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Research, SME Interview, Writing & Editing Example

Summary:

This B2B technical article is the first in a series of eight that were part of a content repurposing marketing strategy and plan created by Debby Wadsworth. The eight topics were also used by Debby for writing, producing, and promoting a webinar series and mini-training video series.

Each article was researched, outlined, ghostwritten, edited, pitched to editors, promoted, and tracked for results by Debby Wadsworth.

Bylines went to the SME for each article to establish further engineering expertise and credibility in the industry. An author with an engineering title has more weight than one with a marketing one for engineering-based publications. When it was written, Debby's position at Emerson was Integrated Marketing Manager.

The series is based upon a book, and eBook Debby also co-wrote, co-edited, and promoted entitled The Engineers Guide to Industrial Temperature Measurement.

Results:

- The article was published by 35 publications (digital/online & print versions), including the following.
  - Process Instrumentation at www.piprocessinstrumentation.com/instrumentation/temperaturemeasurement/thermowells/article/15561379/rtds-vs-thermocouples
  - Control Engineering at www.controleng.com/articles/temperature-sensors-make-the-right-choice-rtd-vs-tc/
  - Control at www.controlglobal.com/multimedia/2014/rtd-vs-thermocouple-whats-the-difference/
  - Chemical Processing at www.chemicalprocessing.com/articles/2015/select-the-most-suitabletemperature-sensor/
- Awards
  - Top Control Engineering Article of the Year
  - Flow Control Network Top Article of the Year
  - Control Engineers' Choice Award
  - Control Global Readers' Choice Award
  - Outstanding Performance & Achievement Award, Emerson
- Orders & Leads
  - 10,000+ orders for The Engineers Guide to Industrial Temperature Measurement, and 1,000+ multiple category leads

Published Digital Version

ENERGY, POWER

Temperature sensors: Make the right choice, RTD vs. TC

When you need a temperature measurement, one of the most basic decisions is choosing which kind of sensor to deploy. The application should guide your decision.

BY ASHLEIGH HAYES JUNE 25, 2013

Temperature variances in process industries can have significant impact on profits, safety, and quality. A variety of industries and applications are affected, including oil and gas, power, refining, petrochemical, pharmaceutical, and more. Monitoring temperature accurately is dependent upon several factors, including selecting the right sensor for the specific application and process.

Two of the most common temperature measurement devices are resistance temperature detectors (RTDs) and thermocouples (TCs). The technology behind them is different, each having its own benefits that drive appropriate selection.

An RTD uses the principle that the electrical resistance of a metal increases as temperature increases—a phenomenon known as thermal resistivity.

In comparison, a TC is a closed-circuit thermoelectric temperature sensing device consisting of two wires of dissimilar metals joined at both ends. A voltage is created when the temperature at one end of a wire or junction differs from the temperature at the other end. This phenomenon is known as the Seebeck effect. That voltage depends on the particular metal as well as the temperature difference. Comparing the different voltages created by the different metals is the basis for TC temperature measurements.

Comparing the differences

RTDs are constructed of a resistive material with leads attached and usually placed into a protective sheath. The resistive material may be platinum, copper, or nickel; the most common is platinum because of its high accuracy, excellent repeatability, and exceptional linearity over a wide range. It exhibits a large resistance change per degree of temperature change. The two most common RTD sensor styles are wire-wound and thin-film.

Wire-wound RTDs are manufactured either by winding resistive wire around a ceramic mandrel or by winding it in a helical shape supported in a ceramic sheath—hence the name wire-wound. For thin-film RTDs, a thin resistive coating is deposited on a flat (usually rectangular) ceramic substrate. Thin-film RTDs are typically less expensive than wire-wound RTDs because fewer materials are needed for their construction.

Normally, RTDs are much more repeatable and have better sensitivity than TCs. Long-term drift of an RTD is predictable, while a TC drift is often erratic. This provides the benefit of less frequent calibration and therefore lower cost of ownership. Finally, RTDs provide excellent linearity. When coupled with the linearization performed in a quality transmitter, a precision of about 0.1 °C is possible, which is much better than what is possible with a TC.

In comparison, a TC is a closed-circuit thermoelectric temperature sensing device consisting of two wires of dissimilar metals joined at both ends. Various combinations of metals are classified as types and have specific characteristics. The most common types are J (which uses iron and Constantan) and K (which uses Chromel and Alumel). TCs have faster response times and higher temperature ranges than RTDs, but are also less accurate. TCs have heavy gauge wire construction for durability and therefore can withstand high vibration (see Figure 1). Chart A compares key sensor characteristics.

