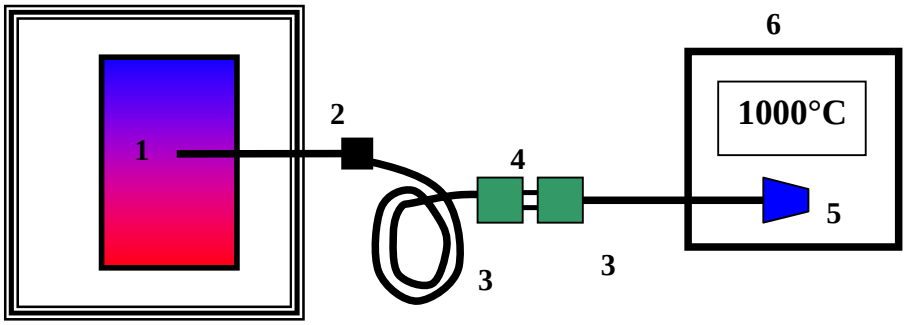
Thermocouple Problem Solving.
Dave Ayres, Calserv

Below is a 6-point procedure we use to determine the cause of problems with thermocouple temperature measuring systems. We hope it might be useful to you when you have a problem.

Things to remember:

A. Thermocouples (T/CS) measure temperature difference and not absolute temperature. The output depends on the temperature difference between the measuring junction and the reference junction.

B. The voltage is produced at the temperature gradients and not at the junctions. The sum of the voltages produced at the various gradients gives the measured voltage.



Procedure:

1. Make sure the measuring junction is in the correct position to give the correct temperature to the uncertainty or tolerance that is required. It sounds obvious but is often missed, especially in applications where there is insufficient immersion of the sensor into the object whose temperature is to be measured. A simple rule of thumb is that the immersion should be more than 10 X diameter plus the length of the sensing part of the thermometer. For a 6mm diameter sheathed T/C we need at least 60mm plus about 5mm because the junction will not be at the end of the sheath. This assumes there is a good contact (about 0.5mm clearance if in a pocket or immersed in a liquid) between the object and the thermometer, and that the object's temperature is uniform i.e. isothermal. It is safer to use 20 X the diameter or more if in any doubt. A simple test to determine if there is an immersion problem is to withdraw the thermometer by 1cm or 2cm and see if the reading changes significantly. Observed changes may be due to a fault with the thermometer such as contaminated or strained wires in a T/C. Remember T/C voltages are produced at the temperature gradients so if a T/C is moved such that the gradient falls on a different part of the T/C where the wires (or a wire) are physically or chemically different from before then the output voltage will change.

2. The temperature gradients should occur on the T/C used for the temperature measurement rather than on any extension or compensating cable. If the T/C has been calibrated then the gradient must occur on the T/C in a similar way and extent as it was when it was calibrated.

3. The T/C should be of the correct type and tolerance for the application from the measuring end right through to where it is terminated. It is possible to buy Class 1 mineral insulated metal sheathed (MIMS) T/Cs where only the sheathed part of the T/C is Class 1 and the tails and connections are compensating cable. If there is a significant gradient on the tails then the reading will be incorrect. This problem is common where type R and S T/Cs are used.

4. Always use good quality connectors of the correct T/C type. Pay special attention to them as colour codes have changed; a green connector now identifies it as type K where it was formerly a compensating connector for Type R and S. All connections should be at room temperature with no temperature gradients on them wherever possible.

5. The reference end of the T/C is usually in an instrument that compensates electronically for it not being at 0℃. Electronic compensation can be a major source of error, especially for logging systems with a large number of inputs but only a few connection-temperature sensing points along the connections. Look at the maker's specification and if it is not clear take the worst-case situation you can.

6. The temperature indicator should be fit for the purpose and located in a position where the ambient conditions do not affect it. Many organisations spend time calibrating the indicator only, whereas most system faults are due to the T/C.

If you have any temperature related problems then contact Dave Ayres at info@calserv.co.uk or go to www.calserv.co.uk