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Comparing Three Types Of Temperature Sensors

RTDs vs. THERMOCOUPLES vs. THERMISTORS

RTDs

Resistance Temperature Detectors (RTDs) are temperature sensing devices consisting of a wire coil or deposited film of pure metal, usually platinum. The element's resistance increases with temperature in a known and repeatable manner. RTDs exhibit excellent accuracy over a wide temperature range, –200 to 650°C (–328 to 1202°F).

RTDs offer

Stability and repeatability: The platinum RTD is the primary interpolation instrument used by the National Institute of Standards and Technology from –260 degrees Celsius to 630 degrees Celsius. Precision RTDs can be manufactured with a stability of 0.0025 degrees Celsius per year. However, most industrial models drift less than 0.1 degrees Celsius per year.

Linearity: The platinum RTD produces a more linear curve than thermocouples or thermistors. The RTD's non-linearities can be corrected through proper design of resistive bridge networks.

Sensitivity: The voltage drop across an RTD provides a much larger output than a thermocouple. Since thermistors have a higher resistance than RTDs, the measuring current through them may be so low as to limit self-heating, making their voltage drop less than that of an RTD.

Standardization: RTDs are manufactured to industry standard curves, usually 100 ohm platinum to IEC 751, which makes them very interchangeable.

System Cost: RTDs usually offer a lower system cost than do thermocouples as they use ordinary copper extension leads and require no cold junction compensation.

Thermocouples

A thermocouple consists of two wires of dissimilar metals welded together into a junction. At the other end of the signal wires, usually as part of the input instrument, is another junction called the reference junction. Heating the sensing junction generates a thermoelectric potential (emf) proportional to the temperature difference between the two junctions. This millivolt-level emf, when compensated for the known temperature of the reference junction, indicates the temperature at the sensing tip. Published millivolt tables assume the reference junction is at 0 degrees Celsius.

Thermocouples are simple and familiar. Designing them into systems, however, is complicated by the need for special extension wires and reference junction compensation.

—Thermocouple advantages include—

Extremely high temperature capability: Thermocouples with a noble metal junction may be rated as high as 1700°C (3100°F).

Ruggedness: The inherent simplicity of thermocouples makes them resistant to shock and vibration.

Small size/fast response: A fine-wire thermocouple junction takes up little space and has low mass, making it suitable for point sensing and fast response.

Thermistors

Thermistors are resistive devices usually made of metal oxides formed into a bead and encapsulated in epoxy or glass. Thermistors show a large negative temperature coefficient. Their resistance drops dramatically and non-linearly with a temperature increase. A thermistor's sensitivity is many times that of an RTD, but its useful temperature range is limited.

Because of wide variations of performance and cost among thermistors, generalized advantages and disadvantages may not always apply.

Typical benefits are

Lower Sensor Cost: Basic thermistors are less costly than RTDs and thermocouples, but when assembled in protective sheaths or wells the price difference narrows. Thermistors with tighter interchangeability or extended temperature ranges often cost more than RTDs.

High Sensitivity: Resistance may be several thousand ohms, which provides a larger output than RTDs with the same measuring current, offsetting lead wire resistance problems. Caution must be taken to limit measuring current because thermistors are more susceptible to self-heating than are RTDs.

Point Sensing: A thermistor bead may be the size of a pinhead, allowing for small area sensing.