia	1400	2550	1400	2550	1400	2550

Resistivity

The resistivity of Kanthal Super material increases sharply with temperature, making it necessary to use some form of voltage control to limit the current drawn at low temperatures. A current-limiting thyristor may be used in conjunction with a step-down transformer, but this must be rated at a high enough output to allow the furnace to heat up from cold. Because the power dissipated by an element increases as its emperature falls, the fime for a furnace to regain temperature is reduced, and conversely as the element heats, there is a reduced risk of the furnace over-heating, as the power falls.

As Kanthal Super elements do not increase in resistance with use, there is no need for a voltage reserve, and should one fail it may be replaced without affecting the others in circuit.



Resistivity of KANTHAL SUPER 1700 (green), 1800 (blue), 1900 (red) and Excel (yellow).

Furnace wall loading

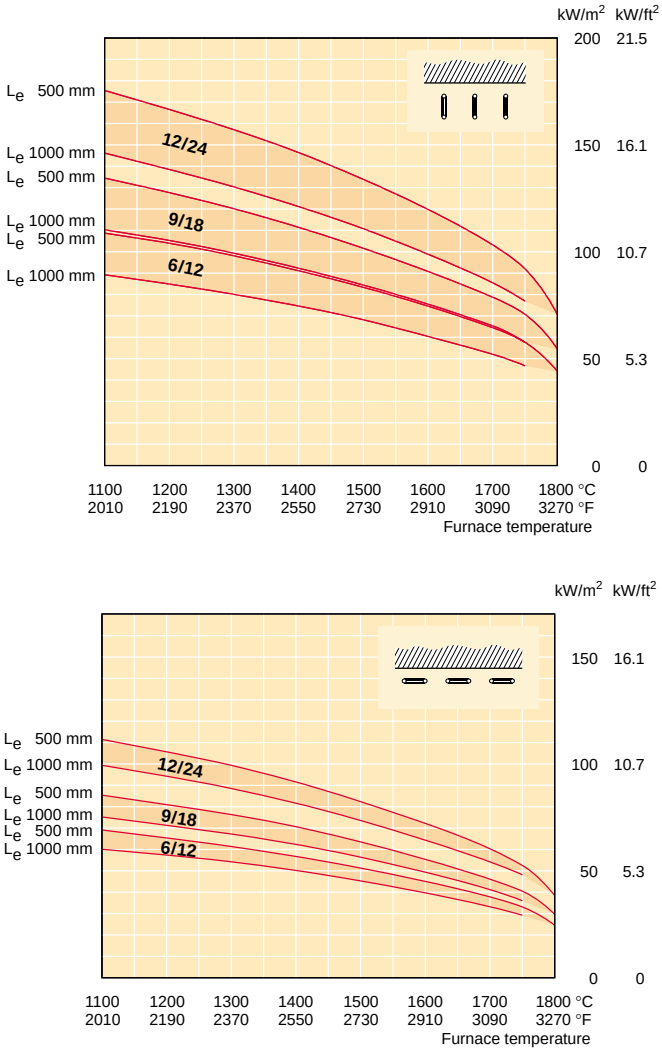
Because Kanthal Super elements may be operated at very high temperatures, it is possible to design furnaces having a higher power dissipation per unit area of the wall, than for one fitted with metallic elements. As a result, heating up times can be reduced, with a consequential increase in production rates. The wall loading that can be attained is dependant on whether the elements are mounted parallel, or at right-angles to the wall, see Fig. 3.

