Detailed analysis difference between resistance thermometer and thermocouple?

Thermocouples and thermal resistances are both contact temperature measurement in temperature measurement. Although their functions are the same to measure the temperature of the object, their working principles and characteristics are different. Thermocouples are the most widely used temperature in temperature measurement. Devices and thermal resistance do not require compensation wires and are cheaper than thermocouples. What is the difference between thermocouple and thermal resistance?

1. Thermocouple: can transmit 4-20mA electrical signal far away

Thermocouple temperature measurement principle: The thermocouple temperature measurement principle is based on the thermoelectric effect. Connecting two different conductors or semiconductors into a closed loop, when the temperatures at the two junctions are different, thermoelectric potential will be generated in the loop. This phenomenon is called the thermoelectric effect, also known as the Seebeck effect. The thermoelectric potential generated in the closed circuit is composed of two kinds of electric potentials; the temperature difference electric potential and the contact electric potential. Thermoelectric potential refers to the electric potential generated by the two ends of the same conductor due to different temperatures.Different conductors have different electron densities, so the electric potentials generated by them are not the same, and the contact potential, as the name implies, refers to when two different conductors are in contact. Because their electron densities are different, they produce a certain amount of electron diffusion. When they reach a certain equilibrium, the potential formed by the contact potential depends on the material properties of the two different conductors and the temperature of their contact points. The advantages of thermocouples: wide temperature measurement range, relatively stable performance, simple structure, good dynamic response, and can transmit 4-20mA electrical signals remotely, which is convenient for automatic control and centralized control.

At present, the thermocouples used internationally have a standard specification. The international regulations stipulate that thermocouples are divided into eight different divisions, namely B, R, S, K, N, E, J, and T. The lowest possible measurement

temperature is B, R, S, K, N, E, J, and T. Measure minus 270 degrees Celsius, up to 1800 degrees Celsius. Among them, B, R, and S belong to the platinum series of thermocouples. Because platinum is a precious metal, they are also called precious metal thermocouples and the remaining ones are called cheap metal thermoelectrics.

型号 Model	分度号 Graduation	允差等级 Tolerance level			
		I		II	
		测温范围 ℃ Range of temperature measurement ℃	允差值 Tolerance value	测温范围 ℃ Range of temperature measurement ℃	允差值 Tolerance value
WRNK	K	-40~+375	±1.5℃	-40~+333	±2.5℃
		375~1000	±0.004|t|	333~1200	±0.0075|t|
WRMK	N	-40~+375	±1.5℃	-40~+333	±2.5℃
		375~1000	±0.004|t|	333~1200	±0.0075|t|
WREK	E	-40~+375	±1.5℃	-40~+333	±2.5℃
		375~800	±0.004|t|	333~900	±0.0075|t|
WRFK	J	-40~+375	±1.5℃	-40~+333	±2.5℃
		375~750	±0.004|t|	333~750	±0.0075|t|
WRCK	T	-40~+125	±0.5℃	-40~+133	±1.0℃
		125~350	±0.004|t|	133~350	±0.0075|t|
WRPK	S	0~+1100	±1.0℃	0~600	±1.5℃
		1100~1600	±[1+0.003(t-1100)]	600~1600	±0.0025|t|
WRQK	R	0~1100	±1℃	0~600	±1.5
		1100~1600	±[1+0.003(t-1100)]	600~1600	±0.0025|t|
WRRK	B	—	—	600~1700	±0.0025|t|
		—	—	—	—

There are two types of thermocouples, common type and armored type. Ordinary thermocouples are generally composed of thermode, insulating tube, protective sleeve and junction box, while armored thermocouple is a combination of thermocouple wire, insulating material and metal protective sleeve. A solid combination formed by stretching. But the electrical signal of the thermocouple needs a special wire to transmit, this kind of wire is called compensation wire. Different thermocouples require different compensating wires, and their main function is to connect with the thermocouple to keep the reference end of the thermocouple away from the power supply, so that the temperature of the reference end is stable. Compensation wires are divided into two types: compensation type and extension type. The chemical composition of the extension wire is the same as that of the thermocouple being compensated. However, in practice, the extension wire is not made of the same material as the thermocouple. Replace with wires with the same electron density. The connection between the compensation wire and the thermocouple is generally very clear. The positive pole of the thermocouple is connected to the red wire of the compensation wire, and the negative pole is connected to the remaining color. Most of the general compensation wires are made of copper-nickel alloy.

2. Thermal resistance: no compensation wire is needed, the price is cheaper

The principle of temperature measurement of thermal resistance: based on the

characteristics of the resistance of conductors or semiconductors that change with temperature.

The advantages of thermal resistance: it can also transmit electrical signals remotely, with high sensitivity, strong stability, interchangeability and accuracy, but it needs power supply and cannot instantaneously measure temperature changes.

Disadvantages of thermal resistance: Although thermal resistance is widely used in industry, its application is limited due to its temperature measurement range.

