

**KANTHAL®**

# POWDER METALLURGY HIGH-TEMPERATURE TUBES

KANTHAL® APM AND KANTHAL® APMT





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# MORE POWER, LONGER LIFE AND LESS MAINTENANCE

**Kanthal® APM and Kanthal® APMT iron-chromium-aluminum (FeCrAl) alloys, based on powder metallurgy, has been successfully used for many years in the form of wire, strip, radiant and protection tubes. Used mainly in the heat treatment, steel and aluminum industries, tubes in Kanthal® APM and Kanthal® APMT FeCrAl alloys contribute to much higher furnace productivity by offering more power, less maintenance and longer service life.**

Tubes made from Kanthal® includes Kanthal® APM (advanced powder metallurgy), suitable for most types of processes, and Kanthal® APMT, an alloy with improved hot strength for extra demanding horizontal applications.

Tubes made from Kanthal® APM and Kanthal® APMT are suited to both gas and electrically heated furnaces.

## **EXTRA HIGH TEMPERATURE**

Can operate at temperatures up to 1250°C (2280°F).

## **HIGH LOADING POTENTIAL**

At a furnace temperature of 1000°C (1830°F), the loading can be more than double that of nickel-chromium (NiCr) and iron-nickel-chromium (FeNiCr) tubes. This allows more flexible furnace designs and conversion of existing heating systems to higher furnace power. Fewer tubes are needed for the same power rating.

## **LONG LIFE**

When heated, Kanthal® APM and Kanthal® APMT alloys form an aluminum oxide ( $Al_2O_3$ ) scale that protects the alloy from further corrosion and prolongs the service life, compared with ordinary NiCr or FeNiCr tubes.

## **NO TUBE CARBURIZATION**

The alumina oxide protects the alloy from carburization in high carbon-potential atmospheres.

Kanthal® APM and Kanthal® APMT materials withstand coking and metal dusting.

## **LESS MAINTENANCE**

The oxide is non-spalling, hence no scaling and no impurities inside the tube to contaminate the heating element or gas burner. No need for downtime to clean the tubes. No scaling on the outside to contaminate the goods in the furnace.

## **NO WEAK SPOTS**

Tubes are extruded, so there are no welded seams, eliminating a source of potential failure.

## **EXCELLENT FORM STABILITY**

Excellent form stability even at elevated temperatures.

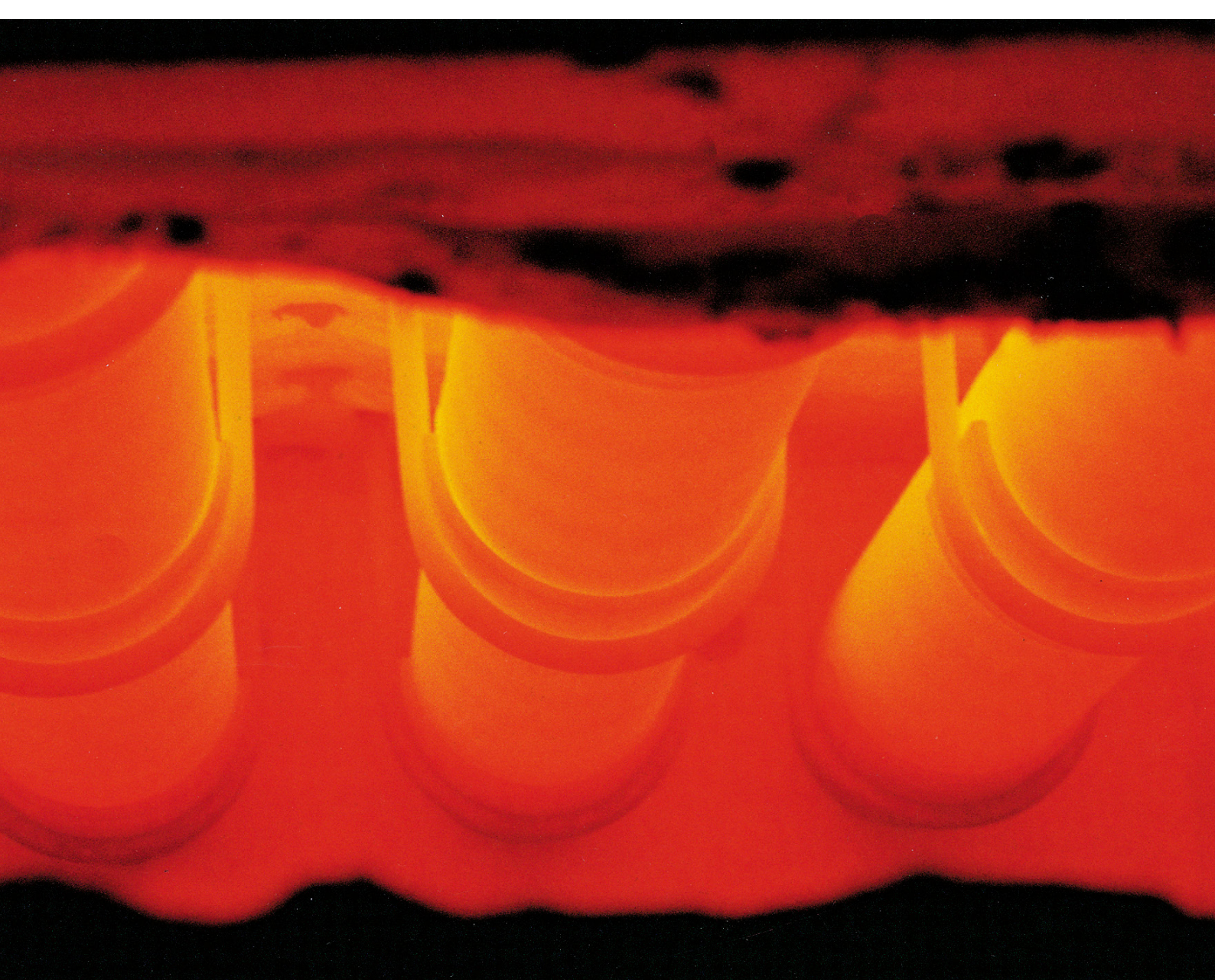
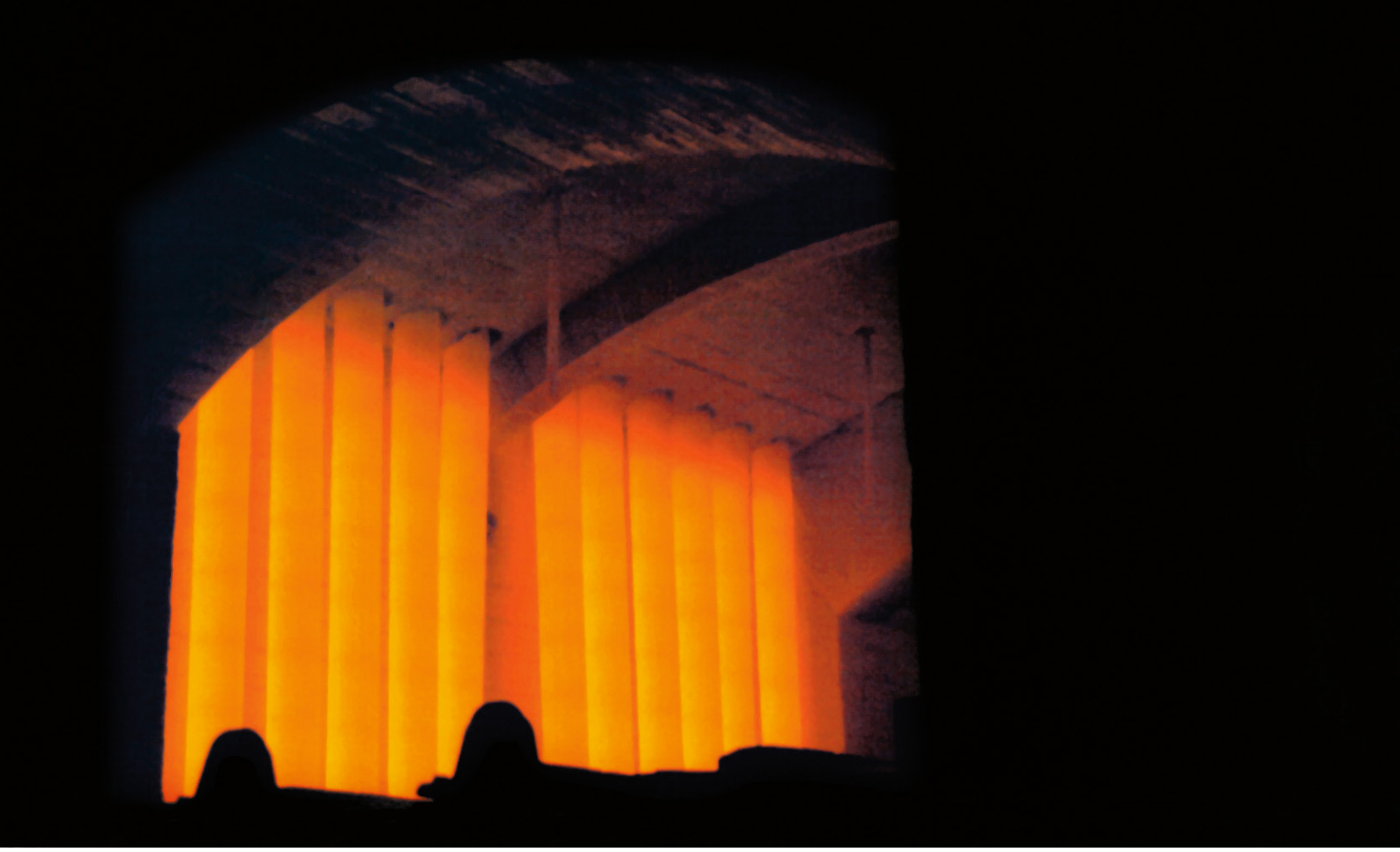
## **LOW WEIGHT**

Tubes in Kanthal® APM and Kanthal® APMT alloys weigh less than equivalent NiCr and FeNiCr tubes of the same dimension.