Element surface loading

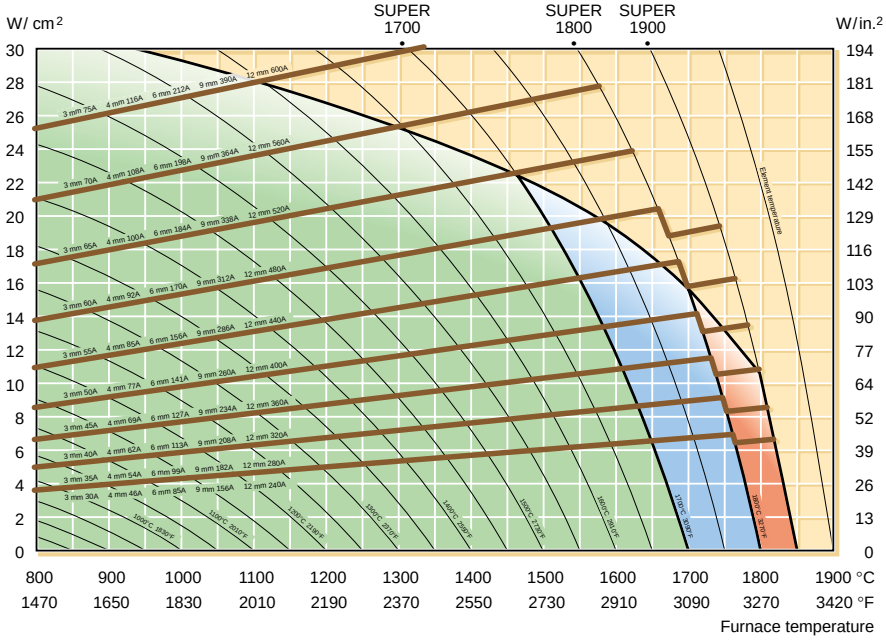
Compared with conventional electric elements a very high surface load may be applied to Kanthal Super elements. This is due partly to the high permissible temperature and partly to the mode of installation which permits free radiation from the element.

The ability to apply a very high load to the elements together with a minimum space requirement enables the furnace designer to apply high power concentrations when necessary.

When designing a furnace using elements at very high surface loadings, that is, when very high currents are drawn, care must be taken in the specifications of the material and length of the passage bricks, as these affect the operating temperature of the terminals. The advice of Kanthal should be sought regarding this, and the design of suiable contacts.



Maximum recommended wall loading as a function of the furnace temperature for different element diameters and mode of installation.



Maximum recommended surface loads for Kanthal Super 1700, 1800 (blue) and 1900 (red). An example how to use above graph: At a furnace temperature of 1300°C, 2370°F, and a surface load of 17,5 W/cm², 113 W/in² the element temperature becomes 1515°C, 2760°F, with a current of 170A for 6 mm and 312A for 9 mm diameter.

Product Range

2-shank elements

The moust commonly used element is the 2-shank design, in which the two ends of the heating zone are welded to terminals having twice the diameter of the heating zone material.

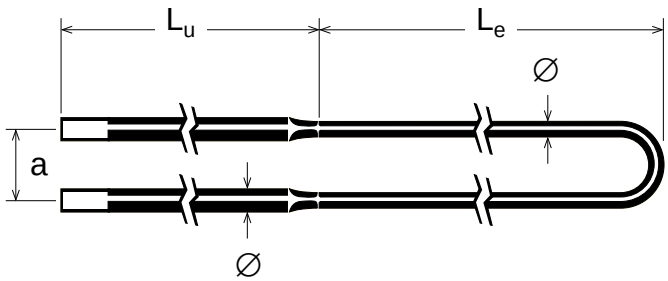
Range of KANTHAL SUPER two-shank elements.

Qualities			Standard dimensions	
1700	1800	1900	Heating zone, L_e ø mm	Terminal, L_u ø mm
	X	X	3	6
	X	X	4	9
X	X	X	6	12
X	X	X	9	18
X	X		12	24

2-shank elements with straight terminals are specified by:

- Material quality
- Heating zone diameter, mm *in*
- Terminal diameter, mm *in*
- Heating zone length, L_E, mm *in*
- Terminal length, L_U, mm in
- Distance between shank centres, a, mm *in*

Exemple: Kanthal Super 1700, 9/118,
L_E=560 mm 22 in, L_U=450 mm 17.7 *in*
a=60 mm 2.36 *in*



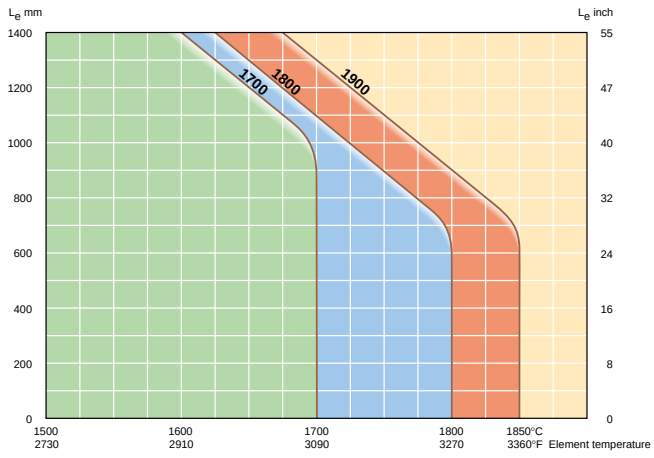
To facilitate the installation and replacement of elements, an assembly has been developed that consists of a special passage brick, an element holder and an anchor system. Special assemblies are available for the air cooling of the terminals, and gas-tight installations.

