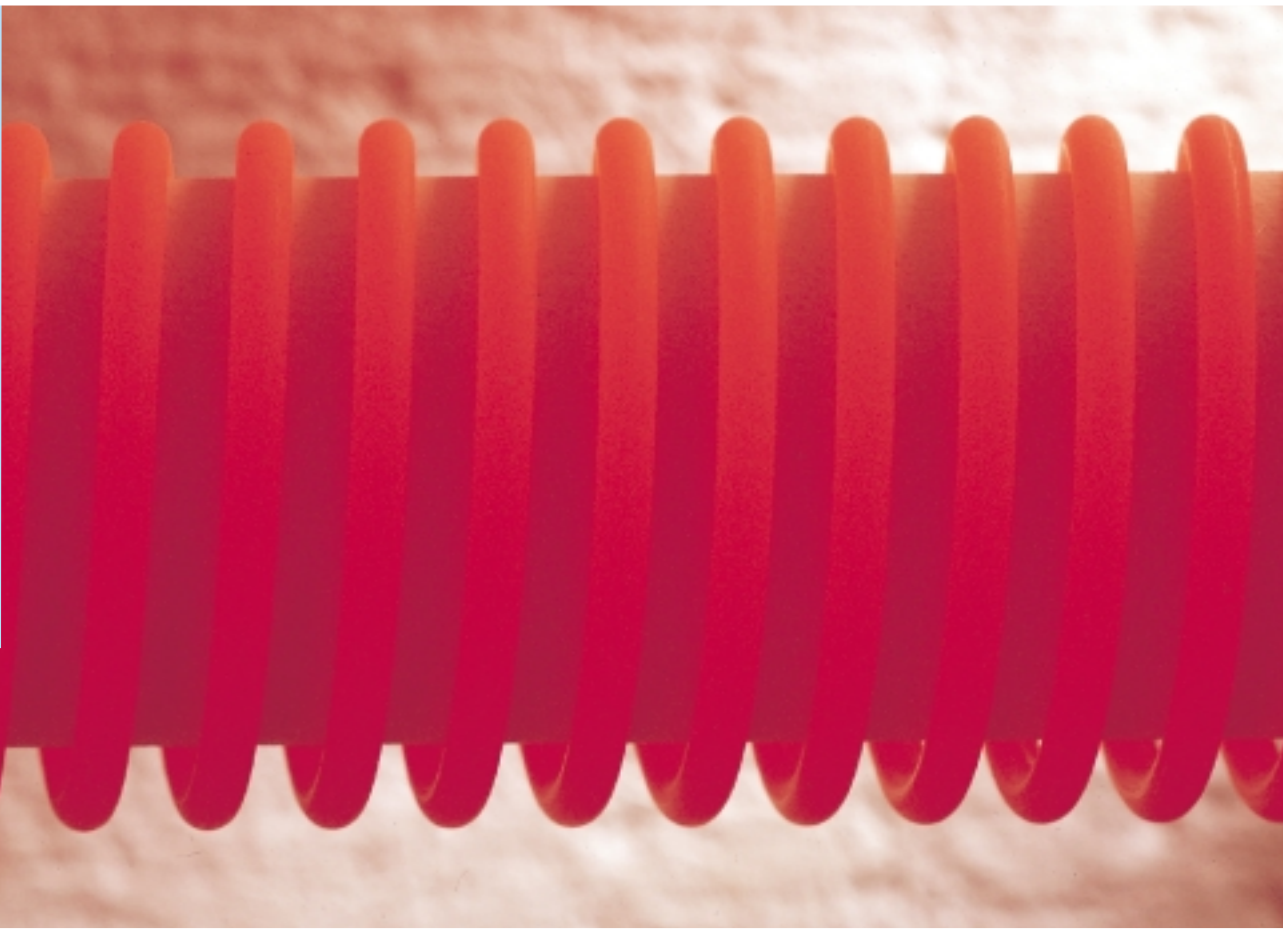
KANTHAL®
HANDBOOK

Resistance Heating Alloys and Systems for Industrial Furnaces



KANTHAL®

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KANTHAL HANDBOOK

Resistance Heating Alloys and Systems for Industrial Furnaces

Metallic heating elements from Kanthal

This booklet contains technical data for our resistance heating alloys KANTHAL and NIKROTHAL.

We also include some instructions for the calculation and design of heating elements for industrial furnaces as well as examples of support systems and insulation. The APM tubes are described shortly. For more information, ask for the special Tube Handbook.

The latest product- and application information is found on **www.kanthal.com.**

We can assist you:

– in choosing suitable element material, element type, support system and insulation,
– by supplying complete heating elements ready for installation,
– to upgrade electric furnaces to latest heating technology for maximum output and economy
– to replace radiant tubes with Kanthal APM tubes in both gas- and electrically heated furnaces and to supply complete recuperative systems (SER).

Our modern workshops have developed considerable experience in manufacturing heating elements and can manufacture to any specifications.

Our delivery times are short and our service objectives are high.

KANTHAL or NIKROTHAL?

There are two main types of electric resistance alloys. Nickel-chromium (e.g. 80 Ni, 20 Cr) was developed around the turn of the century and was soon used as heating element material in industrial furnaces as well as in electric household appliances.

In the thirties Kanthal introduced a new resistance heating alloy based on iron-chromium-aluminium with a longer life and a higher maximum operating temperature than nickel-chromium.

The two main types of alloys have their own specific properties, with advantages and disadvantages, and are supplied in many different grades and forms. Kanthal manufactures both types of alloys under the names NIKROTHAL (nickel-chromium) and KANTHAL (iron-chromium-aluminium).

In general KANTHAL is superior to NIKROTHAL in respect of performance and life and is therefore nowadays a standard material choice when it comes to metallic heating elements for industrial furnaces. The most important advantages are:

- Higher maximum element temperature of 1425°C *2600°F* compared to 1250°C *2280°F*
- Longer life (2–4 times)
- Higher surface load
- Higher resistivity
- Lower density
- No spalling oxide, which may contaminate the goods and the furnace and also cause short circuit or failure of elements and gas burners.

For the furnace user, using KANTHAL results in less material at a lower price and also – a longer life. Table 1 shows an example of weight saving – and lower cost – obtained by using KANTHAL instead of nickel-chromium alloys. This lower element weight will also result in considerable cost savings in the support system, because fewer suspension hooks are necessary.

The NIKROTHAL alloy may have special advantages if you need a heating element having very good mechanical properties in the hot state. KANTHAL APM has, however, creep strength at elevated temperatures in the same level as NiCr 80/20.

Table 1. A 120 kW furnace equipped with R.O.B. elements. 3 elements of 40 kW each, 380 V.

Element Data	**NiCr 80/20**		**KANTHAL AF**	
Furnace temperature, °C *°F*	1000	*1830*	1000	*1830*
Element temperature, °C *°F*	1068	*1955*	1106	*2025*
Hot resistance, R_w	3.61		3.61	
Temperature factor, C_t	1.05		1.06	
Cold resistance, R_{20}	3.44		3.41	
Wire diameter, mm *in*	**5.5**	***0.217***	**5.5**	***0.217***
Surface load, W/cm² *W/in²*	3.09	*19.9*	3.98	*25.7*
Wire length, m, *ft* 3 elements	224.9	*738*	174.6	*573*
Wire weight, kg, *lb* 3 elements	**44.4**	***98***	**29.6**	***65***

Weight saving: $\frac{44.4—29.6}{44.4} = 33\%$ $\frac{98—65}{98} = 33\%$

Kanthal APM heating material

Kanthal APM is a resistance material which can be used to improve the performance at high temperatures, where conventional metallic elements can cause problems (e.g. bunching, creeping, oxide spalling) and to open up new applications where metallic elements are not used today.