## **READY TO INSTALL**

Tubes in Kanthal® APM and Kanthal® APMT alloys are supplied as complete plug-in units for gas or electric furnaces. We can assist you in calculating and choosing the most suitable system for your particular needs.

Tube systems are stocked in standard dimensions to fit most furnaces and to allow fast deliveries.



# KANTHAL® APM AND KANTHAL® APMT ALLOYS

The Kanthal branded family of high-temperature materials is aimed initially at the manufacture of resistance wire and strip for electric furnace applications. Tubes in Kanthal® APM and Kanthal® APMT, are seamless and produced by extrusion. They are suitable for use in a wide range of temperatures and atmospheres, covering many applications and processes in various industries.

Kanthal® APM and Kanthal® APMT are based on the well-known Kanthal FeCrAl alloy, the basis of electric elements in many different types of kiln and furnace for over 70 years. Both grades are produced by an ad-

vanced powder metallurgy process route. The powder metallurgy alloys maintain all of the benefits of the traditional Kanthal alloys and add many more. The most obvious benefit is the higher mechanical strength achieved by dispersion strengthening.

Kanthal® APMT is a further development of Kanthal® APM, designed for especially demanding applications. The alloy has the same excellent high temperature corrosion resistance as Kanthal® APM, but with even higher strength.



# CHEMICAL COMPOSITION AND PHYSICAL PROPERTIES

## TYPICAL CHEMICAL COMPOSITION

	WEIGHT %						
	C	SI	MN	CR	MO	AL	FE
Kanthal® APM	≤0.05	≤0.7	≤0.4	22	–	5.8	balance
Kanthal® APMT	≤0.05	≤0.7	≤0.4	22	3.0	5.0	balance

	KANTHAL® APM	KANTHAL® APMT
Density, g/cm <sup>3</sup> (lb/in <sup>3</sup> )	7.1 (0.257)	7.2 (0.260)
Emissivity – fully oxidized material	0.7	0.7
The material is magnetic up to approx. 600°C (1110°F) (Curie point)		

## COEFFICIENT OF THERMAL EXPANSION

TEMPERATURE °C (°F)	THERMAL EXPANSION, 10 <sup>-6</sup> K <sup>-1</sup>	
	KANTHAL® APM	KANTHAL® APMT
20–250 (68–480)	13	12
20–500 (68–930)	13	13
20–750 (68–1380)	14	14
20–1000 (68–1830)	15	15
20–1250 (68–2280)	16	15

## THERMAL CONDUCTIVITY

	TEMPERATURE, °C (°F)											
	50	(120)	600	(1110)	800	(1470)	1000	(1830)	1200	(2190)	1400	(2550)
Kanthal® APM, Wm <sup>-1</sup> K <sup>-1</sup> (Win <sup>-1</sup> °F <sup>-1</sup> )	11	(0.16)	20	(0.28)	22	(0.31)	26	(0.37)	27	(0.38)	35	(0.49)
Kanthal® APMT, Wm <sup>-1</sup> K <sup>-1</sup> (Win <sup>-1</sup> °F <sup>-1</sup> )	11	(0.16)	21	(0.30)	23	(0.32)	27	(0.38)	29	(0.41)	32	(0.45)

## SPECIFIC HEAT CAPACITY

	TEMPERATURE, °C (°F)							
	20 (68)	200 (390)	400 (750)	600 (1110)	800 (1470)	1000 (1830)	1200 (2190)	1400 (2550)
Kanthal® APM, kJkg <sup>-1</sup> K <sup>-1</sup>	0.46	0.56	0.63	0.75	0.71	0.72	0.74	0.80
Kanthal® APMT, kJkg <sup>-1</sup> K <sup>-1</sup>	0.48	0.56	0.64	0.71	0.67	0.69	0.70	0.74

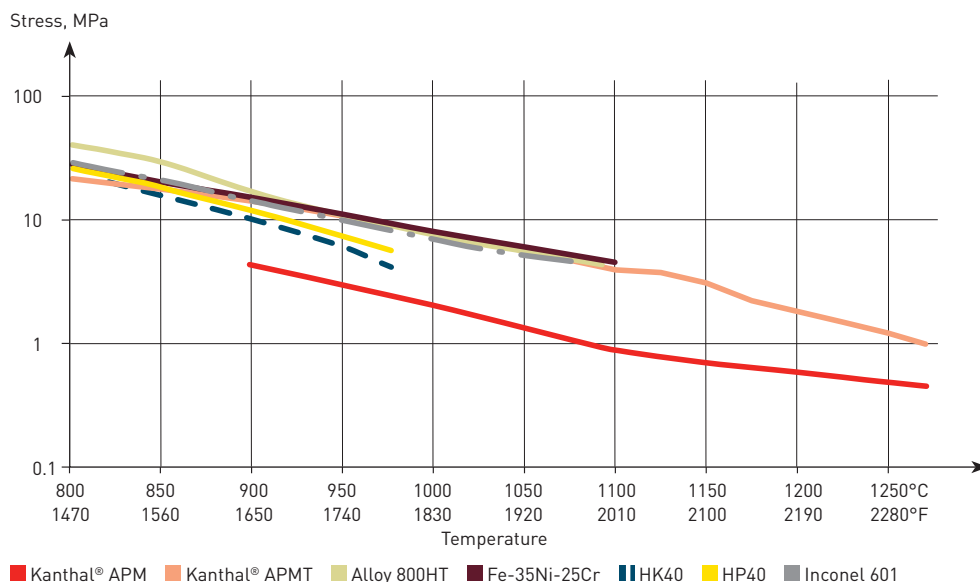
# HIGH-TEMPERATURE STRENGTH

## CREEP RUPTURE STRENGTH

Tubes in Kanthal® APM and Kanthal® APMT offer a unique combination of strength and corrosion resistance, which allows them to be used at higher temperatures than NiCr tubes and still exhibit a long working life.

With Kanthal® APMT, tubes have similar strength values as NiCr tubes, but retain much of their strength up to temperatures well above the working temperature of NiCr tubes.

## CREEP RUPTURE STRENGTH – 10000 H



## RESISTANCE TO SAGGING DEFORMATION

Sagging is a form of creep deformation. Most creep data is the result of uniaxial tests of standardized samples. However, it is often very difficult to translate creep data for horizontal and other applications where the stresses are more complex. This difficulty of applying creep data can be illustrated by the following example.

The austenitic steel (Fe-35Ni-25Cr) has substantially higher creep resistance than Kanthal® APM and equal to Kanthal® APMT at 1100°C (2010°F). When testing three extruded tubes of exactly the same dimension in a sagging rig, tubes in both Kanthal® APM and Kanthal® APMT outperformed the FeNiCr-material. There are several reasons for the difference between sagging data and creep data. In the sagging test, the density of the tube material plays a larger role than in a creep



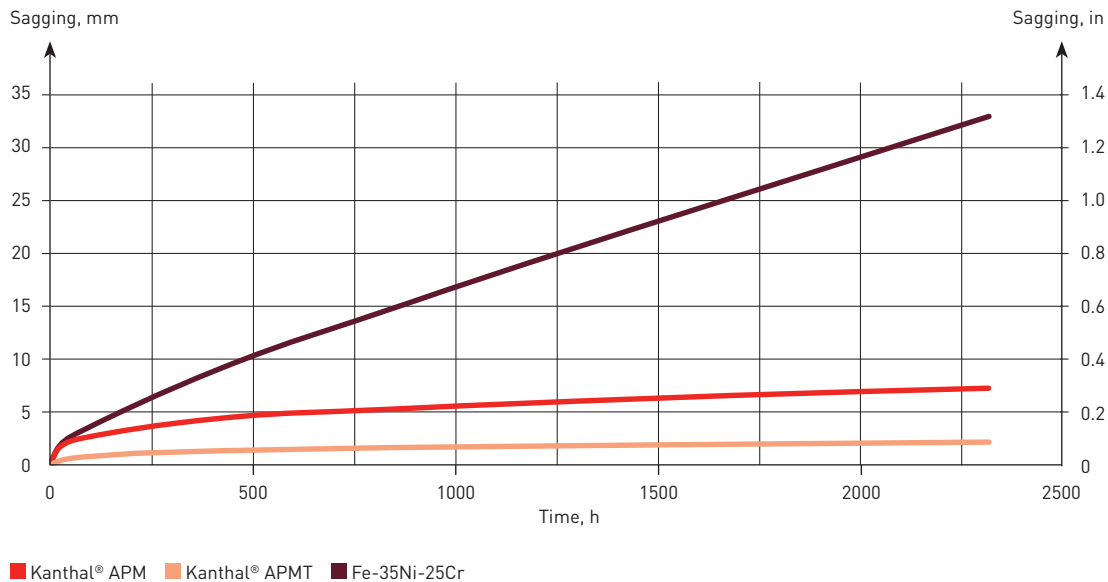
test, where weights are applied independently of the alloy tested. Another factor is the change in deformation behavior with time. All tubes show initially a higher deformation rate. After the initial sagging, the FeNiCr material follows a fairly linear behavior with time. In the case of Kanthal PM the deformation rate continues to decrease with time.

This is often the experience in real applications. Rotating tubes 180° at regular intervals is common practice

in furnaces with welded or spun cast NiCr. Normally it is not necessary to turn tubes in Kanthal® APM and Kanthal® APMT, but if preferred, then only once at the first maintenance stop after installation.