2-shank element with a standard passage brick, element holder, anchor system and contact clamps.

The operating temperature of the element determines the recommended maximum length of the hot zone – see Fig. 6, which shows the maximum lengths recommended for vertically mounted 6/12 & 9/18 elements of the three material qualities.

The minimum heating lengths possible are for:

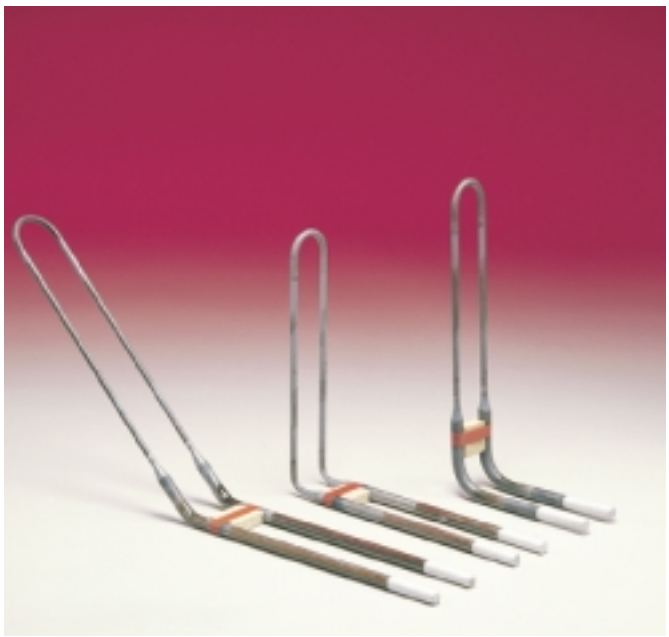
3/6	50 mm	2 *in*
6/12	125 mm	5 *in*
9/18	125 mm	5 *in*
12/24	125 mm	5 *in*



Maximum recommended heating zone lengths for vertically suspended 6/12 & 9/18 elements.
Blue: Kanthal Super 1700; Red: Kanthal Super 1800; Black: Kanthal Super 1900.

2-shank bent elements

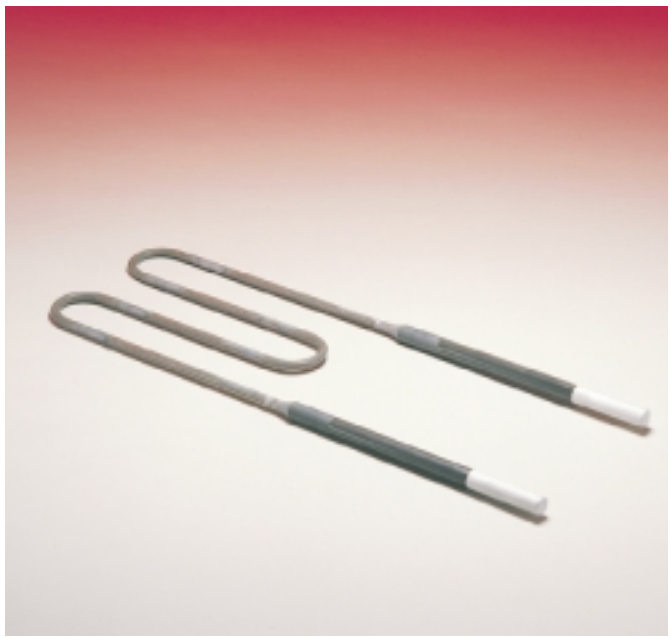
Elements that are bent at 30°, 45° or 90° are particularly useful when there is insufficient room for terminal connections above the furnace, or the height of the furnace is too great to permit the installation of only one element to cover the full heated height required. By installing several layers of bent elements it is also possible to arrange for different zones at different levels. Because the terminals will be in contact with, and supported by brick or fibre, the maximum furnace temperature is limited to 1600°C, *2910°F.*



2-shank bent elements 45° and 90°.

4-shank elements

In cases where the furnace roof is particularly low, the use of horizontally mounted elements is a solution. A typical example is the use of this method of mounting elements in ferrite furnaces, where the 4-shank element – see Fig. 8 – is commonly used. The 4-shank element is more economical than a 2-shank one, as fewer elements are required per unit length of chamber, and there are half the number of terminals from which heat is lost. When mounted horizontally, the temperature of Kanthal Super elements must not exceed 1600°C, *2190°F.*



4-shank element for horizontal use.