The great advantages of Kanthal APM are:

Improved hot strength, giving:

- much better form stability of the heating element
- less need for element support
- low resistance change (ageing)
- longer element life

Excellent oxide, giving:

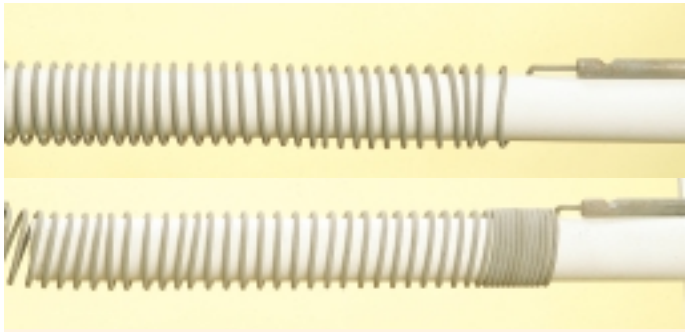
- good protection in most atmospheres, especially corrosive atmospheres
- no scaling and impurities
- a longer element life

Creep rupture strength

	Temperature	
Time (h)	1000°C	*1832°F*
	MPa	*psi*
100	5.6	*812*
1000	3.4	*478*
10000	2.2	*320*

	Temperature	
Time (h)	1200°C	*2192°F*
	MPa	*psi*
100	3.3	*478*
1000	1.6	*232*
10000	0.7	*100*

	Temperature	
Time (h)	1400°C	*2552°F*
	MPa	*psi*
100	1.3	*189*
1000	0.5	*72*
10000	0.2	*30*



Comparison between Kanthal APM (top) and conventional FeCrAl after 1250 h at max 1225°C, *2240°F* element temperature.

Fig. 1 Elongation at 1300°C, *2370°F* element temperature.

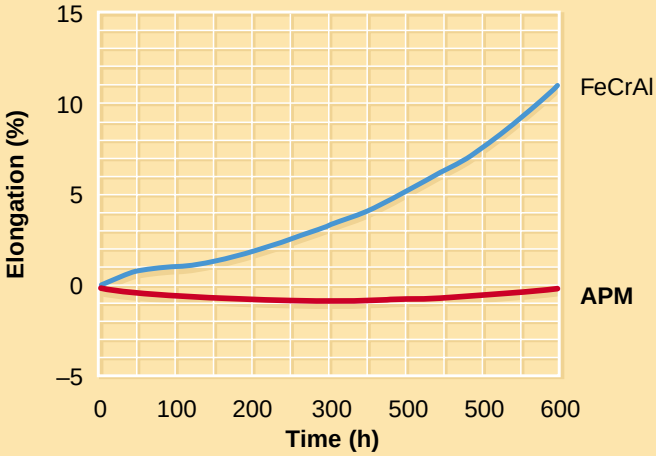
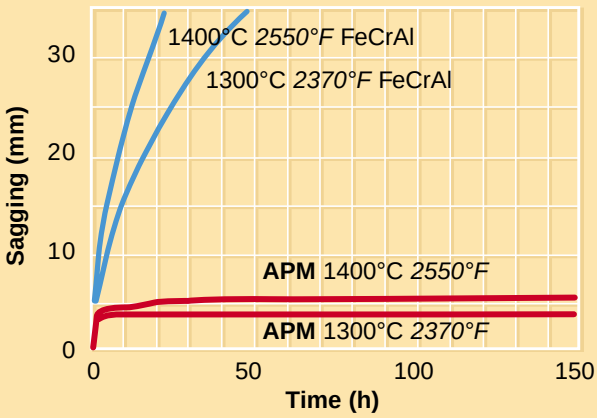


Fig. 2 Sagging test dia. 9.5 mm, 1300°C, *2370°F* and 1400°C, *2550°F*, 300 mm between supports.



Physical and Mechanical Properties

KANTHAL and NIKROTHAL alloys are generally available in wire or strip form. Physical and mechanical properties of the alloys are listed in Table 2.

Table 2. KANTHAL and NIKROTHAL, Wire and Strip.

	KANTHAL APM	KANTHAL A-1	KANTHAL AF	KANTHAL D	NIKROTHAL 80	NIKROTHAL 70	NIKROTHAL 60	NIKROTHAL 40
Max continuous operating temp., °C	1425	1400	1300	1300	1200	1250	1150	1100
°F	*2600*	*2550*	*2370*	*2370*	*2190*	*2280*	*2100*	*2010*
Nominal composition, % Cr	22	22	22	22	20	30	15	20
Al	5.8	5.8	5.3	4.8	–	–	–	–
Fe	Rest	Rest	Rest	Rest				
Ni	–	–	–	–	80	70	60	35
Resistivity at 20°C, $\Omega mm^2 m^{-1}$	1.45	1.45	1.39	1.35	1.09	1.18	1.11	1.04
at 68°F, Ω/cmf	*872*	*872*	*836*	*812*	*655*	*704*	*668*	*626*
Density, g/cm^3	7.10	7.10	7.15	7.25	8.3	8.1	8.2	7.9
lb/in^3	0.256	0.256	0.259	0.262	0.300	0.296	0.296	0.285
Coefficient of thermal expansion, K^{-1}								
20-750°C, *68–1380°F*	*14.10^{-6}*	*14.10^{-6}*	*14.10^{-6}*	*14.10^{-6}*	*17.10^{-6}*	*16.10^{-6}*	*16.10^{-6}*	*18.10^{-6}*
20-1000°C, *68–1838°F*	*15.10^{-6}*	*15.10^{-6}*	*15.10^{-6}*	*15.10^{-6}*	*18.10^{-6}*	*17.10^{-6}*	*17.10^{-6}*	*19.10^{-6}*
Thermal conductivity at 20°C								
W m^{-1} K^{-1}	13	13	13	13	15	13	13	13
68°F, Btu in ft^{-2} h^{-1} $°F^{-1}$	*90*	*90*	*90*	*90*	*104*	*90*	*90*	*90*
Specific heat capacity								
KJ kg^{-1} K^{-1}, 20°C	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.50
Btu lb^{-1} $°F^{-1}$, 68°F	*0.110*	*0.110*	*0.110*	*0.110*	*0.110*	*0.110*	*0.110*	*0.119*
Melting point, °C	1500	1500	1500	1500	1400	1380	1390	1390
°F	*2730*	*2730*	*2730*	*2730*	*2550*	*2515*	*2535*	*2535*
Mechanical properties (approx.)*								
Tensile strength, N mm^{-2}	680	680	680	680	750	875	750	750
psi	*99000*	*99000*	*99000*	*99000*	*109000*	*127000*	*109000*	*109000*
Yield point, N mm^{-2}	445	445	445	445	450	450	450	450
psi	*65000*	*65000*	*65000*	*65000*	*65000*	*65000*	*65000*	*65000*
Hardness, Hv	230	230	230	230	180	185	180	180
Elongation at rupture, %	19	19	19	19	30	30	30	30
Tensile strength at 900°C, Nmm^{-2}	40	34	37	34	100	120	100	120
1650°F, psi	*5800*	*5000*	*5400*	*5000*	*14500*	*17400*	*14500*	*17400*
Creep strength at 800°C, N mm^{-2}	14	6	8	6	15	15	15	20
1000°C, N mm^{-2}	1.8	1	1.5	1	4	4	4	4
1470°F, psi	*2000*	*870*	*1160*	*870*	*2160*	*2160*	*2160*	*2160*
1830°F, psi	*260*	*145*	*215*	*145*	*580*	*580*	*580*	*580*
Magnetic properties	Magnetic (Curie point 600°C *1100°F*)				Non	Non	Slightly	Non
Emissivity, fully oxidized condition	0.70	0.70	0.70	0.70	0.88	0.88	0.88	0.88

*) The values given apply for sizes of 4 mm, *0.16 in* diameter for the KANTHAL alloys and of 1 mm, *0.04* in for the NIKROTHAL alloys.