Another factor that often plays a significant role in real applications and is not considered in the standard laboratory test is corrosion. Corrosion will not only change the mechanical strength of the material, but equally importantly, it reduces the load bearing cross-section.

### COMPARATIVE SAGGING TEST AT 1100°C (2010°F)



Tubes in Kanthal® APMT (left) and Fe-35Ni-25Cr (right) after the sagging test.

# HIGH TEMPERATURE CORROSION PROPERTIES

Kanthal® APM and Kanthal® APMT alloys exhibit excellent high temperature corrosion properties. The explanation for the excellent corrosion resistance is the formation of a dense, cohesive aluminum oxide layer on the surface protecting the base material from corrosion attack. This aluminum oxide,  $Al_2O_3$ , is formed through selective oxidation of the aluminum in the alloys. There are some criteria that an effective protective oxide must fulfill.

## THERMODYNAMICALLY STABLE

The oxide should not be reduced or react in any other way with the surrounding atmosphere

## ADHERENT

The oxide must not spall during thermal cycling

## LOW GROWTH RATE

Slow oxide growth is necessary to ensure long life of the product

The aluminum oxide formed on Kanthal® APM and Kanthal® APMT alloys fulfills the above criteria better than any other protective oxide formed at high temperatures. NiCr and FeNiCr alloys form a chromium oxide as a protective scale. Chromium oxide is less adherent to the metal i.e. chromium oxide tends to spall or scale much more than Kanthal® APM and Kanthal® APMT alloys. Chromium oxide is also volatile in many atmospheres i.e. chromium oxide vaporizes from hot metal surfaces and condenses on to colder surrounding surfaces. Spalled and condensed chromium oxide causes contamination and discoloration of products in furnaces and can, in severe cases, cause furnace malfunctions due to short circuiting of resistance heating elements or clogging/leakage of gas valves.

Kanthal® APM and Kanthal® APMT alloys have the ability to form a protective surface oxide film even when the oxygen concentrations in the surrounding atmosphere are very low. Practically all industrial atmospheres contain enough oxygen to stabilize aluminum oxide. The oxygen needed for the aluminum oxide growth can come from many sources beside  $O_2$ . Atmospheres containing oxygen in form of  $H_2O$ ,  $CO/CO_2$ ,  $CH_3OH$  or  $SO_2$  can be regarded as oxidizing for Kanthal® APM and Kanthal® APMT alloys.



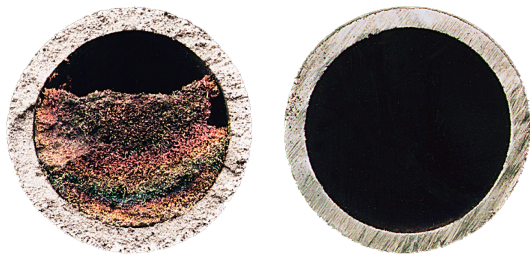
Comparison of Kanthal® APMT tube versus Fe-35Ni-25Cr (after 2300 h at 1100°C (2010°F)). The FeNiCr tube is severely contaminated with oxide flakes.

## EXCELLENT IN HIGH CARBON-POTENTIAL ATMOSPHERES

One of the primary benefits of tubes in Kanthal® APM and Kanthal® APMT, is their excellent resistance to carburization. NiCr and FeNiCr alloys absorb carbon at a much faster rate than Kanthal® APM and Kanthal® APMT, and this results not only in a gradual change in the alloy composition, but also in the accumulation of free carbon on the surface of radiant tubes. This carbon can be hard and cohesive with the tube substrate, and is often almost impossible to remove.

Carbon build-up results in poor heat transfer and can cause overheating of tubes and the heating system. This overheating also causes a further increase in the rate at which carburization proceeds, so that carbon build-up tends to accelerate with time.

However, with tubes in Kanthal® APM and Kanthal® APMT, the protective layer of aluminum oxide formed on the tube surface inhibits reactions between the carbon and the base material. Alumina is highly resistant to carbon. Experience has shown that any carbon, which does accumulate, does not adhere to the tubes and can be easily and periodically brushed off the surface, to prevent any undesirable effects.



Comparison of carbon build-up in a strand annealing furnace, NiCr (left) and APM (right).

This feature is of particular significance in many types of heat treatment furnaces, where a high carbon potential is essential. In these cases, Kanthal® APM and Kanthal® APMT has proved vastly superior to even the best grades of nickel chromium alloys. The graph below shows the comparison between Kanthal® APM and various NiCr alloys, in terms of carburization rate versus temperature. The excellent results speak for themselves.

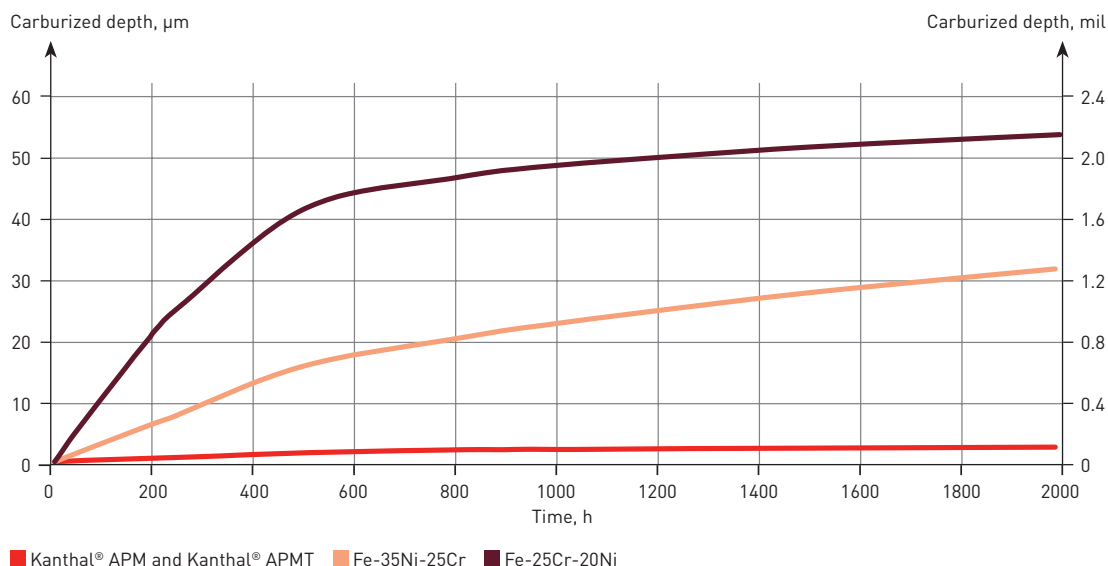
Experience has shown that Kanthal® APM alloys works excellently in metal dusting environments. This is a severe form of localized carbon attack that normally occurs in a temperature interval between 500 and 900°C (930–1650°F). Even though this is a lower temperature range than would normally be used for Kanthal® APM and Kanthal® APMT materials, it has proven to resist attack much better than conventional grades.

### RESISTANT TO SULPHUROUS ATMOSPHERES

Tubes in Kanthal® APM and Kanthal® APMT are highly resistant to sulphurous atmospheres, where sulphidation and oxidation are competing reactions. The corrosion resistance is good as long as oxidation is the dominant reaction. Sulphidation usually results in much higher corrosion rates. The relationship between sulphur and oxygen in the atmosphere is important for which reaction will be dominant.

Compared to NiCr tubes, tubes in Kanthal® APM and Kanthal® APMT are much more resistant to sulphidation, since the alumina surface oxide is much more stable at low oxygen concentrations than chromium oxide.

### CARBURIZATION RESISTANCE



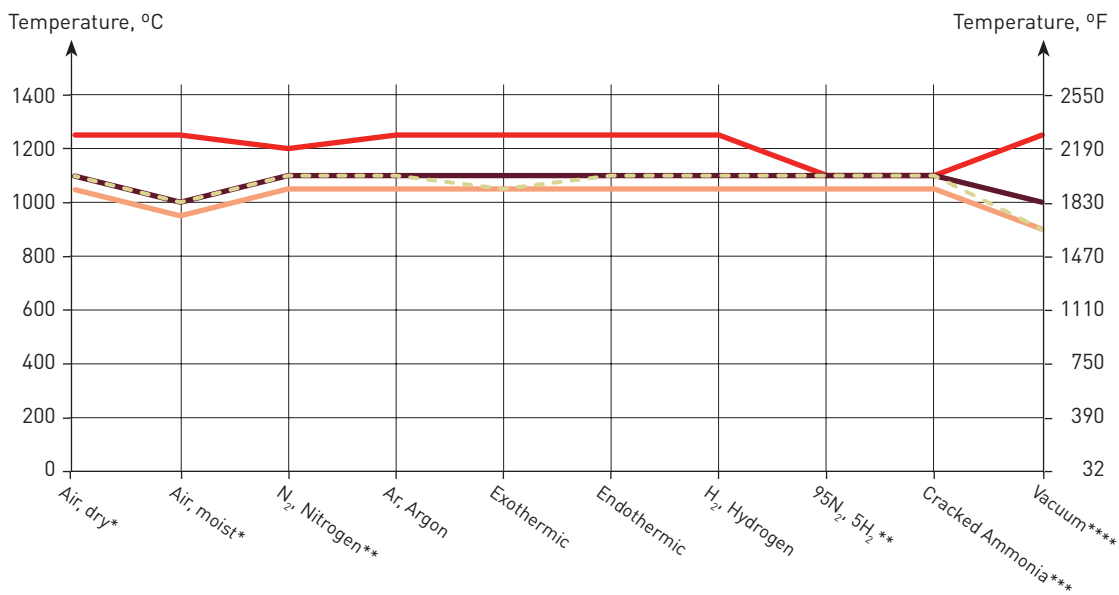
Tf = 1150°C (2100°F)  
 Carbon potential 1.4 ± 0.1%  
 Dew point 0°C (32°F)

## MAXIMUM RECOMMENDED TEMPERATURES

The diagram below shows recommended maximum temperatures for different alloys in various atmospheres. These temperatures are chosen from a practical, industrial point of view, although the material can withstand higher temperatures if needed.

