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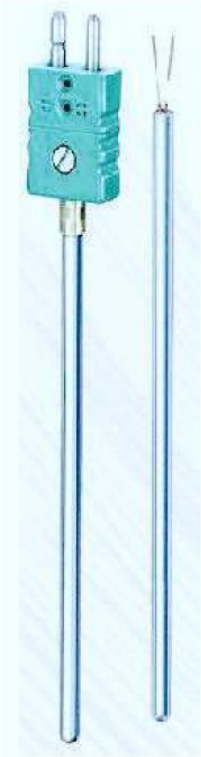
T9 – MANTEL THERMOELEMENTS AND RESISTANCE THERMOMETERS



In the temperature measurement technique, the use of **Mantel** - mineral insulated thermocouples and resistance thermometers is growing more and more in all industrial processes.
Their difference in use compared to thermocouples and resistance thermometers of classical structure are:
- there is no contamination and oxidation of the hot end of the thermocouple, because it is in highly compressed magnesium oxide, without the presence of oxygen,
- the junction of the sensor and the lines is in highly compressed magnesium oxide without the presence of oxygen,
- faster response,
- great resistance to vibrations,
- higher reliability in operation,
- longer service life.

Technical characteristics

The external diameter of the mantle ranges from 0.15 to 8.00 mm.
Thermocouple thermoelectrodes and resistance thermometer sensor leads are insulated with highly compressed magnesium oxide.
They are placed inside a thin-walled tube made of fire-resistant stainless steel.
Thermocouple thermoelectrodes and resistance thermometer sensor leads are insulated from each other and from the sheath.
The ends of the electrodes are welded and form a hot junction, and the sheath is closed at that end with the so-called plug for mantels, which is made of the same material as the mantel sheath.
The hot end is insulated from the sheath, but it can be, according to the customer's request, welded to the sheath - connected to the ground.
For mantel resistance thermometer, the leads are punctured for outputs from the sensor, and the sheath is closed at that end with the so-called plug for mantels, which is made of the same material as the mantel sheath.

Use

- in furnaces/drying kilns
- in gaseous and liquid media (air, gas, water, oil, etc.)
- on external surfaces of containers, pipelines, devices and machines
- in laboratory and experimental devices
- in environments with high and low pressure, with large flows, etc.

MANTEL THERMOELEMENTS

MANTEL THERMOELEMENTS - mineral insulated thermocouples

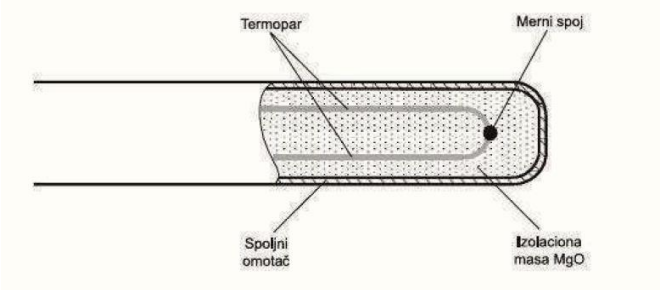
In the temperature measurement technique, the use of Mantel - mineral insulated thermoelements is growing more and more in all industrial processes. Their difference in use compared to thermocouples and resistance thermometers is in their smaller structure, short (fast) response and their flexibility (plasticity) so that they can always be brought to hard-to-reach places. They are resistant to vibrations and have a long service life.

Use:
- in furnaces/drying kilns
- in gaseous and liquid media (air, gas, water, oil, etc.)
- on external surfaces of containers, pipelines, devices and machines
- in laboratory and experimental devices
- in environments with high and low pressure, with large flows, etc.

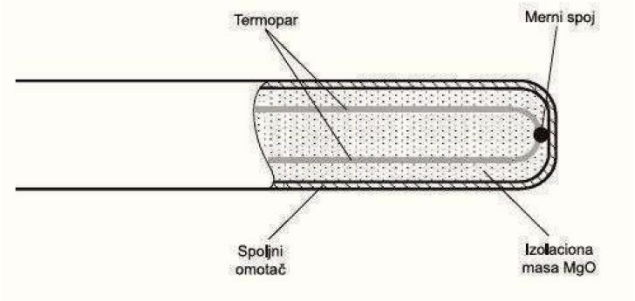
The following table gives the materials used to make the mantel sheath:

Standard	Thermocouple	Type	Mantel sheath material			
			1.4541	1.4841 /1.4845	2.4816 (Inconel 600)	Pt 10%Rh
DIN EN 60584	NiCr-Ni	K	●	○	●	
	NiCrSi-NiSi	N			○	
	Fe-CuNi	J	●		○	
	Pt13%Rh-Pt	R			○	○
	Pt10%Rh-Pt	S			○	○
	Pt30%Rh-Pt6%Rh	B				○
	Cu-CuNi	T	○			
	NiCr-CuNi	E	○			
DIN 43710	Fe-CuNi	L	○		○	
	Cu-CuNi	U	○			
● in stock ○ Purchase, delivery upon special request						