Furnace wall loading

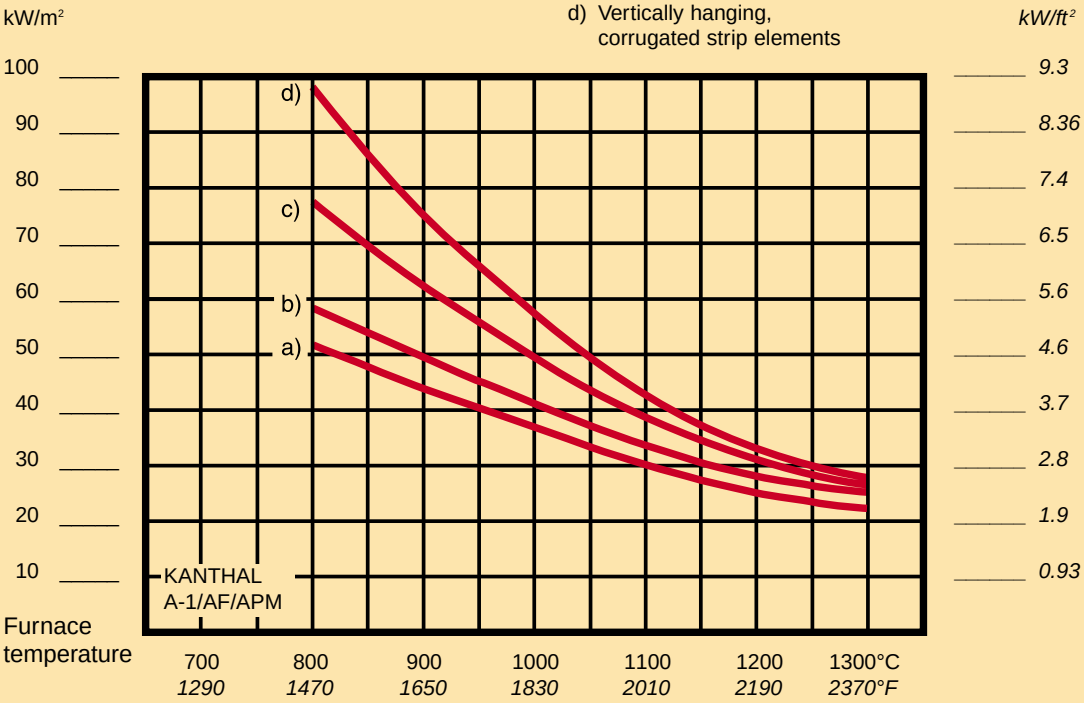
Figure 3 shows the maximum recommended wall loading for four different element types. Please note that the furnace wall loading depends on both element type and element surface load. The lower the surface load, the longer the element life will be. (For description of the element types, see page 7).

When elements are placed on the base of a furnace, special attention must be paid to avoid overheating of the elements. For example, with a hearth plate having a thermal conductivity of (λ)=1.0 Wm^{-1} K^{-1} *6.39 Btu in ft^{-2} h^{-1} $°F^{-1}$* and thickness of 15 mm, *0,63 in*, at a power concentration on the bottom surface of 15 kW/m^2, *1.4 kW/ft^2*, a temperature drop of 225°C, *435°F* is obtained through the plate. The total temperature difference between the base elements and the furnace temperature would thus be about 375°C, *700°F*. This imposes a furnace operating temperature of 1000°C, *1830°F* even using the high-temperature KANTHAL A-1 alloy, since the element temperature will be about 1375°C, *2500°F*.

The example illustrates the significance of choosing a hearth plate of a material having good thermal conductivity, for example silicon carbide or heat-resistant steel. Beside measuring the temperature in the furnace chamber, it may also be advisable to measure the temperature of the base elements by means of a separate thermocouple.

Fig. 3 Maximum recommended wall loading as a function of furnace temperature for different element types.

a) Wire and strip elements in grooves
b) Wire elements on ceramic tubes
c) Vertically hanging, corrugated wire elements
d) Vertically hanging, corrugated strip elements



Element surface load

Since KANTHAL alloys can be operated at higher temperatures than NIKROTHAL alloys, a higher surface loading can be achieved without jeopardizing the life. Element design is also of great importance. The more freely radiating the element form, the higher the maximum surface load. Therefore the R.O.B. (Rod Over Bend) type element (corrugated heavy wire, mounted on the surface), can be loaded the highest, followed by the corrugated strip element.

Spiral elements on ceramic tubes can be loaded higher than spiral elements in grooves.

The values in Fig. 4 are given for the following design conditions:

Element a

Wire and strip element in grooves. Wire diameter min. 3 mm, *0.12 in*, strip thickness min. 2 mm, *0.08 in*.

Element b

Wire element on ceramic tube
Wire diameter min. 3 mm *0.12 in*.

Element types c (strip) and d (heavy wire)

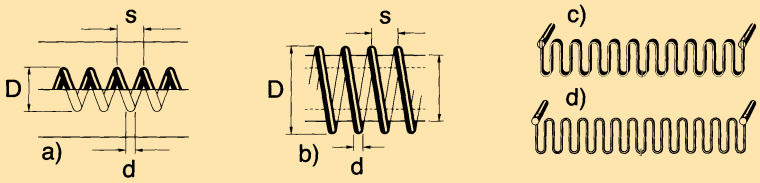
Strip thickness min. 2.5 mm, *0.1 in*. Wire diameter min. 5 mm, *0.2 in*. Pitch min. 50 mm, *2.0 in* at maximum loop length and maximum surface load.