For  $N_2$  and  $N_2+H_2$  atmospheres, at low dew point ( $< -20^\circ C$  [ $-4^\circ F$ ]), special considerations are needed. Please contact Kanthal for further information.

## MAXIMUM RECOMMENDED PERMISSIBLE TEMPERATURE IN VARIOUS ATMOSPHERES



■ Kanthal® APM ■ 25/20 ■ 25/35 ■ 601

- \* Limitation due to mechanical strength. The material can withstand temperatures up to  $1425^\circ C$  ( $2600^\circ F$ )
- \*\* Temperature limitation depending on dew point
- \*\*\* An atmosphere created by cracked ammonia, that may contain uncracked ammonia, will lower the max. permissible temperature. Other materials designed for this atmosphere can be provided upon request
- \*\*\*\* To utilize this temperature, Kanthal® APM and Kanthal® APMT alloys should be reoxidized at certain intervals

### LIMITATIONS OF CONVENTIONAL NICR ALLOYS

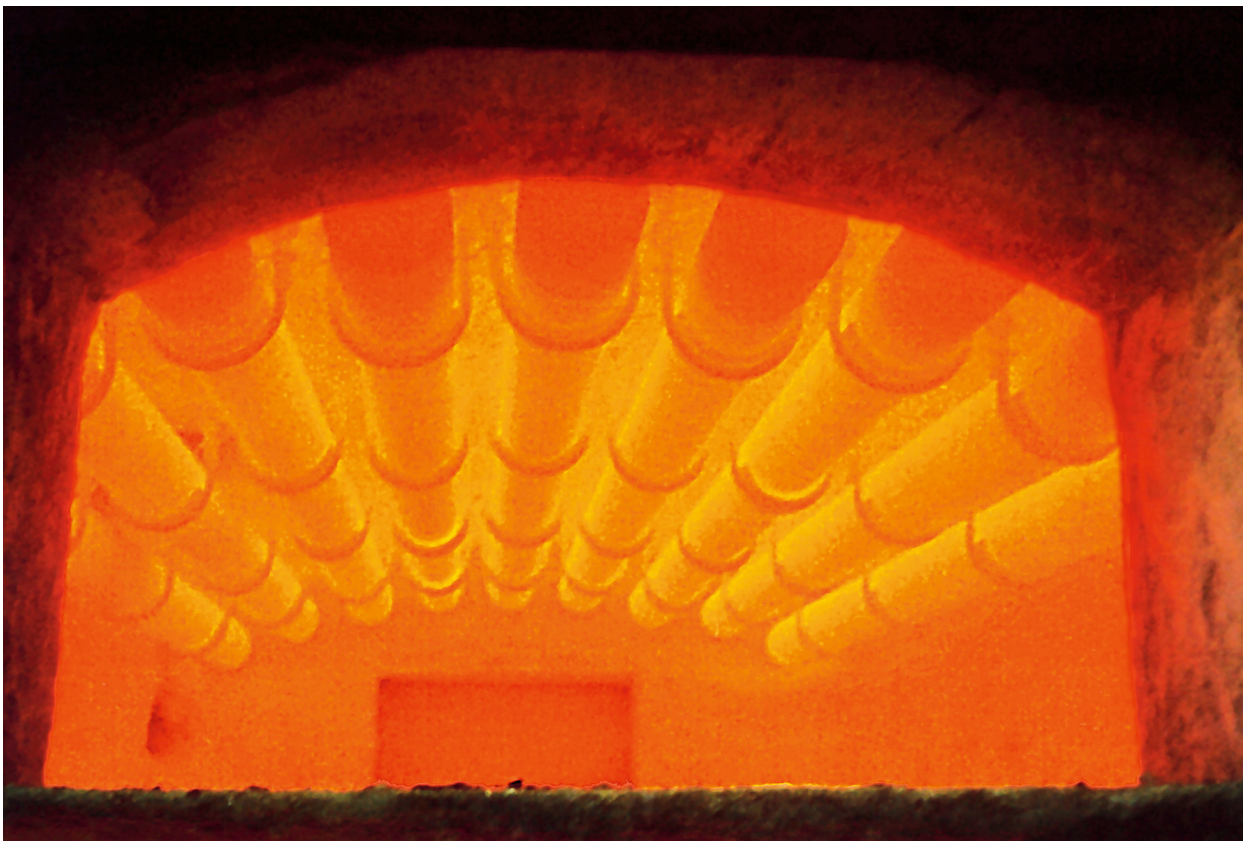
The majority of radiant tubes are manufactured from nickel-chromium, or iron-nickel-chromium alloys, produced by centrifugal casting, extrusion or fabrication from rolled sheet. The limiting factor for the use of these tubes is in most cases not strength, but poor resistance to high temperatures and/or aggressive atmospheres. The limitations in performance have confined their use to relatively low temperatures and power outputs.

The limitations of NiCr alloys, operating in oxidizing conditions, are due primarily to the formation of chromium oxide on the surface. Although this oxide layer offers some protection against further oxidation, it is not cohesive with the substrate, and tends to spall under thermal cycling, exposing fresh

material to attack. As the rate of oxidation increases with temperature, a practical limitation of about 1100°C (2010°F) is imposed on radiant tubes made from the NiCr family of materials.

Other drawbacks of these alloys include rapid carburization in heat treatment furnaces with a high carbon potential, and the formation of NiS in sulphurous atmospheres. As the Cr<sub>2</sub>O<sub>3</sub> oxide spalls, there can also be problems with contamination of the products being fired.

When NiCr tubes are used as protective tubes for electrical heating elements, the oxide spallation is a common reason for premature element failure, since loose oxides from the tube short-circuit the element.



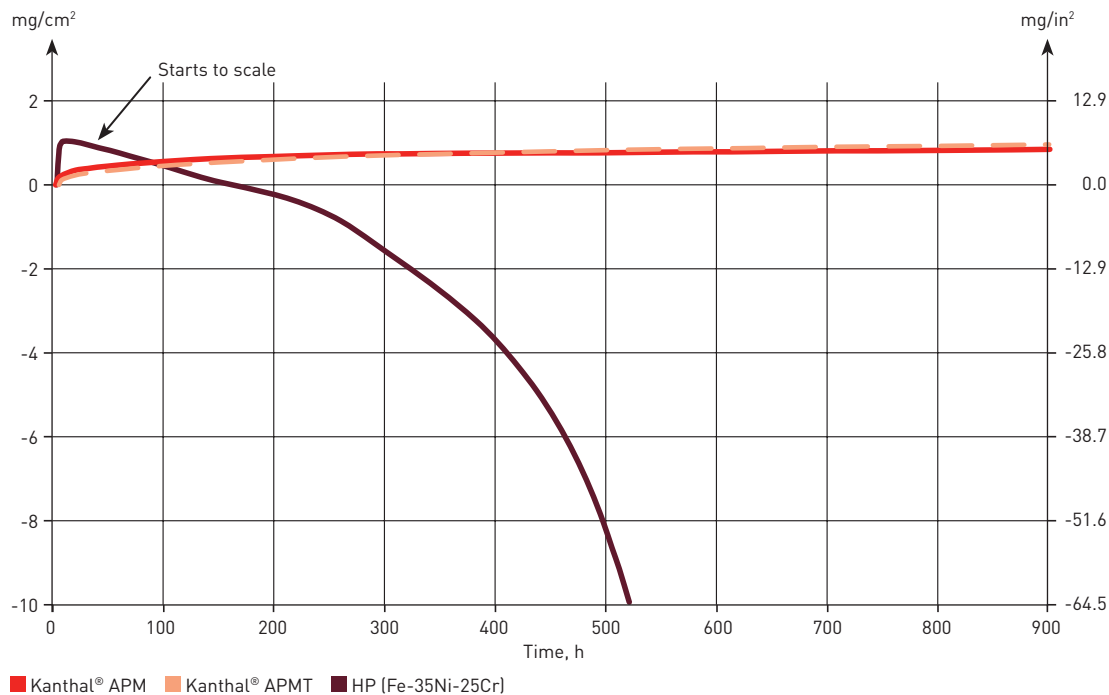
# KANTHAL® APM OR KANTHAL® APMT?

Kanthal® APM has been used successfully for more than a decade in various tube applications and in resistance heating elements. However, there are applications where a higher mechanical strength is desired. Kanthal® APMT is a new alloy specially developed for these applications.

