The common problems of thermocouple wires and solutions

1. Use other types of wires instead of compensation thermocouple wires
According to the operation principle of thermocouple temperature measurement, the thermoelectric potential of the thermocouple circuit is related to the measured temperature and the temperature of the thermocouple reference end. In the industrial site, the temperature of the thermocouple reference end is unstable and is influenced by its surrounding environment. With temperature fluctuation of thermocouple reference end, the compensating wire is used to extend the reference end to an environment with stable temperature or simply somewhere away from the heat source to compensate the deviation caused by temperature change at the thermocouple reference end. Other types of wires can transmit the mV signal value generated by thermocouple temperature measurement, but can not compensate the temperature of the thermocouple reference end, which might result in inaccurate temperature compensation of thermocouple temperature measurement system.

Correct method: For thermocouple signal transmission, we must use the matching type of thermocouple compensating wires with the thermocouple, it is prohibited to replace the compensating wire with a normal electric wire.

2. The insulation layer of the thermocouple compensating wire is damaged.
While connecting the thermocouple, there might be certain degree of wear on the insulation layer at the outlet of the thermocouple junction box or at other parts of the compensating wire. As a result, the temperature display value on the display instrument or in the DCS system is generally smaller than usual.

Correct method: Make sure to fix the insulation layer after finding damaged parts on the thermocouple compensating wire, and restore the normal display value of the control instrument or the paperless temperature recorder.

3. The measurement error occurs when the positive and negative polarity of the thermocouple compensating wire is connected reversely.
The thermocouple as well as the thermocouple compensating wire both have positive and negative polarity. When the compensating wire is inversely connected, the display value on the paperless temperature recording instrument changes greatly as follows:
A. After inversely connecting the polarity of the compensating wire, when the temperature at the junction of the thermocouple and the compensating wire is higher than the temperature in the control room, the temperature shown on the instrument will be lower than the actual measured temperature.
B. After inversely connecting the polarity of the compensating wires, when the temperature at the junction of the thermocouple and the compensating wire is lower than the temperature in the control room, the temperature shown on the instrument will be higher than the actual measured temperature.

C. After inversely connecting the polarity of the compensating wires, when the temperature at the junction of the thermocouple and the compensating wire is the same as the temperature in the control room, the temperature shown on the instrument will be the same as the actual measured temperature.

It is proved by theory that the error caused by the reverse connection of the polarity of the thermocouple compensating wire is about twice more than that when no compensating wire is used.

Different types of thermocouple compensating wires all have red insulation layer for the positive polarity, but different colors for the negative polarity. As a result, the type of compensating wires can be distinguished according to the color of the insulation layer.

**Correct method:** Correctly distinguish the positive and the negative polarity of the thermocouple as well as the thermocouple compensating wire, the polarity can not be connected reversely.

4. **Poor contact between the thermocouple compensating wire and the wiring terminal**
The thermocouple compensating wire is relatively hard, so it is easy to have poor contact between the wire and the wiring terminal when connecting or using it. There might not be any display value on the DCS system, or the display value might exceed the range of the instrument measurement.

**Correct method:** Tighten up the wiring terminal and eliminate the poor contact to restore the normal measurement display of the instrument.

5. **The joint in the thermocouple compensating wire has poor contact**
When producing the thermocouple compensating wire, the number of joints per unit length is limited by standards for the manufacturer. When the extension is needed in the process of laying the compensating wire for long distance, the technician commonly connects the joints of compensating wires together and then apply the insulation on it directly. After using it for a period of time, inaccurate measurement as well as increasing deviation occurs.

**Correct method:** if it is necessary to extend the length of the compensating wire, connect the same polarity of the same type of compensating wires together, weld firmly the connection point, and finally put it into use after applying the insulation.

6. **The signal will be interfered when the compensating wire is laid in parallel with the power cable**
An enterprise laid thermocouple compensating wires and electrical power cables in the same cable bridge during the construction. When the system was put into use, the DCS system showed the thermocouple temperature rose and dropped unstably. After careful inspection, it is confirmed that the thermocouple measurement signal is interfered by the power line which caused the temperature measurement deviation of 100°C.

**Correct method:** During the construction, lay the thermocouple compensating wire and the power cable in the same direction, but lay the power bridge and the signal instrument bridge separately with shielded compensating wires. If the compensating wire has to be on the same bridge with the power cable, shielding baffles or cross-laying method should be used inside the bridge frame to minimize the interference of thermocouple signals.

7. **Using the thermocouple compensating wire for long distance, measurement errors might occur due to the signal attenuation and the interference**

   The electric potential value generated during thermocouple temperature measurement is mV signal. Due to the increase of the length of the compensating wire, the signal attenuation and the on-site magneto-electric interference mix together, which makes the temperature display value of the instrument or the DCS system fluctuate.

   **Solution:**

   A. When laying compensating wires for long distance is needed, the compensating wire’s diameter should not be less than Φ1.5mm2 which can reduce the attenuation of the mV signal.

   B. Pick up the shielded compensating wire and ground the shielding layer according to the standard (the shielding layer must be grounded at the end of the compensating wire, and the grounded layer should be incorporated into the grounding network of the instrument signal, and the grounded layer should not be incorporated into the electrical grounding network of the factory). This can avoid measurement errors caused by incorrect method of grounding for the shielding layer.

   C. Use a temperature transmitter to convert local thermocouple signal into the 4-20ma signal in order to improve the anti-interference ability of the signal.

8. **After using a temperature transmitter along with the thermocouple, the compensating wire is not needed.**

   The thermocouple temperature transmitter is usually installed in the thermocouple junction box and the control cabinet, which are two different types of the temperature transmitter:

   A. The temperature transmitter installed in the thermocouple junction box forms an integrated thermocouple temperature transmitter. The thermocouple wires are directly connected to the input end of the temperature transmitter, and the output uses 2-wire system of 4-20mA signal. The transmitter is directly connected to the display instrument or the DCS system with twisted pair cables.
or two core shielded cable, without thermocouple compensating wires.

B. If the temperature transmitter is installed in the control cabinet, the thermocouple and the temperature transmitter must be connected with compensation wire. The transmitter and the display instrument or DCS system shall be directly connected with the twisted pair or the two-core shielded cable, and the thermocouple compensating wire is not used in this case.

**Correct method**: Based on the application scenario, we determine whether the compensating wire needs to be used for the thermocouple temperature transmission. A compensating wire must be used to connect the thermocouple and the guide rail type of the temperature transmitter.