External diameter of the mantle ranges from 0.15 to 8.00 mm. Thermocouple thermoelectrodes are insulated most often with highly compressed magnesium oxide and placed inside a thin-walled tube made of fire-resistant and stainless steel. Thermocouple thermoelectrodes are insulated from each other and from the sheath. The ends of the thermoelectrodes are welded and form a measuring junction, and the sheath is closed at that end with the so-called plug for mantels, which is made of the same material as the mantel sheath. The measuring junction is insulated from the mantel sheath, but it can be, according to the customer's request, welded to the sheath - connected to the ground as given in the following sketches. When ordering, it is necessary to emphasize whether an insulated measuring junction or a junction connected to ground is required.



Thermocouple/Measuring junction/
External sheath/ Insulating mass MgO



Thermocouple/Measuring junction/
External sheath/ Insulating mass MgO

MANTEL THERMOELEMENTS

Technical details for mantel thermoelements (most used) are listed in the following table.

External diameter of the sheath mm	**Smallest bending radius approx. mm**	**Maximum production length approx. mm**	**Fe-CuNi, Type J IEC 584-1**				**NiCr-NiAl, Type K IEC 584-1**			
			1 thermocouple		**2 thermocouples**		**1 thermocouple**		**2 thermocouple**	
			Thermoelectrode diameter approx. mm	**Resistance per one thermo couple at 20 °C approx. Ω/m**	**Thermoelectrode diameter approx. mm**	**Resistance per one thermo couple at 20 °C approx. Ω/m**	**Thermoelectrode diameter approx. mm**	**Resistance per one thermo couple at 20 °C approx. Ω/m**	**Thermoelectrode diameter approx. mm**	**Resistance per one thermo couple at 20 °C approx. Ω/m**
0.5	2.5	40	0.08	1.22	-	-	0.08	135.0	-	-
1.0	5.0	300	0.15	24.0	-	-	0.15	32.0	-	-
1.5	7.5	300	0.23	11.0	0.18	12.0	0.23	14.0	0.18	16.0
3.0	15.0	300	0.45	2.8	0.36	3.4	0.45	4.4	0.36	5.6
4.5	22.5	140	0.68	1.2	0.54	1.5	0.68	1.9	0.54	2.5
6.0	30.0	80	0.9	0.7	0.72	0.9	0.9	1.2	0.72	1.4
8.0	40.0	45	1.2	0.4	0.96	0.5	1.2	0.6	0.96	0.7

Mantel thermoelements with free lead ends are supplied with moisture resistant connectors. Considering that magnesium is hygroscopic, the ends of the mantle must not remain unprotected for a long time.

In order to minimize errors in temperature measurement, it is recommended that the immersion of the mantle thermoelement in the working medium be:

- at least 5 x external mantel diameter, for liquids.
- at least 20 x external mantel diameter, for gases.

The following table lists the response times for mantle thermocouples in seconds.

Response time in seconds – guidelines for selection															
Measuring conditions	**Interval**	**Insulated hot junction**							**Hot junction welded to ground**						
		Mantel diameter in mm							**Mantel diameter in mm**						
		0.50	**1.00**	**1.50**	**3.00**	**4.50**	**6.00**	**8.00**	**0.50**	**1.00**	**1.50**	**3.00**	**4.50**	**6.00**	**8.00**
Air	0.5	1.80	3.00	8.00	23.0	37.0	60.0	100	1.80	3.00	8.00	23.0	33.0	55.0	97.0
V=2 m/s	0.9	5.52	10.0	25.0	80.0	120	200	360	5.52	10.0	25.0	80.0	110	185	310
Water	0.5	0.06	0.15	0.21	1.20	2.50	4.00	7.00	0.03	0.06	0.13	0.22	0.45	0.55	0.75
v) 0.2 m/s	0.9	0.13	0.50	0.60	2.90	5.90	9.60	17.0	0.10	0.18	0.40	0.75	1.60	2.60	4.60
0.5/0.9: time interval is the time required for the thermocouple to indicate 50% or 90% of the change in the temperature of the working environment															

Minimum insulation resistances of mantle thermocouples, depending on the diameter of the mantle, are given in the following table.