Maximum recommended loop length:

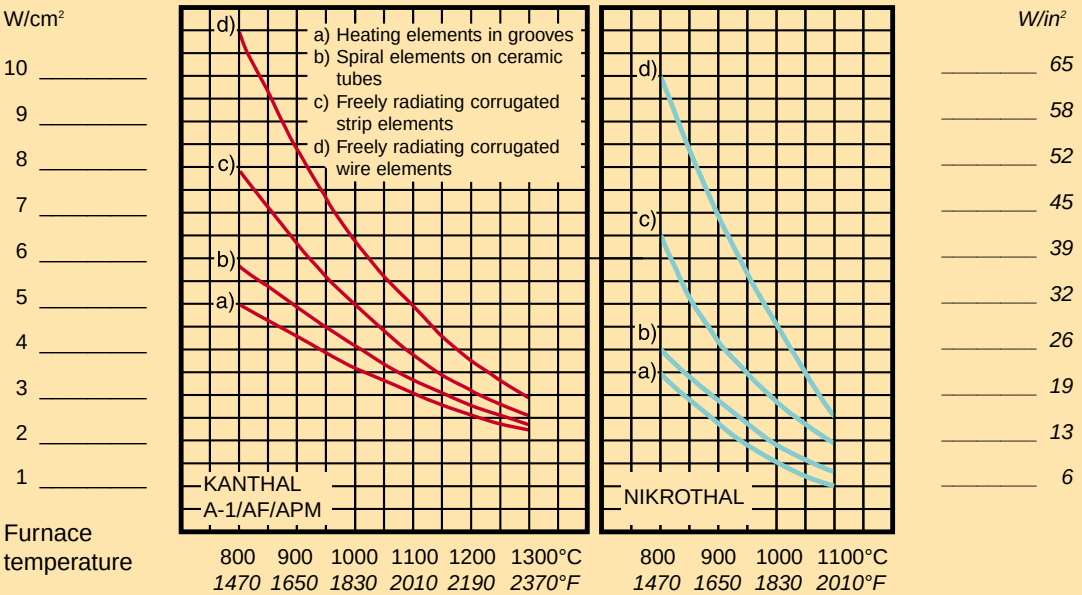
<900°C	*<1650°F*	300 mm	*11.8 in*
1000°C	*1820°F*	250 mm	*9.8 in*
1100°C	*2010°F*	200 mm	*7.9 in*
1200°C	*2190°F*	150 mm	*5.9 in*
1300°C	*2370°F*	100 mm	*3.9 in*

For finer wire diameters and smaller strip thicknesses lower surface loads and shorter loop lengths must be chosen to avoid element deformation and subsequent shorter element life.

Fig. 4 Maximum recommended surface loads for KANTHAL and NIKROTHAL alloys in industrial funaces.



D = (5–8)d s = (2–3)d D = (10–14)d s = (3–6)d



Note: *The diagram is valid for thyristor control. For on-off control lower surface loads should be chosen. (About 20%).*

Operating life and maximum permissible temperature

When heated, resistance heating alloys form an oxide layer on their surface, which prevents further oxidation of the material. To accomplish this function the oxide layer must be dense and resist the diffusion of gases. It must also be thin and adhere to the metal under temperature fluctuations.

In these respects the oxide formed on KANTHAL alloys is superior to that formed on NIKROTHAL alloys, which contributes to the much longer operating life of KANTHAL heating elements. Figure 5 shows the comparative element life.

Below you will find some general advice on how to obtain as long an element life as possible.

Use KANTHAL Alloys

Heating elements made of KANTHAL alloys have 2–4 times longer life than heating elements made of nickel-chromium material. The higher the temperature, the greater the difference.

Avoid temperature fluctuations

The operating life of the heating elements will be reduced by rapid temperature fluctuations. It is therefore advisable to choose an electric control equipment, which gives as even a temperature as possible, e.g. thyristors.

Choose thick element material

The material thickness has a direct relationship to the element life, in that, as the wire diameter is increased, more alloying element is available per surface unit to form a new oxide. Thus, at given temperature, thicker wires will give a longer life than thinner wires. Accordingly, for strip elements, increased thickness gives a longer life.

Adjust the element temperature to the furnace atmosphere

Table 3 shows some common furnace atmospheres and their influence on the maximum operating temperature of the heating elements. NIKROTHAL should not be used in furnaces having a CO-containing protective gas atmosphere due to the risk of ”green rot” at 800–950°C *1470–1740°F*.

In such cases a KANTHAL alloy is recommended, provided the heating elements are pre-oxidized in air at 1050°C *1920°F* for 7–10 hours. Reoxidation of the heating elements should be carried out at regular intervals.

Avoid corrosion from solid substances, fluids and gases

Impurities in the furnace atmosphere, for instance oil, dust, volatiles or carbon deposits can damage the heating elements.

Sulphur is harmful to all nickel alloys. Chlorine in different forms will attack both KANTHAL and NIKROTHAL alloys. Splashes of molten metal or salt may also damage the heating elements.

Fig. 5. Comparative life (KANTHAL A-1 at 1200°C. *2190°F* = 100%

a) KANTHAL APM
b) KANTHAL A-1
c) KANTHAL AF
d) KANTHAL D
e) NIKROTHAL 80
f) NIKROTHAL 60
g) NIKROTHAL 40

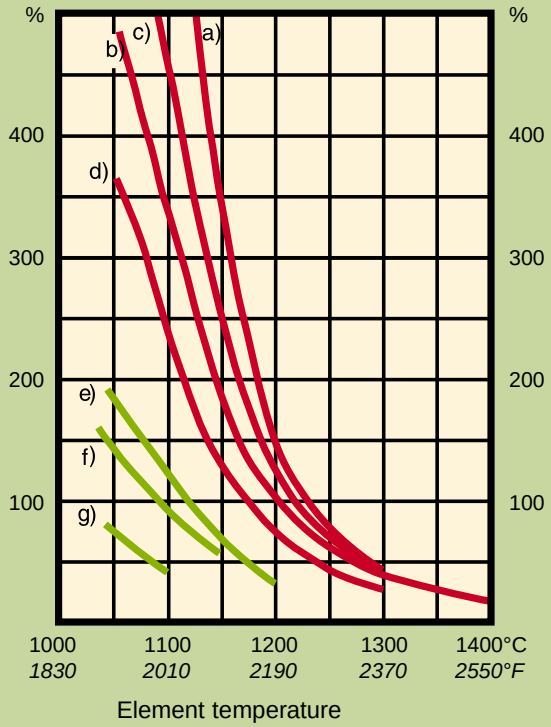


Table 3. Maximum Permissible element Temperatures in various Atmospheres.

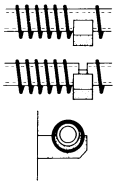
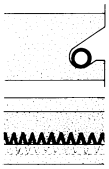
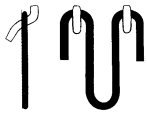
	KANTHAL A-1 and APM		KANTHAL AF		KANTHAL D		NIKROTHAL 80 and 70		NIKROTHAL 60		NIKROTHAL 40	
	°C	*°F*	°C	*°F*	°C	*°F*	°C	*°F*	°C	*°F*	°C	*°F*
Oxidizing:												
Air, dry	1400*	*2550*	1300	*2370*	1300	*2370*	1200****	*2190*	1150	*2100*	1100	*2010*
Air, moist	1200	*2190*	1200	*2190*	1200	*2190*	1150	*2100*	1100	*2010*	1050	*1920*
Neutral:												
N_2, Nitrogen**	1200	*2190*	1200	*2190*	1150	*2100*	1250	*2280*	1200	*2190*	1150	*2100*
Ar, Argon	1400*	*2550*	1300	*2370*	1300	*2370*	1250	*2280*	1200	*2190*	1150	*2100*
Exothermic: 10 CO, 15 H_2 5 CO_2, 70 N_2	1150	*2100*	1150	*2100*	1100	*2010*	1100***	*2010*	1100	*2010*	1100	*2010*
Reducing:												
Endothermic: 20 CO, 40 H_2 40 N_2	1050	*1920*	1050	*1920*	1000	*1830*	1100***	*2010*	1100	*2010*	1100	*2010*
H_2, Hydrogen	1400*	*2550*	1300	*2370*	1300	*2370*	1250	*2280*	1200	*2190*	1150	*2100*
Cracked ammonia: 75 H_2, 25 N_2	–	–	–	–	–	–	1250	*2280*	1200	*2190*	1150	*2100*
Vacuum:												
10^{-3} torr	1150	*2100*	1200	*2190*	1100	*2010*	1000	*1830*	900	*1650*	900	*1650*

*) Max 1425°C, *2600°F*, for APM.
**) The values apply for pre-oxidized material.
***) Please note risk of ”green rot” formation in carburizing atmospheres. Use KANTHAL AF or NIKROTHAL 70.
****) 1250°C, *2280°F*, for NIKROTHAL 70.

