APPLICATION NOTE

COMPARISON OF FIBER OPTIC AND THERMOCOUPLE/RTD SENSORS

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Traditional Thermocouples (TCs) and Resistance Temperature Detectors (RTDs)

Advantages

TCs and RTDs are often the first choice for measuring industrial process temperatures when contact measurements are allowed. These mature technologies typically have lower initial cost. In addition, they are easily available, with a large variety of off-the-shelf sensor configurations. These devices also cover a very wide temperature range and with calibration can provide excellent accuracy. Properly packaged, they can be very robust sensors.

Disadvantages

However, the metallic material construction of TCs and RTDs can lead to issues with electromagnetic interference, electrical conduction, and metal fatigue with repeated bending. In addition, the metal construction can lead to significant heat conduction along the probe, resulting in temperature inaccuracies. Contamination, oxidation, and diffusion can also result in accuracy drift. These factors often increase the need for routine calibration and reduce reliability, which can increase the total cost of ownership over time. These disadvantages have limited their use in critical semiconductor and medical applications.

Fiber Optic (FO) Sensors

Advantages

FO sensors have distinct advantages over TCs and RTDs in certain applications. Their optical temperature measurement and construction of all glass, plastic, and ceramic phosphor sensing elements result in immunity to electromagnetic interference, which allows their use in the presence of radio frequency (RF) fields, microwaves, magnetics, high voltage, or induction environments. These sensors also have superior thermal insulation properties, resulting in lower temperature gradients along the probe, thus producing more accurate temperature measurements. They also require no calibration after installation, minimizing maintenance needs, which is a significant advantage. Jacketing materials are typically chemically resistant, and fiber optic cables are resistant to mechanical wear.

Disadvantages

Disadvantages of fibers optics include higher initial cost, though the cost of ownership over time is typically lower than TCs and RTDs. Supplier availability for fiber optic sensors is limited and they have a more limited temperature range than many TCs and RTDs. In addition, the bend radius of FOs in most cases is not as flexible as the TCs.

Comparison Table

The table below compares the performance and features of these temperature sensors.

Comparison Table			
Parameter	Thermocouples and RTDs	Fiber Optics	Notes
Cost of Ownership	Higher	Lower	FO has the advantages of better accuracy and reliability, and less maintenance.
Initial Cost	Economical	Premium	TC and RTDs are high-volume technologies.
Commercial Availability	Better	Limited	TCs and RTDs are high-volume, mature technologies.
Temperature Range	Wider	Limited	TC range is up to 1700°C, FO up to 450°C.
Accuracy (with calibration)	0.5 to 2.0°C	0.25 to 1.0°C	TCs are known to drift, reducing accuracy.
Electromagnetic Interference	Susceptible to EMI	Immune to EMI	FOs show no RF, microwave, HV, induction interference.
Environmental resistance	Limited	Better	There are no oxidation concerns with FO; jacketing is chemically resistant
Electrical Conduction	High	None	FO probes are intrinsically safe.
Thermal Conduction	Higher	Lower	Thermal conduction along probe can influence temperature accuracy.
Mechanical Reliability	Less	Better	FO has no mechanical fatigue.
Bend Radius	Better	Limited	FO is typically 5 to 25 mm.
Lifetime/Maintenance	Limited	Better	FO requires no calibration or replacement.

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