Choosing the right sensor technology

When choosing the right sensor for your process and application, there are a few basic questions that you should ask. The answers will provide valuable insight for selecting the appropriate sensor.

1. What temperature range you are trying to measure? When selecting a sensor, it is important to determine the correct temperature range. If the temperature is above 850 °C, you must use a TC. If it is below 850 °C, you can select either an RTD or a TC. Also, keep in mind that wire-wound RTDs have a wider temperature range than thin-film RTDs (see Chart B).

2. What is your required sensor accuracy? Determining the level of accuracy needed is also an important factor in the selection process. In general, RTDs are more accurate than TCs, and wire-wound RTDs are more accurate than thin-film RTDs. Assuming there are no other factors driving the selection of one technology over the other, this guideline will help you find the most accurate sensor technology.

3. Is process vibration a concern? The amount of process vibration also needs to be considered when selecting a sensor. TCs have the highest vibration resistance of all of the sensor technologies. If you have a known high vibration, TCs will give you the highest reliability. Thin-film RTDs are also resistant to vibration; however, they are not as robust. Wire-wound RTDs should not be used in high-vibration environments.

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The right choice brings the right results

The overall key to success is asking basic questions and matching up the information with the right sensor for your applications and process. An example would be adding a temperature measurement to a pipeline where the measurement is under varying conditions with constant vibration and a process temperature variance of 200 to 300 °C. The goal is to have the best possible accuracy despite these challenges.

To determine what type of sensor to use, first consider the differences between TCs and RTDs. The temperature range makes both sensor technologies feasible for this application. TCs are known for their higher vibration tolerance, so at a first glance TCs would appear to be a good option. However, in this specific instance the measurement requires the best possible accuracy. The right choice for this application would be a thin-film RTD. Thin-film RTDs are known for their higher tolerance to vibration than wire-wound RTDs, and will provide a higher accuracy than a TC.

A second example would be the temperature in a reactor that ranges between 550 and 900 °C with little vibration. The goal is to gain accuracy within ±5 °C. RTDs provide consistent accurate measurements, especially in environments with little vibration. However, don't forget the temperature range. RTDs typically should not be used above 850 °C. Since the process temperature can range up to 900 °C, a TC would be selected. Sensors are more susceptible to failure and inaccurate measurements when used in improper temperature ranges. That is why it is critical to select the correct sensor.

Ashleigh Hayes is a marketing engineer for Emerson Process Management.

Key concepts:

- Measuring temperature is a basic requirement in virtually any process manufacturing environment.
- Two sensor technologies support the majority of installations.
- Selecting between the two main approaches depends on specific process requirements and conditions.

Temperature sensors: Make the right choice, RTD vs. TC

When you need a temperature measurement, one of the most basic decisions is choosing which kind of sensor to deploy. The application should guide your decision.

Key concepts

- Measuring temperature is a basic requirement in virtually any process manufacturing environment.
- Two sensor technologies support the majority of installations.
- Selecting between the two main approaches depends on specific process requirements and conditions.

Temperature variances in process industries can have significant impact on profits, safety, and quality. A variety of industries and applications are affected, including oil and gas, power, refining, petrochemical, pharmaceutical, and more. Monitoring temperature accurately is dependent upon several factors, including selecting the right sensor for the specific application and process.

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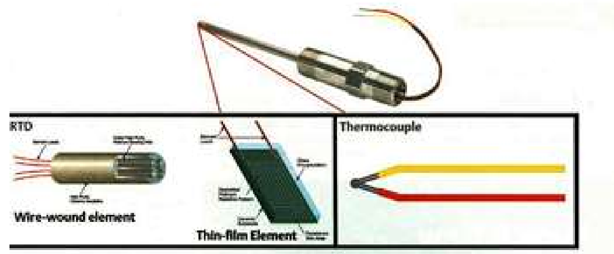
In comparison, a TC is a closed-circuit thermoelectric temperature sensing device consisting of two wires of dissimilar metals joined at both ends. A voltage is created when the temperature at one end of a wire or junction differs from the temperature at the other end. This phenomenon is known as the Seebeck effect. That voltage depends on the particular metal as well as the temperature difference. Comparing the different voltages created by the different metals is the basis for TC temperature measurements.

