R 58®
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Installation and operating instructions for sheathed thermocouple assemblies

1. General notes concerning operation

1.1 Design

Our R9 series sheathed thermocouple assemblies (MTE) are specifically designed for use in low and medium temperature ranges. According to customer requirements and the materials used, the designs are built in accordance with or similar to DIN EN 61515 and DIN EN 60584 for a measuring range between -200°C and 1200°C. As standard, our thermocouple probes are equipped with 1, 2 or in special designs, with 3 thermocouples.

1.2 Important factors to note

Thermocouple probes should only be installed by trained and authorized staff. Operational safety essentially depends on proper installation and use. Sheathed thermocouple assemblies are specially designed for measuring temperatures and only work in connection with specially adapted evaluation units such as regulators, graphical recorders, measurement transducers etc. Thermocouple probes are so-called touching sensors. The necessary conduction of the medium / temperature to be measured to the sensor takes place via a touching contact to the medium. Before starting any work, staff need to have carefully read and understood these instructions. A basic requirement for safe working practice is to make sure you have received all the safety notes and operating instructions as stated in these instructions. In addition the relevant local accident prevention rules apply as well as the general safety provisions outlining where the equipment can be used.

1.3 Limitation of liability

All information and notes in these instructions have been put together taking into account the applicable standards and rules, the state of technical progress as well the findings and experience we have gathered over time. The manufacturer does not assume any liability for damage due to

- non-compliance with these instructions
- usage other than that specified
- usage by staff who have not been trained
- unauthorised modifications
- technical changes
- the use of non-approved spare parts

The actual scope of delivery can differ from the explanations and representations described here in the case of special designs, where the customer has made use of additional ordering options (customized orders) in the case of the latest technical developments (technical changes). The obligations agreed in the supply contract, the general terms and conditions, the manufacturer's delivery conditions and the applicable statutory rules and regulations which apply when the contract is concluded all apply.

1.4 Copyright protection

1.5 Customer service

Our customer support team is available to provide technical information. For contact details, please refer to page 1. In addition, our staff are always interested in finding out new information and user experiences which arise from use of the equipment and which could be of use in improving our products.

2. Installation and operation

2.1 Carrying out tests before installation

Users need to make sure that our R9 series thermocouple probes are checked for mechanical damage and/or transport damage, i.e.

- no damage to the outer sheath of the thermocouple assemblies or the connecting conductors
- that the minimum bending radii (for this, see chapter 2.2) have been adhered to.

2.2 Installing the sheathed thermocouple assemblies

The processing connection of the sheathed thermocouple assembly must correspond with the processing connection of the system. When installing the sheathed thermocouple assembly with a clamp connection, the terminal nut is tightened manually until the arrester is clearly felt and then, using a spanner which fits the width across the flat, fully tightened by ¼ of a turn in the case of PTFE female support rings and 1 ¾ turns in the case of a (VA) stainless steel tapered ring. In the case of sensors < 0°C, it is preferable to use a precision class 3 sensor (in accordance with DIN EN 60584-2).
In order to avoid cracks and/or joining / changes in the outer sheath, sheathed thermocouple assemblies should only be inserted very slowly or pre-heated in a process.
The sheath materials that we use correspond with the technical standard DIN EN 61 515.
The sheath conductors can be curved without damaging the technical characteristics, wherein the bending radius has to be larger than 6 times the outer diameter of the sheath conductor.
In the case of small outer diameters, the thermo-wires are very thin and as such, produce a relatively high level of loop resistance. It is especially in these cases that the user must make sure that the downstream electronic devices are equipped with high-impedance inputs.
The exchangeability of thermocouple probes is only assured in the case of standardised units.
In order to keep measurement errors through thermal conduction as small as possible, the tip of the probe should be dipped as deep as possible in the medium to be measured.
The recommended minimum insertion depth for thermocouple probes is 6 - 8 x the diameter of the protective tube in fluids and 10 - 15 x the diameter of the protective tube in air/gases.
If an insufficient insertion depth is provided in vertically fitted, small diameter pipelines, the sheathed thermocouple assembly should be installed at an angle or in a pipe elbow (in each case against the direction of flow).

2.3 Electrical connection

Contact between the thermocouple probe and the evaluation units may only take place with a compensation or thermocouple conduct corresponding to the thermocouple (in accordance with DIN EN 60584-3).

The following points should be considered when selecting and laying the contact conduct:

- The insulation materials used must be resistant to the thermal, mechanical and chemical stresses which arise at the place of use.
- All conductors on the contact points must: feature bare metal (do not use core cable ends with compensation terminals), be free from corrosion, moisture, dirt and be capable of forming perfectly connected electrical contacts.
- In order to avoid electromagnetic disturbance, all compensation and thermocouple conductors must be at a distance of 0.5 m and/or run at right angles to the energy conducts. Likewise, electromagnetic disturbance can be avoided through the use of conducts with a static shield and twin stranded wires.
- According to the current ATEX guidelines, measurement conductors and conductors carrying voltage have to be laid in a way which spatially separates them (separate cable channels) of when connecting Ex - approved temperature sensors (for further information, see our special operating instructions for explosion protected temperature sensors).
- The risk of ‘spurious thermal voltage’ through the formation of interim elements can be avoided by keeping the temperature of the contact points stable (normal terminals, no thermal material).

