Temperature Info

Basic Theory

The measurement of temperature is important in many applications such as building control, food processing and the manufacture of steel and petrochemicals. These very different applications require temperature sensors of different physical construction and often different technology.

In industrial and commercial applications the measurement point is frequently far away from the indication or control point. Often there is a requirement for further processing of the measurement in controllers, recorders or computers. Such applications are unsuitable for direct-indicating thermometers as we know them from every-day use but require devices which convert temperature into another form, an electrical signal. To provide this remote electrical signal it is common practice to employ RTD's, thermistors and thermocouples.

The electrical conductivity of a metal depends on the mobility of the conductive electrons. If a voltage is applied to the ends of a metal wire the electrons move to the positive pole. Faults in the crystal lattice interfere with this movement. They include foreign or missing lattice atoms, grain boundaries, and atoms on interlattice positions. Since these fault positions are independent of temperature they produce a constant resistance. With rising temperature the atoms of the metal lattice exhibit increasing oscillations about their rest positions and thereby impede the movement of the conduction electrons. Since this oscillation increases linearly with temperature, the resistance increase caused by it depends as a first approximation directly on the temperature.

What is the difference between NTC, Thermistor, TC, ATC, Resistor and other common names used for temperature correction elements?

Nomenclature:

- TC or temperature compensation (also a name for a thermocouple, but we do not offer that type of temperature element)
- ATC or automatic temperature compensation
- Thermistors or NTC is a negative temperature coefficent
- Resistor or RTD is a resistive temperature device

A thermistor (NTC) is a thermally sensitive resistor. This is a semiconductor composed of metallic oxides such as manganese, nickel, cobalt, copper, iron, and titanium. Basic ceramic technology is utilized to fabricate thermistors in wafer, disk, bead, and other shapes. There are two basic types of thermistors — negative temperature coefficient (NTC) and positive temperature coefficient (PTC). NTC thermistors are much more commonly used than PTC thermistors. The resistance of NTC thermistors decreases with increasing temperature. Thermistor applications are based on the resistance-temperature characteristic of a thermistor. NTC thermistors give a relatively large output (change of resistance) for a small temperature change. This output can be transmitted over a large distance. The amount of change per °C is expressed by Beta value (material constant) or Alpha coefficient (resistance temperature coefficient). The larger Alpha or Beta the greater the change in resistance with temperature, and the temperature versus resistance curve is steeper.

The principle of RTD (resistive temperature device) function is similar to a thermistor. A current must be passed through the RTD, the same as with thermistors, and the change of voltage with temperature is measured. Materials for RTDs can be gold, silver, copper or platinum. Platinum, however, has become the most-used metal for RTDs. A thin film of platinum or a thin platinum wire is deposited on a flat ceramic material and sealed. Platinum has a nearly linear temperature versus resistance relationship. The operating temperature range of RTD's is from –220°C to 850°C. RTDs have a self-heating error that depends on the electrical energy input.

Applications

In the measurement of water, temperature is almost always a factor. The question is whether or not you are measuring in a temperature controlled environment, in which case you would likely not need automatic temperature compensation provided by adding a temperature element to your electrode or buying a stand alone temperature device.

Which is right for me?

1. Platinum RTD's are the most accurate and stable sensors over a long time period.

2. Thermistors are not quite as accurate or stable as RTD's but they are easier to wire and cost slightly less.

Stand alone versus integration with other sensors

When buying an electrode other than temperature, you have to answer several key questions before deciding to include temperature in the electrode:

- What is my measurement parameter?
With some sensors temperature is not an absolute requirement for many applications. ORP is a good example of an electrode that most applications don't require temperature compensation.

- Does my application temperature vary?
If your application is temperature stable, then the benefit versus cost of an ATC will not be as apparent.

- Does my electrode size accomodate a temperature sensor?
Many electrodes are pressed for space before adding anything additional, it is advisable to talk to your sales representative about which electrode size would best fit your application with a temperature element.

- Does the temperature element need to be in direct contact with the application?
Sometimes when a small electrode is needed for an application, having an exposed temperature element is not possible, and if the temperature element does not require a fast speed of response we can place it inside of the electrode where the signal is slowed by the barriers of construction.

- What is my temperature range?
Most temperature elements have a range that is optimal, so knowing this information up front will save you a lot of hassle later on in your project.

- What is my temperature fluxuation rate?
The rate at which your application temperature cycles up and down.

- What is my cost requirement?
Cost is important to everyone, adding temperature compensation can add as little as $6 to $1000 per electrode depending on accuracy, ease of construction and standard versus custom design elements.

Which wire is which?

If your electrode has a temperature element built into it as a temperature compensation device, the wire will be labeled unless you required a connector - in which case we always use your wiring requirements.

Troubleshooting Tips

Temperature elements very rarely fail due to the device itself. If your temperature device is not responding correctly, you will want to verify that you specified the correct element and that it is compatible with your measurement system. If that information is correct, then the failure is likely a short in the wiring and the electrode will need to be replaced.