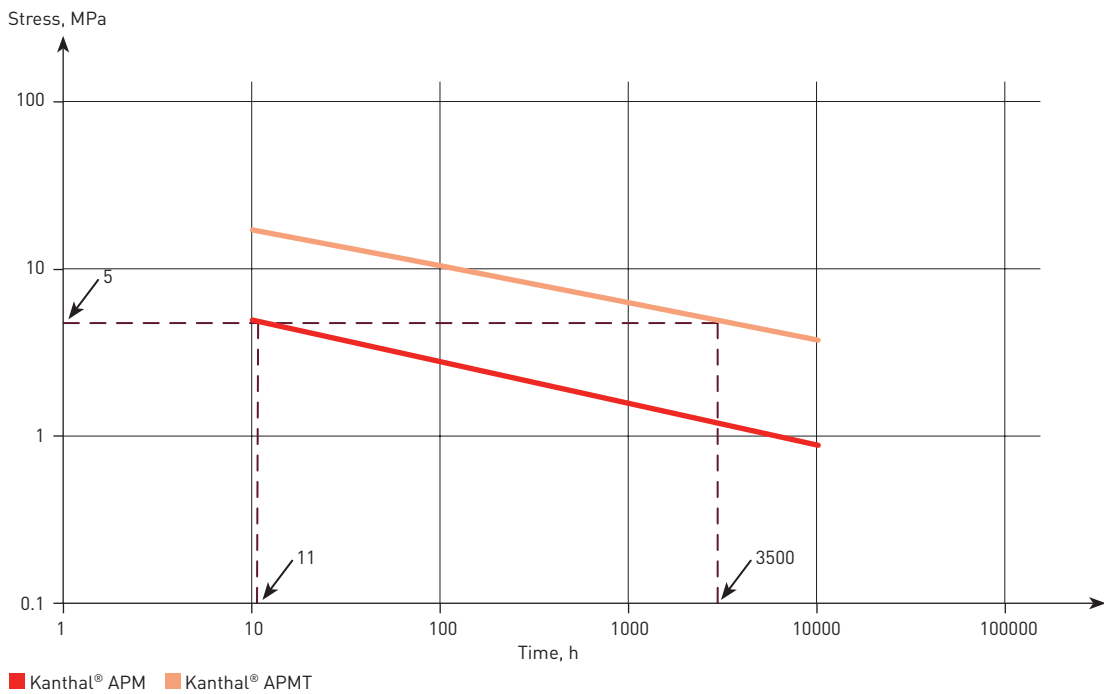
The composition of Kanthal® APMT is slightly modified compared to Kanthal® APM. The base is still FeCrAl, but Kanthal® APMT also contains 3 wt% molybdenum and the aluminum content is slightly lower. These small modifications in composition have not affected the oxidation resistance. Kanthal® APMT forms a protective aluminum oxide, just like Kanthal® APM, and tests show that the behavior in carburizing and sulphidising atmospheres is practically identical for the two alloys.

Tubes in Kanthal® APMT are considered a complement to tubes Kanthal® APM in applications where higher form stability is needed. In some instances, sagging deformation can be a problem for long, horizontal tubes in Kanthal® APM containing electric resistance heating elements like SiC Globar® or Tubothal®. Tubes in Kanthal® APMT can also solve deformation problems of metallic inner tubes or sagging of the outer tube in SER assemblies.

## SAMPLE WEIGHT GAIN - 1100°C (2010°F)



### CREEP RUPTURE TIME AT 1100°C (2010°F)



Example that illustrates the difference in creep/mechanical strength of Kanthal® APMT vs Kanthal® APM.  
At a given stress of 5 MPa time to rupture for Kanthal® APM is 11 hours compared to 3500 hours for Kanthal® APMT.

# GAS-FIRED HEATING SYSTEMS

## STRAIGHT THROUGH TUBES

In its simplest form, a radiant tube consists of a straight tube, with the burner fitted at one end and the exhaust at the other. These straight through tubes, although simple and relatively inexpensive, are inherently inefficient, as the temperature of the exhaust gases is significantly higher than the furnace temperature, and the majority of the energy of combustion is lost to the atmosphere. The use of tubes in Kanthal® APM and Kanthal® APMT, however, allows higher temperature and power output and longer life than NiCr tubes.

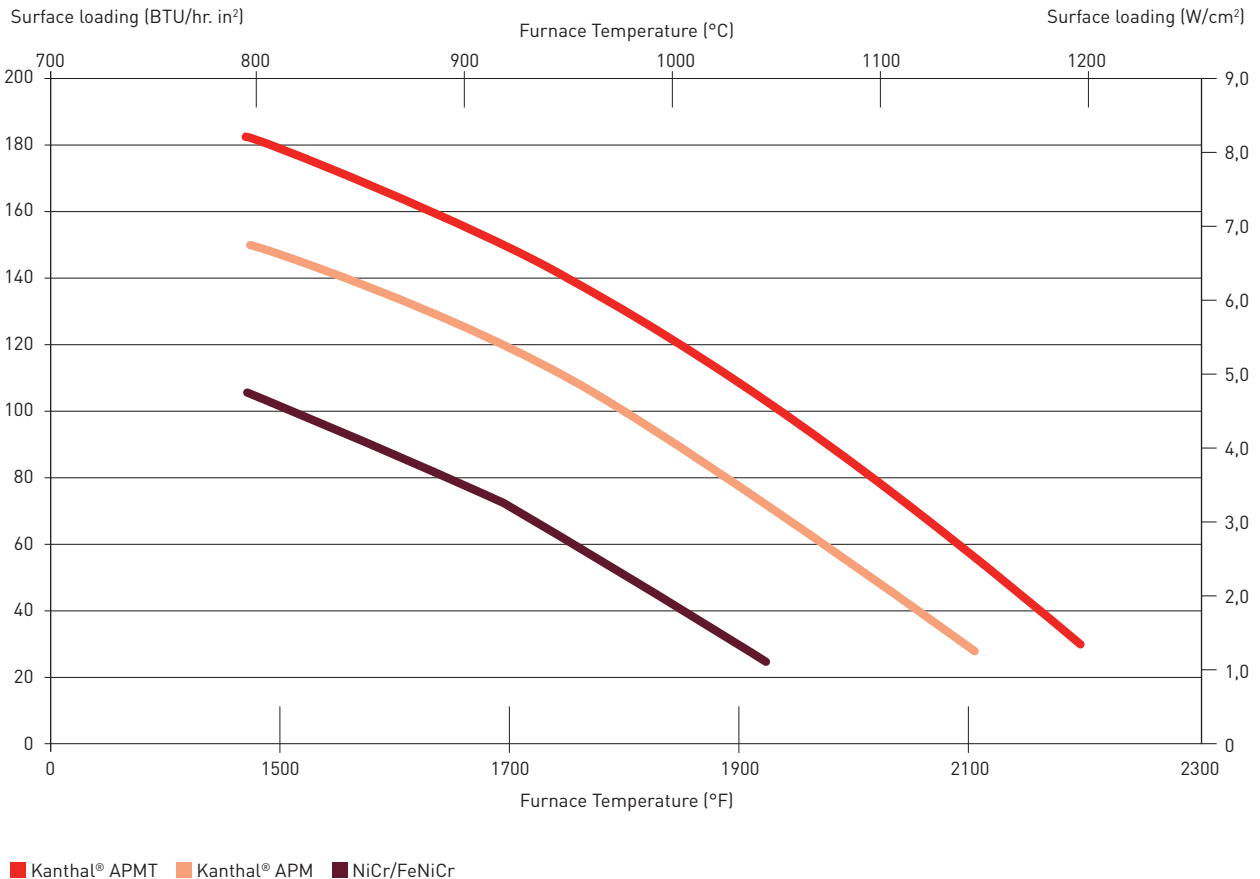
## RECUPERATIVE RADIANT TUBES - SER SYSTEMS

The majority of tubes in use today are of a single ended design, where the burner and exhaust are situated on the same side of the furnace. With these designs, the exhaust gases can be used to pre-heat the air required for combustion. This results in a major improvement in

system efficiency, by exhausting only low temperature gases into the atmosphere. Common designs are U, W, and P shaped tubes, but these are gradually being replaced by less expensive and lighter single-ended recuperative burners, SER. With this design, the recuperator is integrated with the tube. Recovery of heat from the exhaust gases takes place within the furnace wall, minimizing heat loss in the process.

Modern, high efficiency SER systems offer efficiencies in excess of 80% and are highly cost effective compared with direct fire systems and straight through designs of radiant tube. The inherent reliability and temperature capability of tubes in Kanthal® APM and Kanthal® APMT makes them an ideal partner for the modern low NOx, high efficiency burners available, and they are rapidly becoming the preferred choice for the most demanding of radiant tube applications.

## MAXIMUM TUBE SURFACE LOADING





With SER burners, the limiting factor in the design is normally the inner or re-circulation tube, which operates at a significantly higher temperature than the outer tube. Even in low temperature applications, the inner tube temperature can exceed the practical maximum for NiCr materials, especially when the burner output is high. This has imposed severe limitations on the output of radiant tube designs.

Radiant tubes in Kanthal® APM and Kanthal® APMT however, are capable of far higher operating temperatures than NiCr. This has allowed burner manufacturers to exploit the higher outputs of modern designs to the full, dissipating the same power input in the furnace with fewer tubes, or uprating the input to existing systems. The potential benefits, in terms of productivity and installed costs, are immense and the use of Kanthal® APM and Kanthal® APMT alloys has extended the temperature range of radiant tube assemblies.

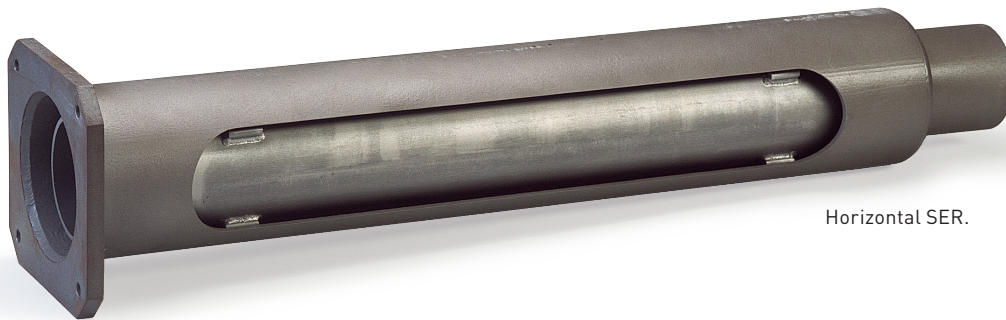
### SILICON CARBIDE INNER TUBES

Silicon carbide can be combined with tubes in Kanthal® APM and Kanthal® APMT in gas applications, where the temperature is higher or the power loading is higher than metallic tubes can endure. SER systems that work at very high temperature or high loading can be designed with a ceramic flame tube (inner). The flame tube is the part in the system that works at the highest temperature, often 100–200°C (210–390°F) warmer than the outer tube. As outer tubes, Kanthal® APM and Kanthal® APMT alloys can work under tougher conditions than other metallic tubes and have better resistance to mechanical shock than ceramic tubes. Flanges, end caps and support systems are much cheaper and easier to install for metallic systems compared to ceramic.