Minimum insulation resistances of mantle thermocouples				
Number of internal electrodes	**Mantel sheath diameter in mm**			
	≤ 1.6	>1.6 to >3.0	≥3.0 to <8.0	≥8.0
2	U= 100 V R> 1000 (MΩ · m)	U= 500 V R> 1000 (MΩ · m)	U= 500 V R> 1000 (MΩ · m)	U= 500 V R> 1000 (MΩ · m)
4	U= 50 V R> 1000 (MΩ · m)	U= 250 V R> 1000 (MΩ · m)	U= 500 V R> 1000 (MΩ · m)	U= 500 V R> 1000 (MΩ · m)
6			U= 500 V R> 1000 (MΩ · m)	U= 500 V R> 1000 (MΩ · m)
U – Test voltage DC R - Insulation resistance in relation to the mantle length, unit (Ω · m) at ambient temperature 20 ± 15°C and humidity <80%				

MANTEL THERMOELEMENTS

Guidelines for selection of the external sheath material of the mantel thermoelement depending on the use

Wall thickness of the external sheath of the mantel thermoelement is about 15% of the diameter of the sheath. The diameter of the thermoelectrodes depends on the number of thermocouples in the mantle and can have a value ranging from 12% to 19% of the diameter of the mantle.

Material: W.Nr 1.4541 (AISI 321)

Resistance to corrosion and temperature: Material has excellent resistance to aggressive media including hot crude oil, steam and mixed gases. When the working medium is air, its resistance to oxidation is up to a temperature of 900°C. When temperatures vary, its resistance to oxidation is up to 800°C. Resistance to carbon dioxide is up to 650°C. It is also stable at temperatures below zero, down to -250°C. It has excellent resistance to corrosion in a medium in which particles of different sizes are present. It is well shaped and is suitable for temperature measurement in pipelines and is suitable for all welding technologies.

Use in chemical apparatus, heat exchangers, furnaces, textile and paper industry, crude oil processing industry-petrochemistry, chemical industry, food industry, milk and beer production, etc.

Material: W.Nr 1.4571 (AISI 316 Ti)

Resistance to corrosion and temperature: As with the above-mentioned material 1.4541. Due to the content of molybdenum, it has an increased resistance to corrosion in case the medium is an aggressive environment - sulfuric acid, phosphoric acid, salt water, etc. When the working medium is air, its resistance to oxidation is up to a temperature of 900°C. When temperatures vary, its resistance to oxidation is up to 800°C. Resistance to carbon dioxide is up to 650°C. It is also stable at temperatures below zero, down to -250°C. It has excellent resistance to corrosion in a medium in which particles of different sizes are present. It is well shaped and is suitable for temperature measurement in pipelines and is suitable for all welding technologies.

Use: Due to the increased level of resistance to corrosion, it is suitable for installation in equipment for the chemical industry, for installation in furnaces, sulfur and chemical mixtures, for equipment in the textile, photochemical and pharmaceutical industries, as well as in petrochemistry.

Material: W.Nr 1.4841 (AISI 314/310 S)

Resistance to corrosion and temperature: Fire-resistant steel which, when the working medium is air, can be continuously operated up to a temperature of approximately 1150°C (1.4841) or 1050°C (1.4845) as well as when the temperature varies up to approximately 1000°C. It has exceptional resistance to corrosion. It is highly resistant to the environment in which nitrogen, carbon dioxide and a small amount of oxygen are present. Carbon dioxide resistance is up to 900°C. It is also resistant to concentrated nitric acid up to 20°C and liquid nitrates up to 420°C. It maintains mechanical strength at high temperatures. The presence of a large amount of nickel results in sensitivity to sulfur-containing furnace gases, especially in

reduced atmospheres. It has resistance to the atmosphere containing carbon dioxide. The arc welding technique is used for this material.

Use: In all areas where extremely high resistance and strength are an advantage. It is especially used in the crude oil processing industry - petrochemistry, for installation in furnaces, heat exchangers, air heaters, construction materials industry (cement, bricks, glass, ceramics, etc.)

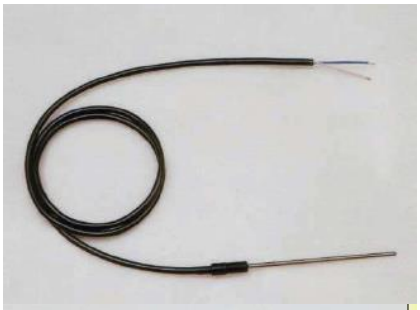
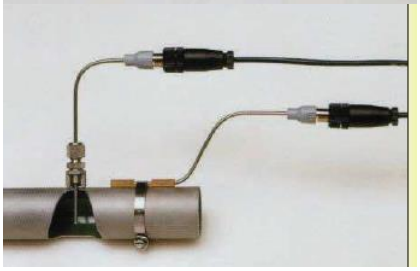
Material: W.Nr 2.4816 (Inconel 600)

Resistance to corrosion and temperature: Inconel 600 is an alloy in which a large amount of nickel is present, which is why it shows exceptional mechanical properties at high temperatures. It has great flexibility. It is highly resistant to corrosion, as well as to enhanced corrosion that leads to cracking. Exceptional resistance to oxidation up to 1150°C. It is highly resistant to halogen elements: chlorine and hydrogen. It has weak resistance to nitric acid. Suitable for all welding techniques. Suitable for use in molten metals such as brass, lead, etc.