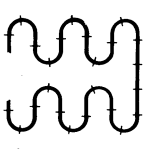
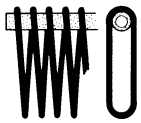
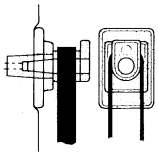
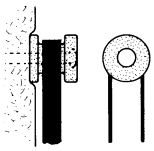
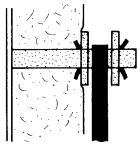
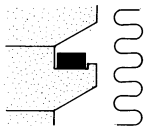
Key Data for Kanthal Elements

Table 4.

Wire Elements

Element systems	**Spiral**	**Spiral**	**Porcupine**	**Rod over Bend**
Supports	Ceramic tubes	Grooves	Ceramic tubes	Metallic rods
				
Material	Sillimanite	Chamotte or Grade 28	Sillimanite	Kanthal APM
Max. furnance temperature, °C *°F*	1300 *2370*	1250 *2280*	800 *1470*	1300 *2370*
Max. wall loading at 1000°C *1830°F* furnace temperature, kW/m² *kW/ft²*	40 *3.7*	35 *3.3*	– –	50 *4.6*
Max. surface load at 1000°C *1830°F* furnace temperature W/cm² *W/in²*	3–4 *19–26*	3–4 *19–26*	– –	5–6 *32–39*
Wire diameter (d), mm *in*	2.0–6,5 *0.08–0.26*	2.0–5.0 *0.08–0.2*	1.0–6.5 *0.04–0.26*	⩾5.0 ⩾*0.2*
Strip thickness (t), mm *in*	– –	– –	– –	– –
Strip widht (w), mm	–	–	–	–
Outer coil diameter (D), mm	(12–14) d	(5–6) d	–	–
Max. loop length at 1000°C *1830°F* furnace temperature, mm *in*	– –	– –	– –	250 *9.8*
Min. pitch at max. loop length, mm *in*	3d	2d	3d	40 *1.6*

Strip Elements

Corrugated	**Looped**	**Deep-Corrugated**	**Deep-Corrugated**	**Deep-Corrugated**	**Corrugated**
Metallic staples	Ceramic tubes	Ceramic cup locks	Ceramic bushes	Ceramic tubes	Grooves
					
U-shaped KANTHAL-nails	Sillimanite	Cordierite Mullite	Cordierite or Mullite	Sillimanite	Chamotte or Grade 28
1300 *2370*	1300 *2370*	1300 *2370*	1300 *2370*	1300 *2370*	1300 *2370*
50 *4.6*	60 *5.6*	60 *5.6*	60 *5.6*	60 *5.6*	20–40 *1.9–3.7*
3–6 19–39	5–6 32–39	5–6 32–39	5–6 32–39	5–6 32–39	3–4 32–39
2,0–5,0 *0.08–0.2*	⩾5,0 *⩾0.2*	– –	– –	– –	– –
– –	– –	2.0–3.0 *0.08–0.12*	2,0–3,0 *0.08–0.12*	2,0–3,0 *0.08–0.12*	1,5–3,0 *0.06–0.12*
–	–	(8–12) t	(8–12) t	(8–12) t	(8–12) t
–	–	–	–	–	–
100 *3.9*	250 *9.8*	250 *9.8*	250 *9.8*	250 *9.8*	(2–3) w
40 *1.6*	40 *1.6*	50 *2.0*	50 *2.0*	50 *2.0*	1.5 w

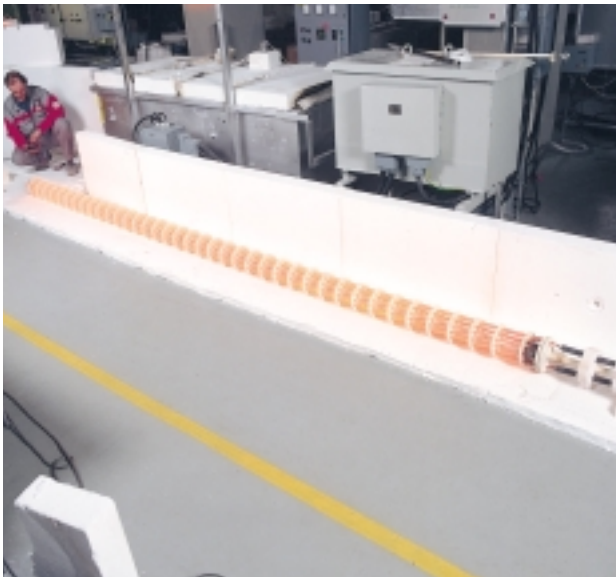
Tubothal® heating element

TUBOTHAL electrical elements when used in radiant tubes have been designed to give a long life whilst operating at maximum power. This has been made possible due to the application of APM wire in combination with an improved element design, developed and tested by Kanthal, with a power rating up to 40 kW per metre *(12.2 kW per ft.)* length. Furthermore the element assembly is low weight, which means that long elements and tubes can be mounted horizontally without any extra support.

Long life

The use of APM wire is the reason for the high performance of TUBOTHAL elements. The life at 1000°C *1830°F* furnance temperature is more than double that of NiCr wire.

Another major advantage of the Tubothal system is the possibility to adjust the element to existing power supply. Typically no transformer is needed.



TUBOTHAL is manufactured in lengths up to 6 meters or 20ft.

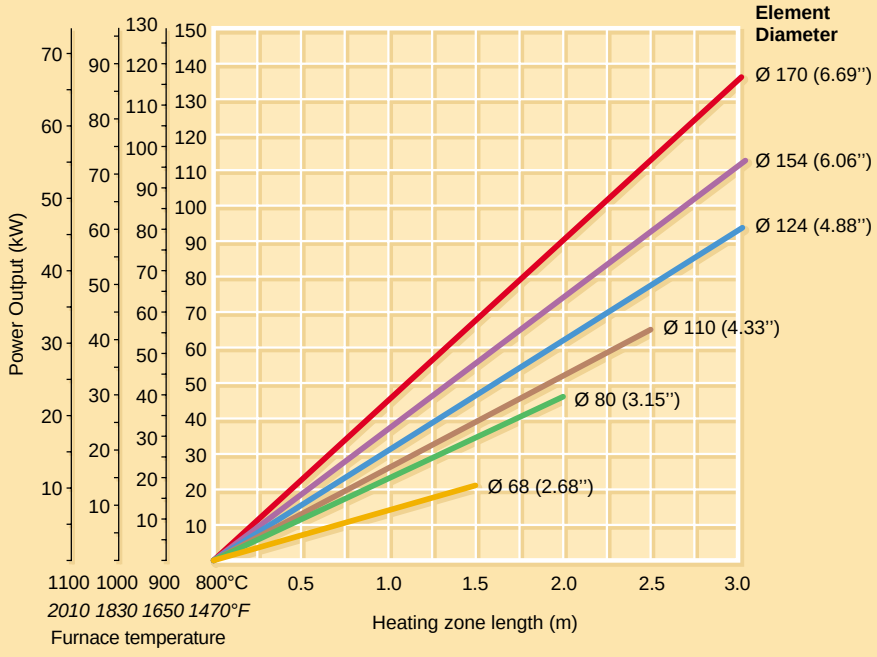


Diagram showing maximum possible loadings at different furnace temperature

Extensive range of sizes

The size and rating of the element can be designed to suite all situations. Incorporating the six standard sizes of 68, 80, 110, 124, 154 and 170 mm *(2.7, 3.2, 4.9, 6.1 and 6.7 in)* diameter in lengths up to 6 m, *20 ft*.