Vertical SER.

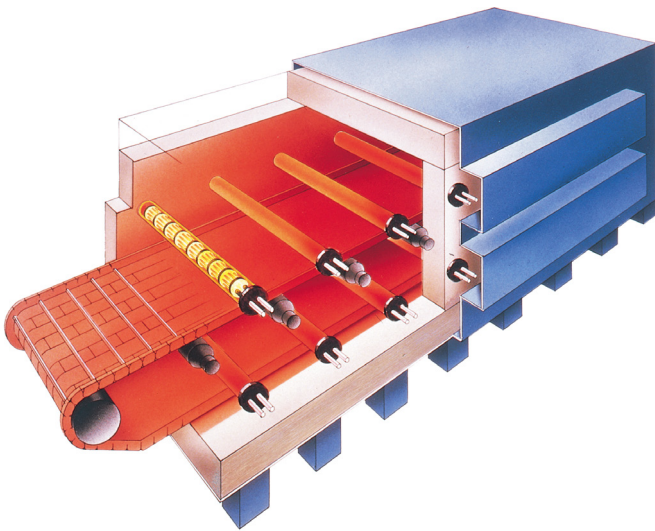
Straight through.



Horizontal SER.

# APPLICATION AREAS

Extruded tubes in Kanthal® APM and Kanthal® APMT alloys have rewritten the rule book. The combination of good hot strength, superior oxide properties, and a far higher temperature capability have opened up entirely new areas of application, previously the domain of NiCr and ceramic tubes, but with none of their drawbacks.



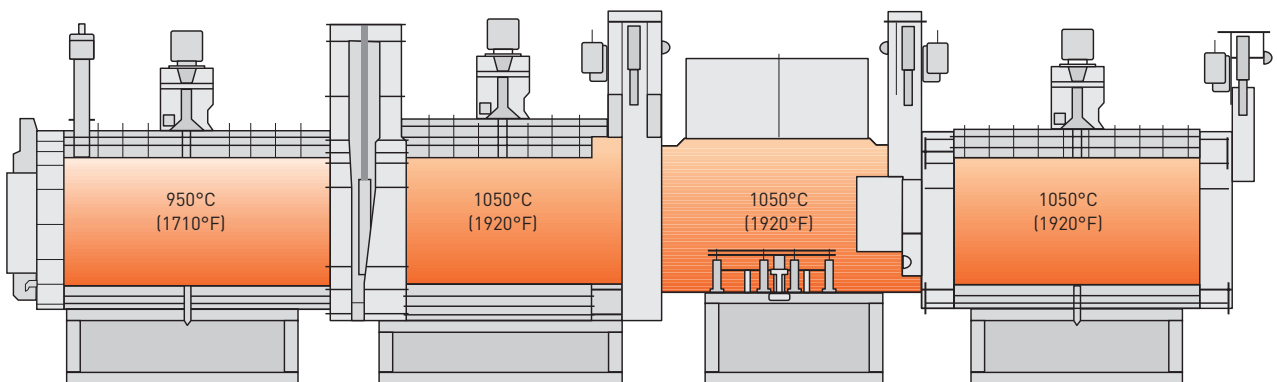
## HEAT TREATMENT PROCESSES

### CONTINUOUS HARDENING, CARBURIZING AND TEMPERING FURNACES

Tubes in Kanthal® APM and Kanthal® APMT alloys and Tubothal® heating elements have proved to be a maintenance free combination in this type of operation. Aluminum oxide scale protects the tube from carburization, and because of the higher rating potential, productivity can be increased without putting tube life at risk. A retrofit with tubes in Kanthal® APM and Kanthal® APMT for gas or electric furnaces is easily carried out, resulting in higher production and reliable long-term operation.

### HIGH TEMPERATURE CARBURIZING

Carburizing normally takes place at 930°C (1710°F) but with Tubothal® heating elements, it is possible to increase the temperature to 1050°C (1920°F) and the furnace capacity by some 30%. The system with Tubothal® heating elements are in fact the only metallic system that could work at this elevated temperature. The furnace atmosphere, endothermic with a high carbon potential at the carburizing zone, is not a problem for tubes in Kanthal® APM and Kanthal® APMT.



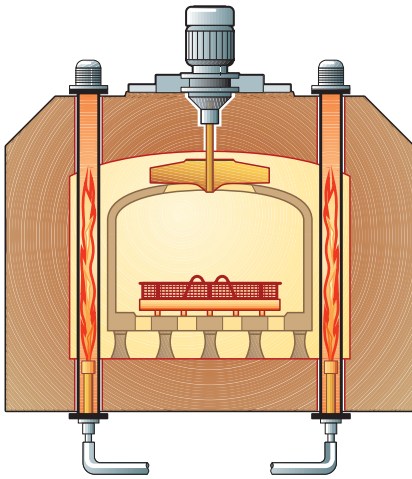
A schematic outline of the furnace type with typically four zones. No 1 heating at 950°C (1710°F), No 2 heating at 1050°C (1920°F), No 3 carburizing and No 4 diffusion both at 1050°C (1920°F).

**SEALED QUENCH FURNACES**

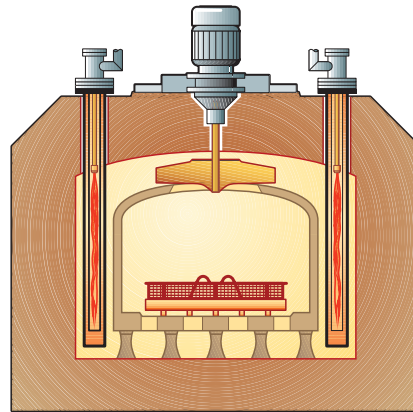
The carburization resistant properties of tubes in Kanthal® APM and Kanthal® APMT make them ideal for use in sealed quench furnaces with high carbon potential atmospheres. High loading and temperature possibilities can uprate the furnace and increase production at low cost.

**Gas heated** – with or without inner tubes.

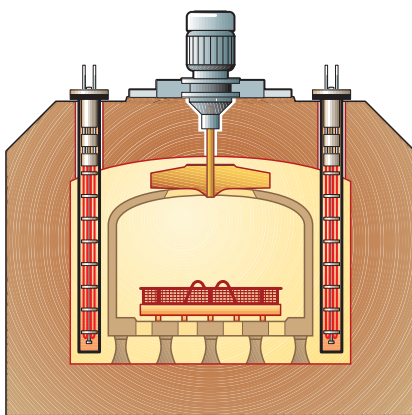
**Electric heated** – with Tubothal®, Kanthal® Super or Globar® heating elements.



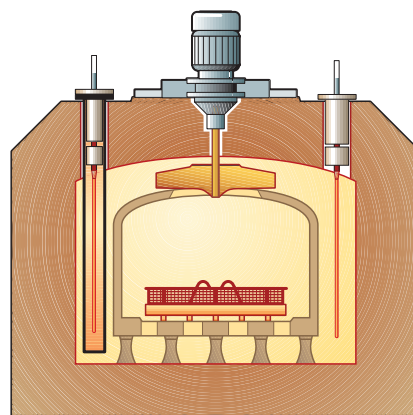
Gas heated – straight through.



Gas heated – SER.



Electric – Tubothal®.



Electric – Kanthal® Super or Globar®.

## NON-FERROUS INDUSTRY

### ALUMINUM MELTING AND HOLDING

The high power of Tubothal® heating elements, combined with the corrosion resistant oxide surface of tubes in Kanthal® APM and Kanthal® APMT alloys, is the main reason for the success of this system in melting and holding furnaces. A lifetime of up to three trouble free years is not unusual.