Superthal heating modules

The heating modules are made up of vacuum formed ceramic fibre shapes, with an integral Kanthal Super heating element.

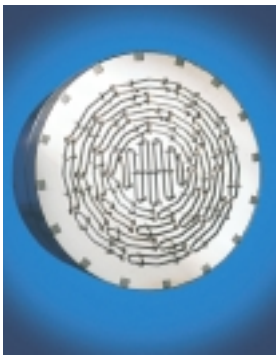
The standard range includes muffles, halfcylinders and flat panels. Single wafer reactors and infrared radiators are also available as special products.

The heating element is made from conventional Kanthal Super 1800 material. The elements have a proven long life even when working at high power density with fast heating and cooling cycles. Modules are capable of operating continuously up to a maximum of 1600°C, *2900°F,* in air.

Superthat heating modules, half cylinder and muffle.

(SFP)

(SWR)



(SIR)

SUPERTHAL Infrared Radiators (SIR)

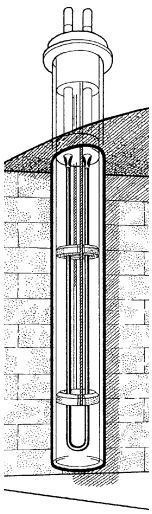
Multi shank elements of 3 or 4 mm KANTHAL SUPER 1800 material mounted in ceramic fibre boxes, freely radiating, are mainly used for drying purposes. The element temperature is in the range of 1550 °C (2820 °F), corresponding to a peak energy wavelength of about 1.5 µm. The inner surface of the ceramic fibre box normally has a temperature of 1100 °C (2010 °F), corresponding to a peak energy wavelength of about 2.2 µm. The maximum power concentration is about 240 kW/m².

SUPERTHAL Flat Panels (SFP)

Multi shank elements are fitted to flat ceramic fibre panels for horizontal installation. They are capable of operating continuously up to a maximum of 1600 °C (2900 °F) element temperature, in air. Typical applications include glass feeders, continuous sintering furnaces and continuous case hardening of steel.

SUPERTHAL Single Wafer Reactors (SWR)

Multi shank and flat coil elements are fitted to circular flat ceramic fibre panels for horizontal or vertical installation. The power is controlled radially, in order to attain even temperature. They are capable of operating continuously up to a maximum of 1600 °C (2900 °F) element temperature, in air. Typical application is development of prototypes and processing of Silicon Wafers, where accurate temperature profiles, fast heat-up/cooling cycles, and high temperature capabilities are desirable parameters.



Extruded tube assemblies

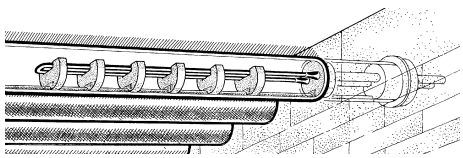
In continuous furnaces, such as roller hearth, pusher, and mesh-belt conveyor types, where the internal height of the chamber is small, or the atmosphere has a high carbon potential or other detrimental components, the Kanthal Super elements may be supported in, and protected by, sealed tubes. This arrangement is commonly used where the requirements are for high power outputs and long element life.

A number of furnaces converted from fossil fuel heating, to the use of Kanthal Super elements giving a high power output, have shown much lower maintenance costs.

The most common radiant tube materials are the nickel-chromium based alloys. A much improved material for extruded radiant tubes that have an excellent form stability at temperatures up to 1250°C, *2300°F,* has been developed by Kanthal.

One element per tube is used. The standard units are 146 mm dia tube for 9/18, 12/24 and 6/12 elements.

Vertical and horizontal assemblies.



Tube diameter mm outside	Element size* mm	Power/m kW/m	Current amps (typical)
146	12/24	13–16 a = 60	540
146	9/18 a = 60	10–12	350
146	6/12 a = 40	7–8	190

** Typical element length: 1500–2000 mm, for horizontal use.*

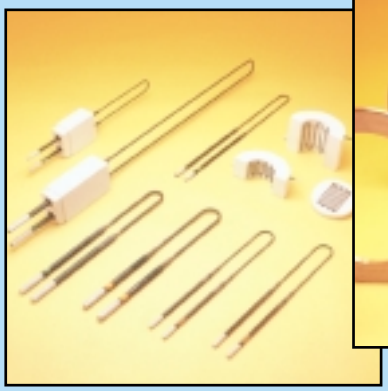
Systems and Services

Our broad range of resistance materials, finished elements, radiant tubes, construction material and other components cover almost any application up to 2000°C. You can get all your requirements from one supplier, as well as qualified technical advice.