The complete package

TUBOTHAL elements are suitable for mounting in all types of radiant tubes. But for the most effective operation the use in Kanthal APM tubes is recommended.

The APM tubes have a superior life and can be used up to 1250°C *2280°F*. They can stand a very high loading up to 7.5 W/cm^2 *48 W/in^2* at 1000°C *1830°F*. The tubes are delivered completely readymade with flange and suitable TUBOTHAL elements.

TUBOTHAL and APM tubes – the complete heating package.

Kanthal AB, Head office and main production unit at Hallstahammar, Sweden.

Kanthal APM Extruded Tubes

Kanthal APM is a powder-metallurgical alloy able to withstand a maximum temperature of 1425°C, limited to 1250°C in tubes. Kanthal APM tubes are seamless and extruded.

The APM is the outstanding choice for high-temperature, corrosive applications. The formation of a cohesive aluminum-oxide film on the inner as well as on the outer surface of the radiant tube, will keep it free from contamination. This in turn means there is no need for cleaning or turning of the tube. The adherent aluminum film formed on the tube is also an extremely efficient barrier against high-carbon activity. It makes the tube highly resistant to carburisation also in those cases where free carbon is allowed to accumulate on its surface. In addition, it makes Kanthal APM highly resistant to sulphurus atmospheres.

Kanthal APM tubes are suitable in both gas- and electrically heated furnaces.

Higher Temperature and Longer Life

* Made of well-proven powder FeCrAl Kanthal alloy.
* Excellent form stability at high temperature.
* Protective surface oxide provides high tolerance to corrosive environments such as sulphurus atmospheres.
* No carburisation. The aluminium oxide protects the alloy from carburisation in high carbon-potential environments.
* The oxide is non-spalling. No scaling and no impurities inside the tube to contaminate the heating element or gas burner, and no scaling on the outside to contaminate the goods in the furnace.
* High loading potential. At a furnace temperature of 1000°C *(1830°F)* the loading can be more than double that of a NiCr tube.
* APM tubes are extruded so there are no welded seams thus eliminating a source of potential failure.
* APM tubes weight less than equivalent NiCr tubes of the same dimension.
* Ready to install. Supplied flanged, with or without inner tube and gas burner or suitable electric heating element.
* Can operate at a maximum tube temperature of 1250°C *(2280°F)*.

Comparison between NiCr and Kanthal APM tubes after 1000 hours at 1150°C *2100°F*.
The NiCr tubes are severely contaminated with oxide flakes while the Kanthal APM tubes are completely clean.

Gas fired systems

The product range includes straight or U-formed tubes or complete systems (SER) with inner and outer tubes and gas burner designed into a single ended recuperative unit.

The system will be delivered in sizes from 89 to154 mm, *3.5 - 6 in* outer tube diameter, to suit most furnaces on the market.

Electrically heated furnaces

Kanthal APM tubes is the ideal choice also for electrically heated furnaces. Our manufacturing program comprises a complete range of electric elements and tubes for most applications. The elements we recommend are Silicon Carbide, Kanthal Super, Tubothal and Kanthal AF. They are all delivered as complete ready to install heaters with elements, support- and insulation material and tubes.

Kanthal APM tubes in a gas fired sealed quench furnace.

Gas fired
U-type, straight through or SER systems with inner- and outer tubes and gas burner

Electrically heated
Kanthal Silicon Carbide elements

Kanthal Super elements

Kanthal AF

Tubothal

Kanthal APM-tubes standard product range

Nominal Size	OD mm	Wall thickness mm	Weight kg/m	*OD in*	*Wall thickness in*	*Weight ib/ft*	Remarks	
3/4” Sch 40S	26.67	2.87	1.52	*1.05*	*0.11*	*1.02*		
	33.7	6.0	3.71	*1.33*	*0.24*	*2.49*		
1” Sch 40S	33.4	3.38	2.26	*1.31*	*0.13*	*1.52*		
	40	3.0	2.48	*1.57*	*0.12*	*1.67*		**
	50.8	6.35	6.35	*2.00*	*0.25*	*4.27*		**
2” Sch 40S	60.33	3.91	4.92	*2.38*	*0.15*	*3.31*		**
	64	4.0	5.35	*2.52*	*0.16*	*3.60*		**
2 1/2”	73	4.5	6.88	*2.87*	*0.18*	*4.62*		**
	75	4.5	7.08	*2.95*	*0.18*	*4.76*		**
	83	5.0	8.70	*3.27*	*0.20*	*5.85*		***
	87	5.0	9.15	*3.43*	*0.20*	*6.15*	6	***
3” Sch 40S	88.9	5.49	10.2	*3.50*	*0.22*	*6.88*		***
	100	5.0	10.6	*3.94*	*0.20*	*7.12*	5 ◊	***
	109	5.0	11.6	*4.29*	*0.20*	*7.79*		***
4”	115	5.5	13.4	*4.53*	*0.22*	*9.02*		***
5”	128	5.5	15.0	*5.04*	*0.22*	*10.1*	4	***
	146	6.0	18.7	*5.75*	*0.24*	*12.6*	3 ◊	*
6”	154	6.0	19.8	*6.06*	*0.24*	*13.3*		*
	164	6.0	21.2	*6.46*	*0.24*	*14.2*		*
	178	8.0	30.3	*7.01*	*0.31*	*20.4*	2	*
	198	9.0	37.9	*7.80*	*0.35*	*25.5*	1 ◊	*
	220	8.5	40.1	*8.66*	*0.33*	*26.9*		*
	260	12.0	55.8	*10.2*	*0.47*	*37.5*		*

Tubothal elements

1. Suits Tubothal element ∅ 170
2. Suits Tubothal element ∅ 154
3. Suits Tubothal element ∅ 124
4. Suits Tubothal element ∅ 110
5. Suits Tubothal element ∅ 80
6. Suits Tubothal element ∅ 68

Kanthal Super elements
◊ Suits Kanthal Super

Kanthal silicon carbide

All tubes suit depending on element type and power.

SER Gas fired systems

* Outer tube
** Inner tube
*** Inner or outer tube


KANTHAL
PACKSEDEL
92557-005

KANTHAL A-1 and APM

Wire and strip. Standard stock items.

Resistivity 1.45 Ω mm^2 m^{-1}. Density 7.1 g cm^{-3}. To obtain resistivity at working temperature, multiply by factor C_t in following table.