### DOSING FURNACES

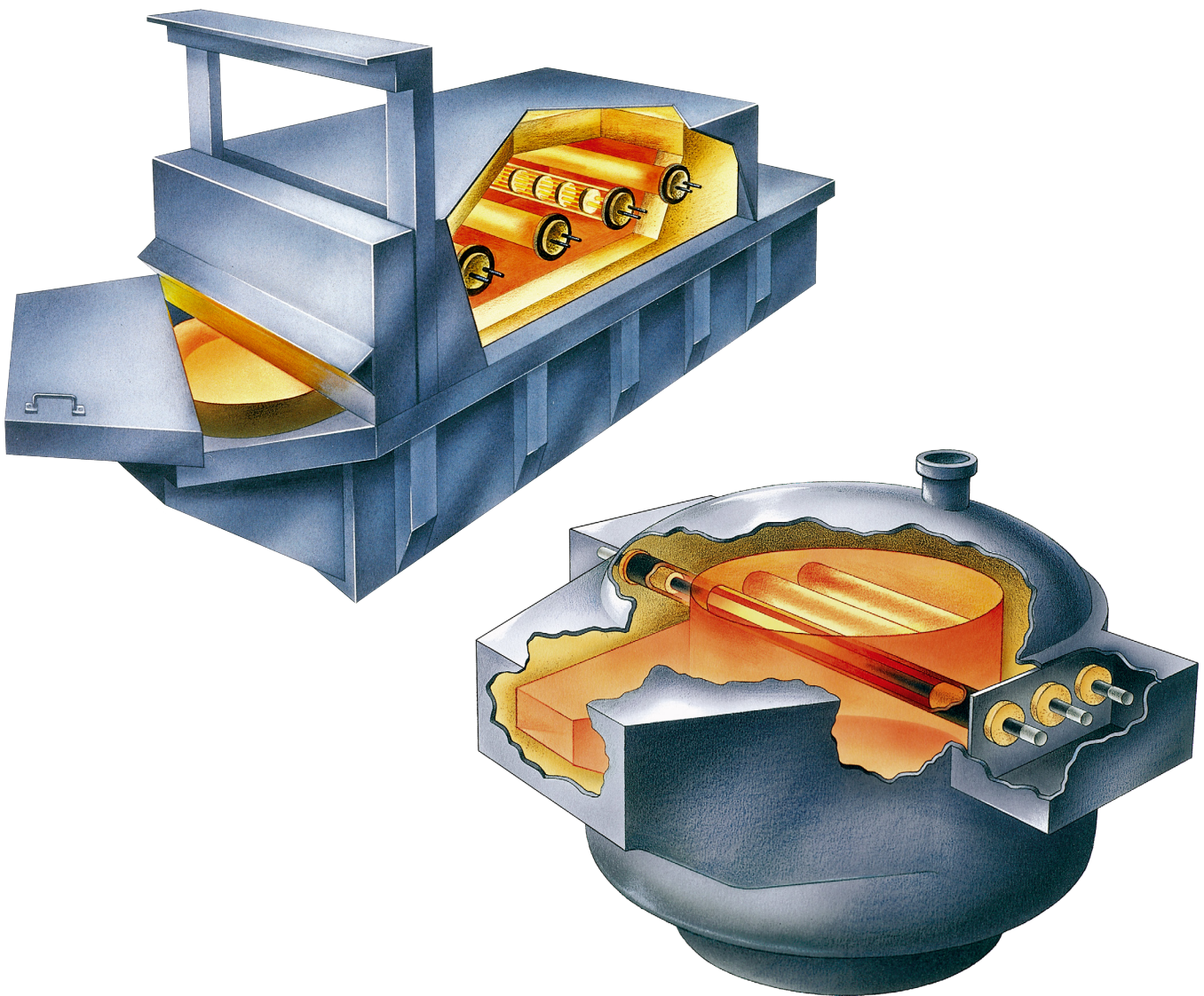
Globar® silicon carbide elements are normally used without protection tubes. The use of tubes in Kanthal® APM and Kanthal® APMT alloys has, however, several advantages. Dross and slag is often removed manually with a risk of breaking the elements and contaminating the aluminum bath. Tubes in Kanthal® APM and Kanthal® APMT alloys will protect the elements and contribute to a long maintenance free operation.

### OTHER AREAS OF APPLICATION

Die-casting furnaces.

Aluminum filter boxes.

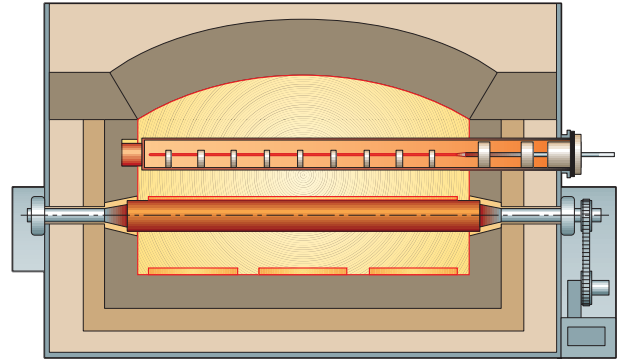
Magnesium melting and holding.



## THE STEEL INDUSTRY

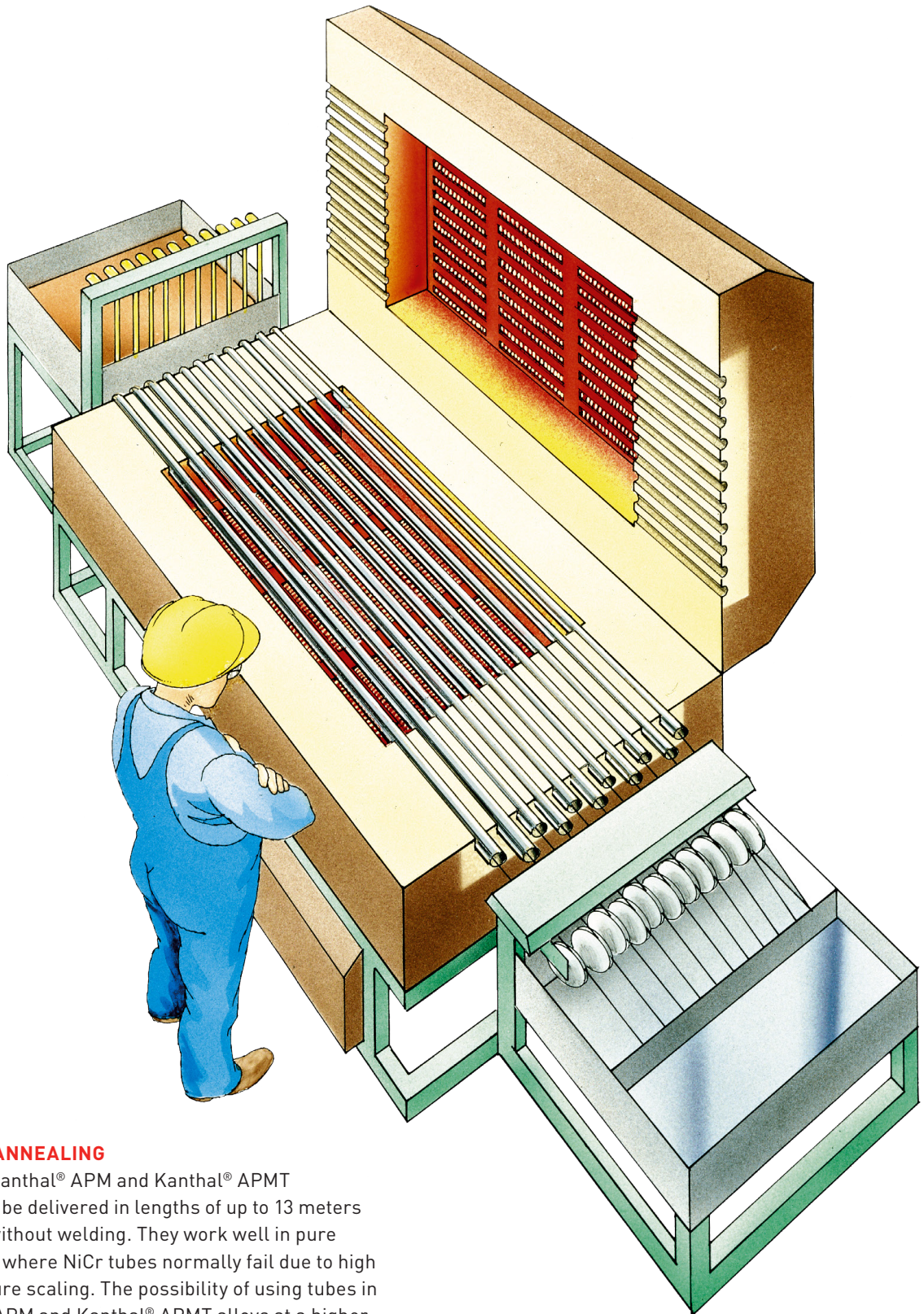
### CONTINUOUS ANNEALING LINES (CAL) AND GALVANIZING LINES (CGL)

The high demands for uninterrupted production and furnace capacity are met by tubes in Kanthal® APM and Kanthal® APMT. High loading potential, long service life and the possibility to exchange elements without interrupting production are the key reasons for their selection in this type of continuous process. Tubes in Kanthal® APM and Kanthal® APMT alloys with Tubothal®, Kanthal® Super or Kanthal Glocal heating elements can be installed horizontally or vertically.



Installation of Tubothal® and Kanthal® APM tubes in a continuous annealing line.





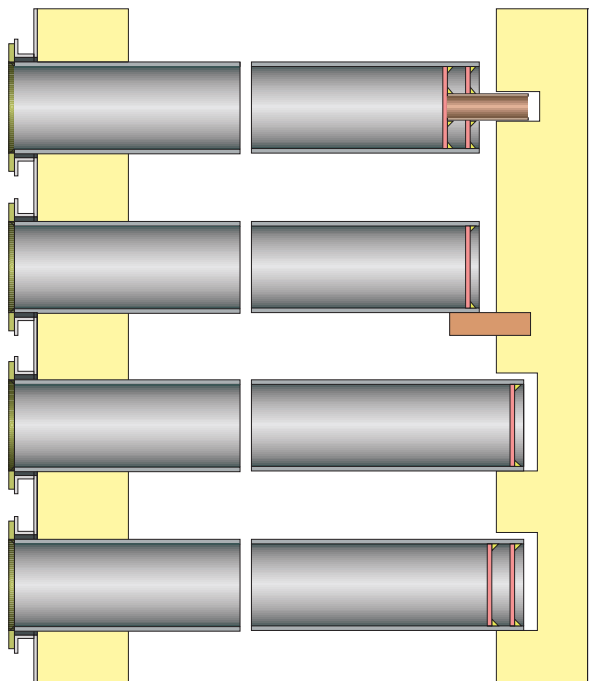
### **STRAND ANNEALING**

Tubes in Kanthal® APM and Kanthal® APMT alloys can be delivered in lengths of up to 13 meters (42.6 ft), without welding. They work well in pure hydrogen, where NiCr tubes normally fail due to high temperature scaling. The possibility of using tubes in Kanthal® APM and Kanthal® APMT alloys at a higher temperature means higher production rates.

