

Sheathed thermocouples

Sheathed thermocouples are very common in the market. Here is some practical information about the bendability and compressibility, measuring junction design, response times and isolation properties for this type of temperature sensor.

Sheathed thermocouples are constructed with what are called MI cables, with MI standing for mineral insulated. It is thereby clear that the cable contains wires that are electrically insulated by a mineral, which is often magnesium oxide, MgO. Because magnesium oxide is sensitive to airborne moisture, all open cable ends must be quickly sealed or stored in an oven hotter than room temperature. Otherwise the insulation deteriorates due to condensation and causes measurement errors. The sheathing consists of steel or nickel-based alloys which are designed so they interact as little as possible with the thermocouple's wires and insulation materials.

In Europe sheathed thermocouples are normally sold in the metric diameters of 0.5 - 1.0 - 1.5 - 2.0 - 3.0 - 4.5 - 6.0 millimetres. Other measurements, including in inches, are available.

Usually the dimensions of the wires are approximately 20% of the sheathing's external diameter. The sheathing's thickness is usually about 10% of the external diameter. See diagram 1.

USE COMMON SENSE WHEN BENDING MI CABLES

MI cables are plastically bendable, which means that they remain in the bent position.

When the initial material is drawn out using drawplates to achieve the desired external di-

ameter, the magnesium oxide becomes very tightly packed and the measurements of the other contents of the cable become proportionately smaller. The cables must not

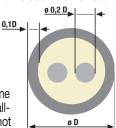


Diagram 1. Cross-section of sheathing material. The measurement ratios are approximate.



Diagram 2: The bending radius should be greater than twice the sheathing dia-

meter. E.g.: A Ø 3 mm sheathing should be bent over at least a Ø 12 mm pipe.

be bent over sharp edges. The Cable manufacturers usually state that you can bend the cable as long as the bending radius is greater than double the sheathing diameter. See diagram 2. A good tip for working with smaller dimensions is to shape the sensor carefully with your fingers.

The homogenously compressed cable structure also makes it possible to use either pressure-tight compression fittings with steel olives or another clamping method to attach the insertion length, for example when measuring through a steel wall or a plate into an oven. Tightening will press the olive tightly against the sheathing so that the sensor cannot subsequently be moved along the insertion length. Olives made of PTFE materials will not do this, but they will allow you to alter the insertion length repeatedly. However, PTFE olives cannot withstand as high pressures as the steel type can. See diagram 3.

DIFFERENT MEASURING JUNCTIONS

Welding together the thermocouple wires and sealing the probe tip can in principle be done in three different ways as depicted in diagram 4 A-C: with an isolated, grounded or exposed measuring junction. What you choose depends on what properties you prioritise.

ISOLATED JUNCTION: We recommend this type be your first choice because it is the safest construction both electrically and mechanically. The wires and outer sheathing are separated by tightly packed magnesium oxide, which does not require the same high resistance galvanic isolation for the accompany-

Diagram 3. Pressure-tight attachment can make it easier to mount a sensor. Pentronic's solution consists of a body, olive, and in some cases pressure bushing, plus cap nuts that provide clamping force.

ing measuring instruments as is required for grounded and exposed junctions. See table 1 and IRef 11.

GROUNDED JUNCTION: The biggest advantage of this type is that it has a somewhat faster response time than the isolated type because the junction is welded to the sheathing, thereby facilitating heat transfer. Grounding the junction does introduce a risk of interruption at rapid temperature cycles of a few hundred degrees. The reason is the stresses caused by the various linear expansions of the sheathing and wires. Another limitation of grounded junctions is the electrical connection created between the junctions when two or more thermocouples are taking measurements at the same installation. Remember that many liquids, including water, are sufficiently conductive to make it impossible to measure temperature differences within the liquid. Bipolar switching loggers or isolating transmitters solve these problems. [Ref 1].

exposed Junction: This type should only be used when your most important priority by far is to have a short response time, for instance when measuring within air flows. The reason is because the seal at the junction limits the temperature level and is sensitive to mechanical stresses.

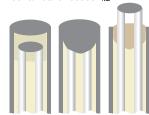


Diagram 4. Fundamental differences between different types of junction designs: A: Isolated junction, B: Grounded junction, C: Exposed junction.

Sheathing diameter D, mm (single thermocouple)	Test voltage, Vdc	Isolation requirement, $\mbox{M}\Omega$
D ≤ 0,8	1	> 20
0,8 < D ≤ 1,5	100	> 1000
D > 1,5	500	> 1000

Table 1. Pentronic's isolation requirements for acceptance testing of manufactured single sheathed thermocouples at room temperature. At higher temperatures, from 800 – 1000 °C, the isolation deteriorates drastically.

[Ref 1] PentronicNews 2009-1.

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