°C	20	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
C_t	1.00	1.00	1.00	1.00	1.00	1.01	1.02	1.02	1.03	1.03	1.04	1.04	1.04	1.04	1.05

Wire dia mm	Resistance Ω/m 20°C	Weight g/m	cm^2/Ω 20°C
1,0	1.85	5.58	17.0
1.1*)	1.53	6.75	22.7
1.2	1.28	8.03	29.4
1.3*)	1.09	9.43	37.4
1.4*)	0.942	10.9	46.7
1.5	0.821	12.5	57.4
1.6*)	0.721	14.3	69.7
1.7	0.639	16.1	83.6
1.8	0.570	18.1	99.2
2.0	0.462	22.3	136
2.2	0.381	27.0	181
2.3	0.349	29.5	207
2.4*)	0.321	32.1	235
2.5	0.295	34.9	266
2.6	0.273	37.7	299
2.8	0.235	43.7	374
2.9	0.219	47.0	416
3.0	0.205	50.2	460
3.25	0.175	58.9	584
3.5	0.151	68.3	730
3.75	0.131	78.4	897
4.0	0.115	89.2	1090
4.25	0.102	101	1306
4.5	0.0912	113	1550
4.75	0.0818	126	1824
5.0	0.0738	139	2127
5.5	0.0610	169	2831
6.0	0.0513	201	3676
6.5	0.0437	236	4673
7.0	0.0377	273	5840
7.35	0.0340	300	5840
8.0	0.0288	357	8690
8.25	0.0271	380	9560
9.5	0.0205	503	14600
10.0	0.0185	558	17000

*) only A-1

Strip*) WxT mm	Resistance Ω/m 20°C	Weight g/m	cm^2/Ω 20°C
5.0x1.0	0.290	35.5	414
10.0x1.0	0.145	49.7	1520
15.0x1.0	0.0967	107	3310
20.0x1.0	0.725	142	5790
12.0x1.2	0.101	102	2620
15.0x1.2	0.101	128	4020
10.0x1.5	0.097	107	2380
12.0x1.5	0.0806	128	3350
15.0x1.5	0.0644	160	5120
20.0x1.5	0.0483	213	8900
25.0x1.5	0.0387	266	13700
30.0x1.5	0.0320	320	19600
15.0x2.0	0.0483	213	7040
20.0x2.0	0.0363	284	12100
25.0x2.0	0.0290	355	18600
30.0x2.0	0.0242	426	26500
20.0x2.5	0.0290	355	15500
25.0x2.5	0.0232	444	23700
30.0x2.5	0.0193	533	33600
20.0x3.0	0.0242	426	19008
25.0x3.0	0.0193	533	26200
30.0x3.0	0.0161	639	41000

KANTHAL AF

Wire and strip. Standard stock items.

Resistivity 1.39 Ω mm^2 m^{-1}. Density 7.15 g cm^{-3}. To obtain resistivity at working temperature, multiply by factor C_t in following table.

°C	20	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
C_t	1.00	1.00	1.01	1.01	1.02	1.03	1.04	1.04	1.05	1.05	1.06	1.06	1.06	1.06	1.07

Wire dia mm	Resistance Ω/m 20°C	Weight g/m	cm^2/Ω 20°C
1.0	1.77	5.62	17.8
1.1	1.46	6.79	23.6
1.2	1.23	8.09	30.7
1.3	1.05	9.49	39.0
1.4	0.903	11.0	48.7
1.5	0.787	12.6	59.9
1.6	0.691	14.4	72.7
1.7	0.612	16.2	87.2
1.8	0.546	18.2	104
2.0	0.442	22.5	142
2.2	0.366	27.2	189
2.3	0.335	29.7	216
2.4	0.307	32.3	245
2.5	0.283	35.1	277
2.6	0.262	38.0	312
2.8	0.226	44.0	390
2.9	0.210	47.2	433
3.0	0.197	50.5	479
3.25	0.168	59.3	609
3.5	0.144	68.8	761
3.75	0.126	79.0	936
4.0	0.111	89.8	1136
4.25	0.0980	101	1363
4.5	0.0874	114	1618
4.75	0.0784	127	1902
5.0	0.0708	140	2219
5.5	0.0585	170	2953
6.0	0.0492	202	3834
6.5	0.0419	237	4875
7.0	0.0361	275	6089
7.35	0.0328	303	7048
7.5	0.0315	316	7489
8.0	0.0277	359	9089
8.25	0.0260	382	9968
9.27	0.0206	483	14141

Strip*) WxT mm	Resistance Ω/m 20°C	Weight g/m	cm^2/Ω 20°C
10.0x1.0	0.139	71.5	1582
15.0x1.0	0.0927	107	3453
20.0x1.0	0.0695	143	6043
10.0x1.2	0.1158	86	1934
12.0x1.2	0.0965	103	2735
15.0x1.2	0.0772	129	4196
15.0x1.5	0.0618	161	5342
20.0x1.5	0.0463	215	9281
25.0x1.5	0.00371	268	14302
15.0x2.0	0.0463	215	7339
20.0x2.0	0.0348	286	12664
25.0x2.0	0.0278	358	19424
30.0x2.0	0.0232	429	27623
15.0x2.5	0.0371	268	27623
20.0x2.5	0.0278	358	16190
25.0x2.5	0.0222	447	24733
30.0x2.5	0.0185	536	35071
20.0x3.0	0.0232	429	19828
25.0x3.0	0.0185	536	27331
30.0x3.0	0.0154	644	39223

KANTHAL D

Wire and strip. Standard stock items.

Resistivity 1.35 Ω mm^2 m^{-1}. Density 7.25 g cm^{-3}. To obtain resistivity at working temperature, multiply by factor C_t in following table.

°C	20	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300
C_t	1.00	1.00	1.01	1.01	1.02	1.03	1.04	1.05	1.06	1.06	1.07	1.07	1.08	1.08

Wire dia mm	Resistance Ω/m 20°C	Weight g/m	cm^2/Ω 20°C
1.0	1.72	5.7	18.3
1.1	1.42	6.9	24.3
1.2	1.19	8.2	31.6
1.3	1.02	9.6	40.2
1.4	0.877	11.2	50.2
1.5	0.764	12.8	61.7
1.6	0.671	14.6	74.9
1.7	0.595	16.5	89.8
1.8	0.531	18.4	107
2.0	0.430	22.8	146
2.5	0.275	35.6	286
2.8	0.219	44.6	401
3.0	0.191	51.2	493
3.25	0.163	60.1	627
3.5	0.140	69.8	784
3.75	0.122	80.1	964
4.0	0.107	91.1	1170
4.25	0.0952	103	1403
4.5	0.0849	115	1666
4.75	0.0762	128	1959
5.0	0.0688	142	2285
5.5	0.0568	172	3041
6.0	0.0477	205	3948
6.5	0.0407	241	5019
7.35	0.0318	308	7257
8.0	0.0269	364	9358

Strip*) WxT mm	Resistance Ω/m 20°C	Weight g/m	cm^2/Ω 20°C
5.0x0.1	2.70	3.6	43
5.0x0.2	1.35	7.3	76
5.0x0.3	0.900	10.9	118
5.0x0.4	0.657	14.5	160
10.0x1.2	0.113	87	1990
12.0x1.2	0.0938	104	2820
15.0x1.2	0.0750	131	4320
15.0x1.5	0.0600	163	5500
20.0x1.5	0.0450	218	9560
15.0x2.0	0.0450	218	7560
20.0x2.0	0.0338	290	13000
25.0x2.0	0.0270	363	20000
20.0x2.5	0.0270	363	16700

NIKROTHAL 80

Wire and Strip. Standard stock items.

Resistivity 1.09 Ω mm^2 m^{-1}. Density 8.30 g cm^{-3}. To obtain resistivity at working temperature, multiply by factor C_t in following table.