Use in: in blast furnaces, chemical industry, synthetic material production, glass industry, paper industry, food industry,in steam boilers, research and development.

MANTEL RESISTANCE THERMOMETERS Pt-100



TECHICAL CAHARACTERISTICS OF MANTEL RESISTANCE THERMOMETERS Pt 100

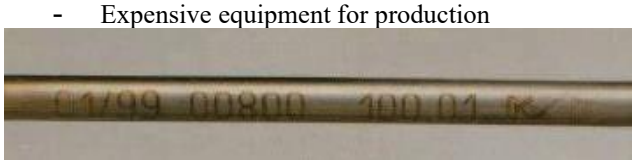
- Single or double sensors Pt 100, class A or B.
- Structure with mineral insulated cable (mantel)
- The temperature ranges from -50°C to + 500.
- Mantel diameters: ∅ 2, ∅ 3, ∅4.5 and ∅ 6(mm).
- Length: standard or upon the request of the customer.

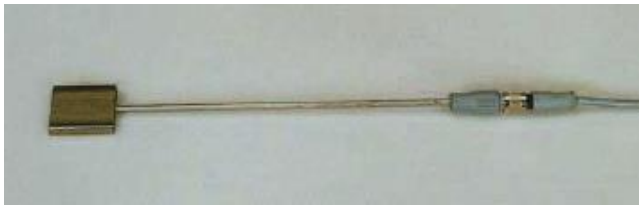
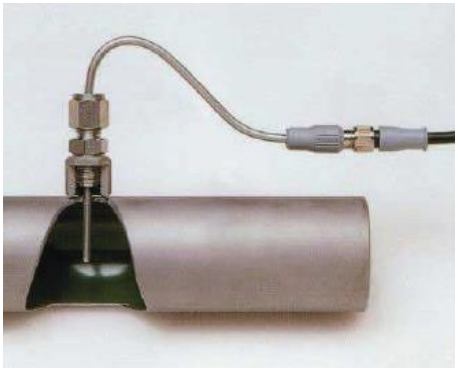
ADVANTAGES

- Fast response
- Flexibility (plasticity)
- High resistance to vibrations
- Reliability in operation

DISADVANTAGES

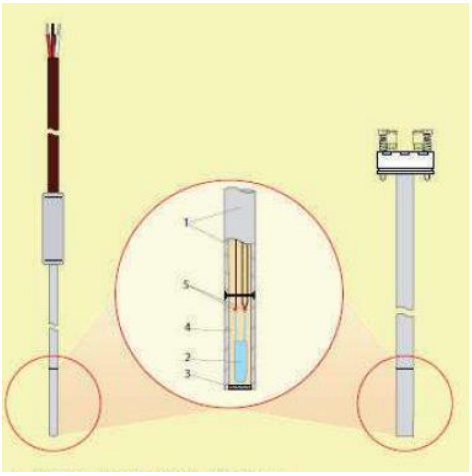
- Expensive equipment for production



When ordering: emphasize that it is a MANTEL RESISTANCE THERMOMETER Pt 100

MANTEL RESISTANCE THMOMETERS Pt - 100



Mineral insulated cable - consists of:

1. Metal tubes with diameter ∅ 2, ∅ 3, ∅4.5 and ∅ 6(mm).

- Internal wires (conductors), there can be 2, 3, 4, 6 or 8 wires. The wires are made of copper, nickel or nickel-plated copper.
- Insulation from highly compressed magnesium oxide, which insulates the internal wires, longitudinally - from each other and from the external sheath.

2. Sensor 1xPt 100 or 2xPt100 - with specific production technology, it is placed inside a metal tube, so that the complete sensor is located in the insulation of highly compressed magnesium oxide.
3. Plug
4. Insulation MgO
5. Punctured connection of the sensor Pt 100 outlet and internal wires

Mantel resistance thermometers Pt 100 are used wherever high requirements are set in terms of mechanical, chemical, electrical stability and where high operational reliability is required, and due to their flexibility, they are increasingly used for temperature measurement in hard-to-reach places.
Optionally, mantel resistance thermometers can be supplied with a transmitter (4-20) mA instead of a ceramic terminal.

Ceramic terminal
For the metal contacts on the terminal, the free ends of the conductors are connected by puncturing