Comparing the differences

RTDs are constructed of a resistive material with leads attached and usually placed into a protective sheath. The resistive material may be platinum, copper, or nickel; the most common is platinum because of its high accuracy, excellent repeatability, and exceptional linearity over

Attribute	RTD	Thermocouple
Accuracy Interchangeability	Class A: ± [0.15 + 0.002 |t|] Class B: ± [0.30 + 0.005 |t|] Per IEC 60751	Typical is ± 1.1 °C or ± 0.4% of measured temperature (Greater). Depends on Type and Range. Degraded by extension wire.
Stability	± 0.05 °C per 1000 Hrs at ≤ 300 °C. Greater at higher temperatures. Wire-wound better than thin film.	Highly dependent on TC type, quality of the wire and operating temperature. Typical is ± 2 to 10 °C per 1000 Hrs.
Speed of Response in Thermowell Installation in Liquid	For 6mm sensor about the same as TC.	For 6mm sensor about the same as RTD. Slightly faster for 3mm sensor.
Calibration	Easily recalibrated for long service life. Best accuracy with Sensor-Transmitter Matching.	Limited to in situ comparison to "Standard TC".
Potential Temperature Range	-200 to 850 °C	-270 to 2000 °C
Life Span	Many years. Shorter at higher temperatures.	Degradation indicates frequent replacement. Much shorter at high temperatures. Higher life cycle costs.
Installation Considerations	Use standard copper wire. Good EMI and RFI immunity.	Requires expensive matching extension wire. Low level signal is very susceptible to EMI and RFI.
Vibration Tolerance	Thin film design is very good.	Larger wire diameters are very good.
Life Cycle Cost	Lower.	Higher.
Purchase Cost	Thin film design about the same. Wire wound higher.	Types R and S most expensive.
System Performance with Transmitter	Always better below 850 °C.	Order of magnitude lower.

There is no single answer that works in every situation. There are tradeoffs in performance characteristics that need to be considered carefully when making a selection. Diagrams courtesy: Emerson Process Management.



The stainless steel probe of a temperature sensor can look the same, so you have to know what's inside.

wide range. It exhibits a large resistance change per degree of temperature change. The two most common RTD sensor styles are wire-wound and thin-film.

Wire-wound RTDs are manufactured either by winding resistive wire around a ceramic mandrel or by winding it in a helical shape supported in a ceramic sheath—hence the name wire-wound. For thin-film RTDs, a thin resistive coating is deposited on a flat (usually rectangular) ceramic substrate. Thin-film RTDs are typically less expensive than wire-wound RTDs because fewer materials are needed for their construction.

Normally, RTDs are much more repeatable and have better sensitivity than TCs. Long-term drift of an RTD is predictable, while a TC drift is often erratic. This provides the benefit of less frequent calibration and therefore lower cost of ownership. Finally, RTDs provide excellent linearity. When coupled with the linearization performed in a quality transmitter, a precision of about 0.1 °C is possible, which is much better than what is possible with a TC.

In comparison, a TC is a closed-circuit thermoelectric temperature sensing device consisting of two wires of dissimilar metals joined at both ends. Various combinations of metals are classified as types and have specific characteristics. The most common types are J (which uses Iron and Constantan) and K (which uses Chromel and Alumel). TCs have faster response times and higher temperature ranges than RTDs, but are also less accurate. TCs have heavy gauge wire construction for durability and therefore can withstand high vibration (see Figure 1). Chart A compares key sensor characteristics.

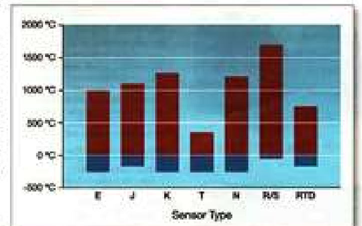
Choosing the right sensor technology

When choosing the right sensor for your process and application, there are a few basic questions that you should ask. The answers will provide valuable insight for selecting the appropriate sensor.

1. What temperature range you are trying to measure? When selecting a sensor, it is important to determine the correct temperature range. If the temperature is above 850 °C, you must use a TC. If it is below 850 °C, you can select either an RTD or a TC. Also, keep in mind that wire-wound RTDs have a wider temperature range than thin-film RTDs (see Chart B).

2. What is your required sensor accuracy? Determining the level of accuracy needed is also an important factor in the selection process. In general, RTDs are more accurate than TCs, and wire-wound RTDs are more accurate than thin-film RTDs. Assuming there are no other factors driving the selection of one technology over the other, this guideline will help you find the most accurate sensor technology.

3. Is process vibration a concern? The amount of process vibration also needs to be considered when selecting a sensor. TCs have the highest vibration resistance of all of the sensor technologies. If you have a known high vibration, TCs will give you the highest reliability. Thin-film RTDs are also resistant to vibration; however, they are not as robust. Wire-wound RTDs should not be used in high-vibration environments.