Industrial thermal resistance generally uses Pt100, Pt10, Cu50, Cu100, the temperature measurement range of platinum thermal resistance is generally -200-500 degrees Celsius, and copper thermal resistance is minus 40 to 140 degrees Celsius. Thermal resistance does not require compensation wires and is cheaper than thermocouples. The most common one is platinum thermal resistance pt100 RTD.

分度号 Graduation	允差等级 Tolerance level	有效温度范围/℃ Effective temperaturerange		允差℃ Range of temperature measurement ℃
		线绕元件 Wirewound element	膜式元件 Membrane element	
Pt100	AA	-50~250	0~150	±（0.1+0.0017|t|）
	A	-100~450	-30~300	±（0.15+0.002|t|）
	B	-196~600	-50~500	±（0.3+0.005|t|）
	C	-196~600	-50~600	±（0.6+0.01|t|）
|t|=温度绝对值，单位为℃ t=temperature Absolute value, units for C				

As two major contact temperature sensors: thermocouple and thermal resistance, the choice of thermocouple or thermal resistance should be judged according to the measured object environment, so you need to fully understand the thermal resistance and thermocouple temperature sensor when choosing a temperature sensor the difference.

How to distinguish between thermocouple and thermal resistance

1, Thermocouple English Thermocouple, referred to as TC, the working principle is: output linear millivolt signal with temperature change. The instrument amplifies the signal and converts it into a temperature signal.

2, thermal resistance. English Resistance is abbreviated as RTD. The working principle is: the resistance value changes linearly with temperature.

3, the temperature transmitter can convert the thermocouple mV voltage signal or the resistance value signal of the thermal resistance into a 4-20mA standard signal for automation system control.

4. Generally speaking, thermal resistance is cheaper than thermocouple.

Which is better, thermocouple or thermal resistance?

The selection of thermocouple should be based on comprehensive considerations

such as temperature range, required accuracy, use atmosphere, performance of the measurement object, response time and economic benefits.

1. Selection of measurement accuracy and temperature measurement range

When the operating temperature is 1300~1800℃ and the accuracy is relatively high, the B type thermocouple is generally used; the accuracy is not high, and the atmosphere allows the use of tungsten rhenium thermocouples. Generally, tungsten rhenium thermocouples are used when the temperature is higher than 1800℃; 1000~1300℃ requires high accuracy and high accuracy. Available S-type thermocouple and N-type thermocouple; below 1000℃ generally use K-type thermocouple and N-type thermocouple, below 400℃ generally use E-type thermocouple; below 250℃ And the negative temperature measurement generally uses T-type thermocouple, which is stable and high precision at low temperature.

2. Choice of atmosphere

S-type, B-type, and K-type thermocouples are suitable for use in strong oxidizing and weak reducing atmospheres, J-type and T-type thermocouples are suitable for weak oxidizing and reducing atmospheres. If a protective tube with better airtightness is used, The atmosphere requirements are not too strict.

3. Choice of durability and thermal response

A thermocouple with a large wire diameter has better durability, but has a slower response. For a thermocouple with a large heat capacity, the response is slow. When measuring a temperature with a large gradient, the temperature control is poor in the case of temperature control. It requires a fast response time and a certain degree of durability, so it is more appropriate to choose an armored couple.

4, the nature and state of the measurement object to choose the thermocouple

The temperature measurement of moving objects, vibrating objects, and high-pressure vessels requires high mechanical strength. Chemically polluted atmospheres require protective tubes. In the case of electrical interference, higher insulation is required.

Model selection process: model-graduation number-explosion-proof grade-precision grade-installation and fixed form-protective tube material-length or insertion depth.

The difference between thermocouple and thermal resistance signal output

1. The nature of the signal. The thermal resistance itself is a resistance. The change of temperature causes the thermal resistance to produce a positive or negative resistance change; and a thermocouple produces a change in the induced voltage, which changes with the change of temperature.

2. The temperature ranges detected by the two sensors are different. The thermal resistance generally detects a temperature range of 0-150 degrees, and the highest measurement range can reach about 600 degrees (of course it can detect negative temperatures). The thermocouple can detect the temperature range of 0-1000 degrees (or even higher). Therefore, the former Rosemount 3051 transmitter is low temperature detection, and the latter is high temperature detection.
3. From the point of view of the material, the thermal resistance is a metal material with a temperature-sensitive change of the metal material, and the thermocouple is a bimetal material, which is two different metals. Due to temperature changes, the two different metal wires A potential difference is generated at the end.
4. The input module of thermal resistance and thermocouple corresponding to plc is also different. This sentence is no problem, but generally plc is directly connected to 4~20ma signal, while thermal resistance and thermocouple generally have transmitters Just access the plc. If you connect to dcs, you don't need to use a transmitter! The thermal resistance is the rtd signal, and the thermocouple is the tc signal!
5, plc also has thermal resistance modules and thermocouple modules, which can directly input resistance and electrical couple signals.
6. Thermocouples are available in j, t, n, k, s and other types. Some are more expensive than resistance, and some are cheaper than resistance. However, including compensation wires, the overall cost of thermocouples is higher.