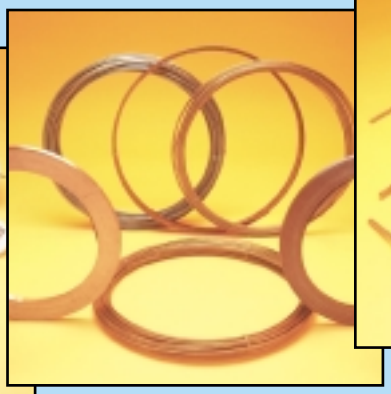
We can also supply complete heating systems e.g. radiant tubes with integrated heating elements or inner tubes for gas heating, Fibrothal and Superthal heating units, Porcupine air heaters, Fibrothal complete systems for renovation of furnaces etc. A complete system saves time and resources.

We can assist you

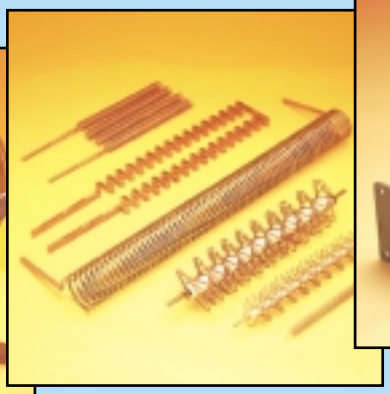
- in choosing suitable element material, element type, support systems and insulation
- with the design and calculation of the elements and heating system
- by supplying complete heating elements or heating systems ready for installation
- with the upgrading of old furnaces or the conversion of gas/oil heated furnaces to electricity



Kanthal Super, Superthal®
Complete element assemblies and heating modules for max. element temperature 1850°C, *3360°F.*

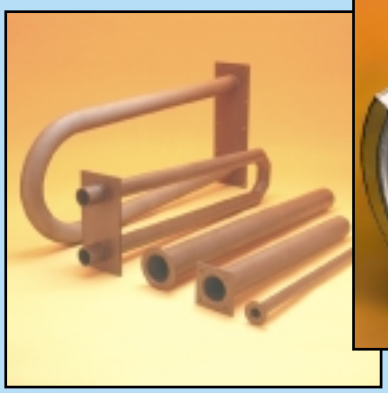


Wire and Strip
KANTHAL and NIKROTHAL® highest quality material for max. element temp. 1425°C, *2590°F.*

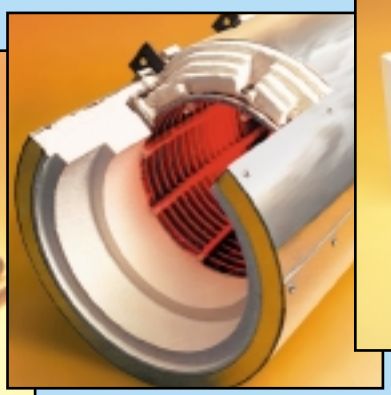


Metallic Elements
Ready-made metallic elements manufactured by Kanthal workshops.

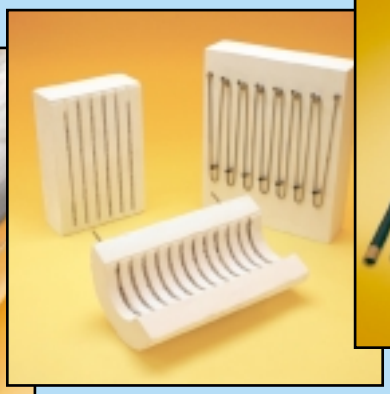
Tubothal®
Long-life elements for all types of radiant tubes, ideally KANTHAL APM, up to 1300°C, *2370°F,* furnace tmeperature.



Extruded Tubes
Kanthal extruded radiant tubes for gas or electriceally heating furnaces.



Heating elements
Elements and systems for diffution furnaces in the semiconductor industry.



FIBROTHAL®
A complete modular building system for heating and insulation.

Silicon Carbide
Hot Rod, Crusilite, Globar, Silit and multileg silicon carbide heating elements for furnace temp between 700 and 1650°C, *1290 and 3000°F.*

Cover photo: Kanthal Super elements in a 1700°C furnace designed and insulated by Zircar® Products Inc.

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