2.4 Temperature measuring transducer in the connection head

By using an electronic temperature measuring transducer in the connection head (according to the actual design) of the thermocouple probe it is possible to reduce the effort needed to perform the electrical installation (no thermal material, 4 - 20 mA Signal is less sensitive to electromagnetic disturbances). The electrical connection of the measuring transducer must take place in accordance with the enclosed operating instructions published by the measuring transducer manufacturer.
With the installation of a head measuring transducer, users must make sure that the temperature of the connection head does not exceed the max. operating temperature of the measuring transducer.

3. Maintenance and testing of the thermocouple probe

3.1 Maintenance recommendations

Users should test the thermocouple probe and the measurement circuit at regular intervals (depending on the respective usage conditions):

- Visual check of the protective tube or the sheathed thermocouple assembly for mechanical wear and tear / damage caused by chemicals
- A test should be carried out to check temperature drift by making a comparison with a calibrated comparable element (connection base with a ‘verifier’ is required)
- A check should be made with regard to soiling/moisture by taking an insulation measurement
- A check should be made for mechanical and chemical changes to the electrical installation and its contact elements (terminal base, connection terminals, transition sleeve)

3.2 Initial error analysis

In order to test the function of a temperature measurement circuit, you require a meter with an mV and Ohm measurement range, an insulation meter with a testing voltage of 60 - 100 V DC and a calibrator for mV voltages according to the thermocouple probe signals.

As a general rule, sheathed thermocouple assemblies with stainless steel thermocouples and an outer sheath made from Inconel should only be operated up to a max. temperature of approx. 800°C. (loss of stability as a result of soiling of the thermocouple in the case of Inconel deposition)
A similar phenomenon can occur in the case of sheathed thermocouple assemblies with a Pt10%Rh sheath. Depending on the operating conditions and the operating time, a 'material migration', starts here as well. This depends on the lessening of the insulation resistance of the MgO at high temperatures (upwards of 900° C), something that can lead to a change in the alloy with a concurrent change in the thermal tension. These changes increase when the outer diameter decreases, wherein the measurement error can also be negatively influenced through the formation of additional measurement bridges within the sheath conductor.
Depending on the operating conditions (e.g. a rapid change in temperature), sheath thermocouple elements in the upper temperature range can become instable through the so-called "K" effect. In such cases, we recommend that type N is used. The (proportion of) silicon in this thermocouple largely compensates this effect thus enabling type N to be used up to 1200° C.

A thermocouple element is OK if, at room temperature:

- When heating the measuring tip (by means of a lighter, Bunsen burner or similar) of the sheathed thermocouple assembly, the mV – voltage rises slowly corresponding to the thermocouple voltage (simple functional test for thermocouple elements).
  For each of the following types, the standardised thermal voltage (in accordance with DIN EN 60584-1) at 20 °C is:
  1.019 mV for type J, 0.790 mV for type T, 1.192 mV for type E, 0.798 mV for type K, 0.525 mV for type N, 0.113 mV for type S, 0.111 mV for type R and -0.003 mV for type B.
- The insulation resistance is $R_{Iso} \geq 1000$ MΩ x m.
  Note:
  Except from the insulation powder, the insulation resistance of a sheath conductor is dependent on the conductor length and therefore, in the case of a sheathed thermocouple assembly length of ≥ 1 m, stated as a linear resistance in Ω x m. The minimum insulation resistance for a sheathed thermocouple assembly of ≥ 1 m is 1000 MΩ x m at room temperature, i.e. the amount of the actual insulation resistance that is measured (e.g. 15 MΩ) times the length of the conductor (e.g. 100 m) has to be larger than 1000 (MΩ x m).
- The resistance of the thermocouple is measured (in accordance with the following table).(Please be aware of the conductor length and the conductor cross section in the case of a connected conductor)

Sheath Ø	Fe-CuNi-1 TP	Fe-CuNi-2 TP	NiCr-Ni-1 TP	NiCr-Ni-2 TP	NiCrSi-NiSl-1 TP
0.25 mm			226.0 Ω / m		879.0 Ω / m
0.5 mm	122.0 Ω / m		135.0 Ω / m		
1.0 mm	24.0 Ω / m		32.0 Ω / m		
1.5 mm	11.0 Ω / m	12.0 Ω / m	14.0 Ω / m	16.0 Ω / m	
3.0 mm	2.8 Ω / m	3.4 Ω / m	4.4 Ω / m	5.6 Ω / m	
4.5 mm	1.2 Ω / m	1.5 Ω / m	1.9 Ω / m	2.5 Ω / m	
6.0 mm	0.7 Ω / m	0.9 Ω / m	1.2 Ω / m	1.4 Ω / m	
8.0 mm	0.4 Ω / m	0.5 Ω / m	0.6 Ω / m	0.96 Ω / m	

By connecting a calibrator instead of the thermocouple element it is easy to check the connected measuring circuit for its function and/or disconnection.

Useful tip in the case of colour indicators which are no longer present:

- Fe-CuNi => positive side is magnetic
- Cu-CuNi => positive side is copper coloured
- NiCr-Ni => negative side is magnetic
- PtRh-Pt => negative side is softer

4. Examples of designs and fixing arrangements