°C	20	100	200	300	400	500	600	700	800	900	1000	1100	1200
C_t	1.00	1.01	1.02	1.03	1.04	1.05	1.04	1.04	1.04	1.04	1.05	1.06	1.07

Wire dia mm	Resistance Ω/m 20°C	Weight g/m	cm^2/Ω 20°C
1.0	1.39	6.52	22.6
1.2	0.964	9.39	39.1
1.3	0.821	11.0	49.7
1.4	0.708	12.8	62.1
1.5	0.617	14.7	76.4
1.6	0.542	16.7	92.7
1.8	0.428	21.1	132
2.0	0.347	26.1	181
2.3	0.262	34.5	275
2.5	0.222	40.7	354
2.6	0.205	44.1	398
2.8	0.177	51.1	497
3.0	0.154	58.7	611
3.25	0.131	68.9	777
3.5	0.113	79.9	971
3.75	0.0987	91.7	1194
4.0	0.0867	104	1449
4.25	0.0768	118	1738
4.5	0.0685	132	2063
4.75	0.0615	147	2426
5.0	0.0555	163	2830
5.5	0.0459	197	3766
6.0	0.0386	235	4890
6.5	0.0328	275	6217
7.0	0.0283	319	7764
7.5	0.0247	367	9550
8.0	0.0217	417	11590

Strip*) WxT mm	Resistance Ω/m 20°C	Weight g/m	cm^2/Ω 20°C
15.0x1.0	0.0727	125	4404
20.0x1.0	0.0545	166	7706
25.0x1.0	0.0436	208	11930
12.0x1.2	0.0757	120	3488
15.0x1.5	0.0484	187	6812
20.0x1.5	0.0363	249	11840
25.0x1.5	0.0291	311	18230
15.0x2.0	0.0363	249	9358
20.0x2.0	0.0273	332	16150
25.0x2.0	0.0218	415	24770
30.0x2.0	0.0182	498	35230
20.0x2.5	0.0218	415	20640
25.0x2.5	0.0174	519	31540
30.0x2.5	0.0145	623	44730

NIKROTHAL 70

Wire. No standard stock items – on special order only.

Resistivity 1.18 Ω mm^2 m^{-1}. Density 8.10 g cm^{-3}. To obtain resistivity at working temperature, multiply by factor C_t in following table.

°C	20	100	200	300	400	500	600	700	800	900	1000	1100	1200
C_t	1.00	1.01	1.02	1.03	1.04	1.05	1.05	1.04	1.04	1.04	1.05	1.05	1.06

Wire dia mm	Resistance Ω/m 20°C	Weight g/m	cm^2/Ω 20°C
1.0	1.50	6.36	20.9
1.1	1.24	7.70	27.8
1.2	1.04	9.16	36.1
1.3	0.889	10.8	45.9
1.4	0.767	12.5	57.4
1.5	0.668	14.3	70.6
1.6	0.587	16.3	85.6
1.7	0.520	18.4	103
1.8	0.464	20.6	122
1.9	0.416	23.0	143
2.0	0.376	25.4	167
2.2	0.310	30.8	223
2.5	0.240	39.8	327
2.6	0.222	43.0	368
2.8	0.192	49.9	459
3.0	0.167	57.3	565
3.25	0.142	67.2	718
3.5	0.123	77.9	897
3.75	0.107	89.5	1103
4.0	0.0939	102	1338
4.25	0.0832	115	1605
4.5	0.0742	129	1905
4.75	0.0666	144	2241
5.0	0.0601	159	2614
5.5	0.0497	192	3479
6.0	0.0417	229	4517
6.5	0.0356	269	5742
7.0	0.0307	312	7172
7.35	0.0278	344	8303
7.5	0.0267	358	8822
8.0	0.0235	407	10706
8.25	0.0221	433	11741
9.0	0.0185	515	15244

Terminals

Resistance and Weight Data

Material	Resistivity Ω mm² m⁻¹	Density g/cm³
KANTHAL APM	1.45	7.10
KANTHAL D	1.35	7.25
KANTHAL A-1	1.45	7.10
NIKROTHAL 80	1.09	8.30
NIKROTHAL 40	1.04	7.90

Material	Resistance Ω/m	Weight g/m
KANTHAL D		
8	0.0269	364
10	0.0172	569
12	0.0119	820
16	0.0067	1460
20	0.0043	2280
KANTHAL A-1 and APM		
8	0.0288	357
10	0.0185	558
12	0.0128	803
16	0.0072	1428
20 (APM only)	0.0046	2231
30 (A-1 only)	0.0021	5019
40 (APM only)	0.0012	8922
NIKROTHAL 80		
8	0.0217	417
10	0.0172	652
12	0.0119	939
16	0.0067	1670
20	0.0043	2610
NIKROTHAL 40		
8	0.0207	397
10	0.0132	620
12	0.0092	893
20	0.0033	2482
30	0.0015	5584

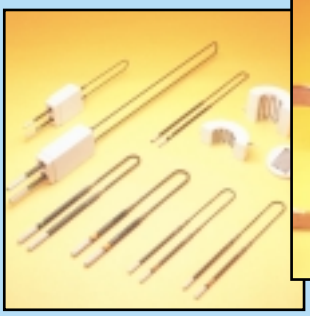
Systems and Services

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.

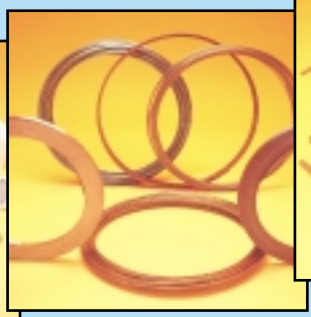
We can assist you

- 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 to latest heating technology.



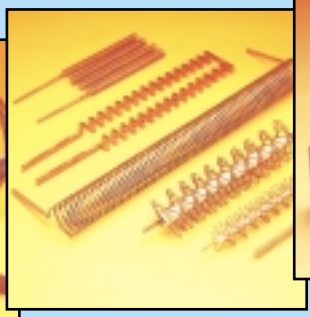
Kanthal Super, Superthal®

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.*

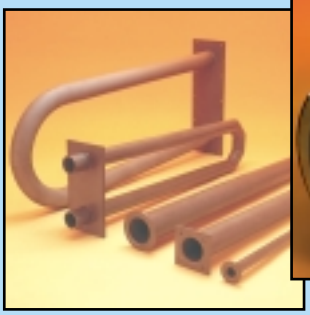


Metallic Elements

Ready-made metallic elements manufactured by Kanthal workshops.

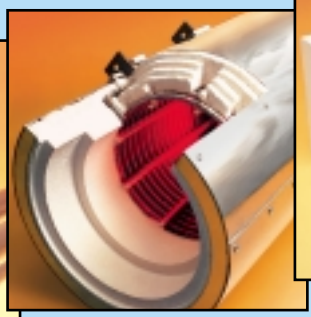
Tubothal®

Long-life elements for all types of radiant tubes, ideally KANTHAL APM, up to 1300°C, *2370°F,* free radiating temperature.



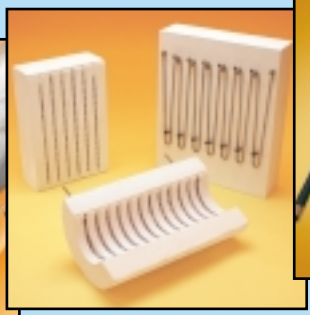
Extruded Tubes

Kanthal extruded radiant tubes for gas or electriceally heating furnaces.



Heating elements

Elements and systems for diffusion 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.*

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