# DESIGN AND INSTALLATION GUIDELINES

How tubes are supported is a key factor in achieving a long working life. The recommendations on how to support tubes depend on many factors, such as temperature, tube dimension, unsupported length, element weight etc.

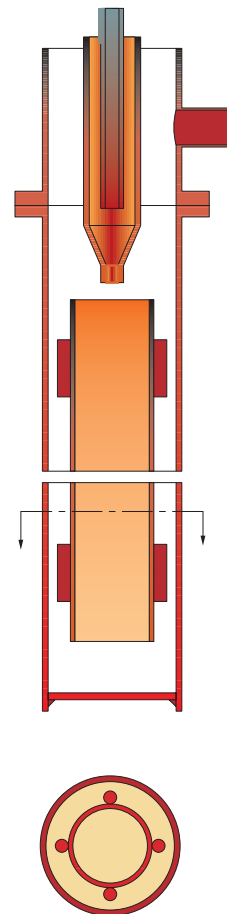
Supports should be designed with as large a support area as possible in order to spread weight and reduce the risk of indentation.



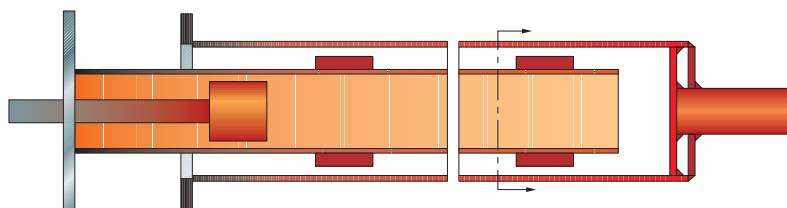
Design of different furnace wall supports.

With thermally isolating support materials, the risk of local overheating due to the shielding effect at the contact area, needs to be considered.

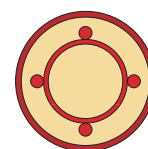
Supports should be designed in such a way that thermal expansion is not restricted.



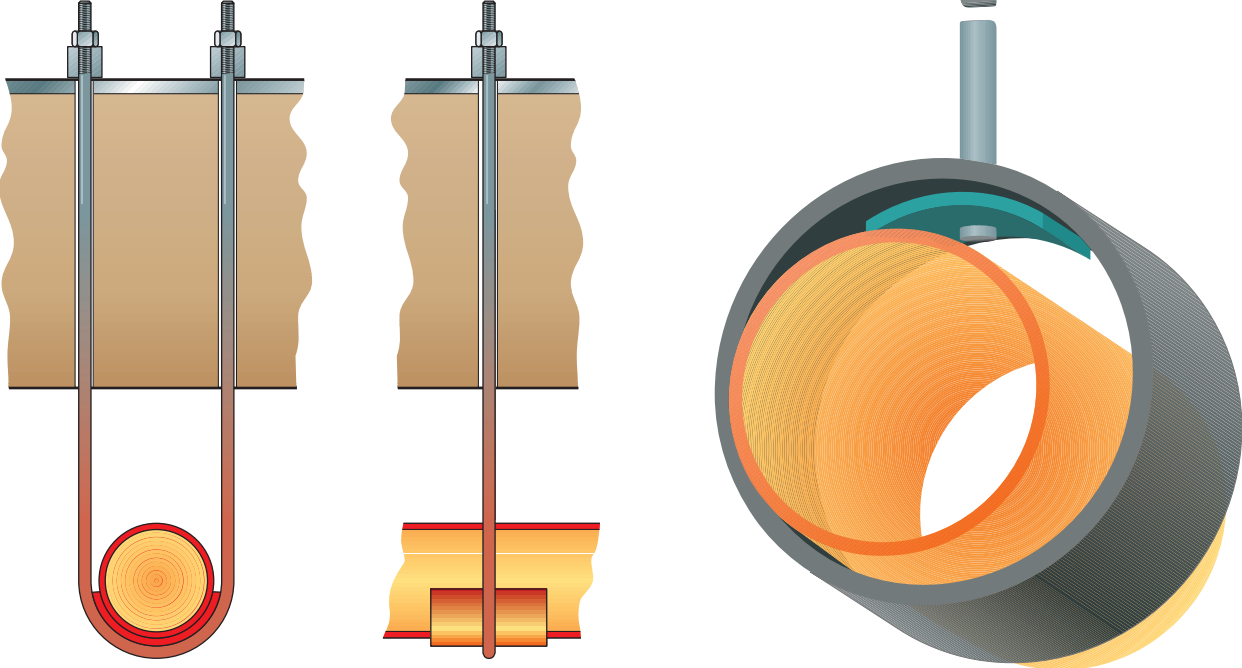
SER systems, vertically installed.



SER systems, horizontally installed.



The hangers below are a common solution for reducing the unsupported length and stress on the tube at the support points.



Designs of hanger systems for long tubes.



# PROTECTION TUBES FOR THERMO- COUPLES AND GAS ANALYZERS

Tubes in Kanthal® APM and Kanthal® APMT alloys have a long record of successful installation as protective tubes for thermocouples and gas analyzers up to temperatures of 1250°C (2280°F). There are also some installations where tubes have been used up to 1400°C (2550°F), after special design considerations.

The most commonly used tubes are in the smaller outer diameters – 26.67, 33.4 and 40 mm (1.05, 1.31 and 1.57 in) OD.

The advantages offered by using protection tubes in Kanthal® APM and Kanthal® APMT alloys are:

- Resistant to temperatures from 150°C to 300°C (300–570°F) higher than other types of metallic protection tubes.
- High resistance to attack by sulphur compounds and to carburization.
- The high temperature resistance of the material makes it possible to produce tubes with thin walls with a long service life. Thin walls give rapid heat transmission, which means higher sensitivity to temperature variations.
- The aluminum oxide layer on the protection tube has a minimal tendency to spall, which means that contamination is avoided.
- No risk of short-circuiting caused by spalled oxide. In contrast to chromium oxide, aluminum oxide is not electrically conductive.

Thermocouple protection tubes are delivered with welded end caps and suitable threads at the other end.

## TUBE DIMENSION AND DIRECT THREAD

Ø 26.67 × 2.87 mm	(1.05 × 0.11 in)	¾"	BSP
Ø 33.4 × 3.38 mm	(1.31 × 0.13 in)	1"	BSP
Ø 40 × 3 mm	(1.57 × 0.12 in)	1 ¼"	BSP



# STANDARD TUBE SIZES

OD		WALL THICKNESS		WEIGHT				MAX. LENGTH		STANDARD STOCK	
MM	IN	MM	IN	KANTHAL® APM		KANTHAL® APMT		M	FT	KANTHAL® APM	KANTHAL® APMT*
				KG/M	LB/FT	KG/M	LB/FT				
26.67	1.05	2.87	0.11	1.52	1.02	1.55	1.04	13.0	42.6	•	•
33.4	1.31	3.38	0.13	2.26	1.52	2.30	1.55	13.0	42.6	•	•
33.7	1.33	6.0	0.24	3.71	2.49	3.76	2.53	10.5	34.4		•
40	1.57	3.0	0.12	2.48	1.67			13.0	42.6	•	
50.8	2.00	6.35	0.25	6.30	4.23			7.0	23.0	•	
60.33	2.38	3.91	0.15	4.92	3.31			8.0	26.2	•	
64	2.52	4.0	0.16	5.35	3.60			7.0	23.0	•	
75	2.95	4.5	0.18	7.08	4.76	7.19	4.83	12.0	39.4	•	•
83	3.27	5.0	0.20	8.70	5.85	8.83	5.93	12.0	39.4	•	•
89	3.50	5.5	0.22	10.2	6.85	10.4	6.99	12.0	39.4	•	•
100	3.94	5.0	0.20	10.6	7.12	10.8	7.26	11.5	37.7	•	•
109	4.29	5.0	0.20	11.6	7.79			10.0	32.8	•	
115	4.53	5.5	0.22	13.4	9.00	13.6	9.14	8.0	26.2	•	•
128	5.04	5.5	0.22	15.0	10.08			12.0	39.4	•	
146	5.75	6.0	0.24	18.7	12.57	19.0	12.77	9.5	31.2	•	•
154	6.06	6.0	0.24	19.8	13.30			8.0	26.2	•	
164	6.46	6.0	0.24	21.2	14.25			7.0	23.0	•	
178	7.01	8.0	0.31	30.3	20.36			6.5	21.3	•	
198	7.80	9.0	0.35	37.9	25.47	38.5	25.87	5.0	16.4	•	•
260	10.24	11.0	0.43	61.1	41.06			3.0	9.8	•	

\* Tubes in Kanthal® APMT are also available in all sizes. Please contact Kanthal for special requests.

## TOLERANCES

### TUBES ≤OD 50 MM

#### OD

± 1.5%, min ± 0.75 mm (0.030 in)

#### Wall thickness

± 15%, min ± 0.6 mm (0.024 in)

#### Straightness

Max height of arc 3 mm/1000 mm (0.12 in/39.4 in)

### TUBES >OD 50 MM

#### OD

± 1%

#### Wall thickness

± 15%

#### Straightness

Max height of arc 3 mm/1000 mm (0.12 in/39.4 in)

Tubes made from Kanthal® APM and APMT material are not suitable, classified or approved for use in applications where they will be securing a pressure or vacuum. I.e. in applications where stresses are induced in the construction/tube wall/material caused by a pressure differential between the inside and the outside.

It's the user's responsibility to check the suitability of the chosen material/ product for their application and to ensure that the use is in accordance with local laws and regulations.