Thermocouples come in a variety of types determined by the combination of wire types. Most types have a higher temperature limit than an RTD.

The right choice brings the right results

The overall key to success is asking basic questions and matching up the information with the right sensor for your applications and process. An example would be adding a temperature measurement to a pipeline where the measurement is under varying conditions with constant vibration and a process temperature variance of 200 to 300 °C. The goal is to have the best possible accuracy despite these challenges.

To determine what type of sensor to use, first consider the differences between TCs and RTDs. The temperature range makes both sensor technologies feasible for this application. TCs are known for their higher vibration tolerance, so at a first glance TCs would appear to be a good option. However, in this specific instance the measurement requires the best possible accuracy. The right choice for this application would be a thin-film RTD. Thin-film RTDs are known for their higher tolerance to vibration than wire-wound RTDs, and will provide a higher accuracy than a TC.

"The overall key to success is asking basic questions and matching up the information with the right sensor for your applications and process."

A second example would be the temperature in a reactor that ranges between 550 and 900 °C with little vibration. The goal is to gain accuracy within ±5 °C. RTDs provide consistent accurate measurements, especially in environments with little vibration. However, don't forget the temperature range. RTDs typically should not be used above 850 °C. Since the process temperature can range up to 900 °C, a TC would be selected. Sensors are more susceptible to failure and inaccurate measurements when used in improper temperature ranges. That is why it is critical to select the correct sensor. ce

Ashley Hayes is a marketing engineer for Emerson Process Management.

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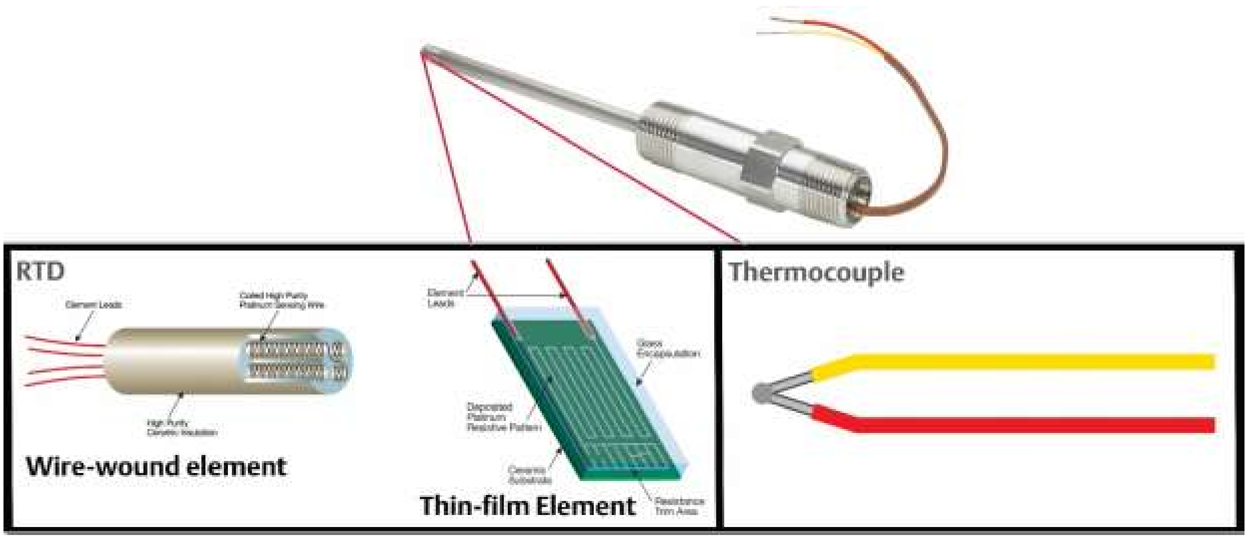
Original Article

RTDs or T/Cs?

The choice for temperature is critical: make-it-or-break-it.



Temperature variances in a process can significantly impact safety, viability, quantity, quality, and profits. Therefore, finding effective ways of controlling and managing temperature is critical. It is a challenge shared by a variety of industries and applications that include Pharmaceutical, Biotech, Oil & Gas, Power, Refining, Petrochemical, and more.

Getting it right requires overcoming the challenge by finding the best way to monitor temperature throughout your specific process. A key factor in making this happen is selecting the right sensor, which can make or break your process. The two most common temperature measurement devices used for monitoring are Resistance Temperature Detectors (RTD) and Thermocouples (T/Cs).

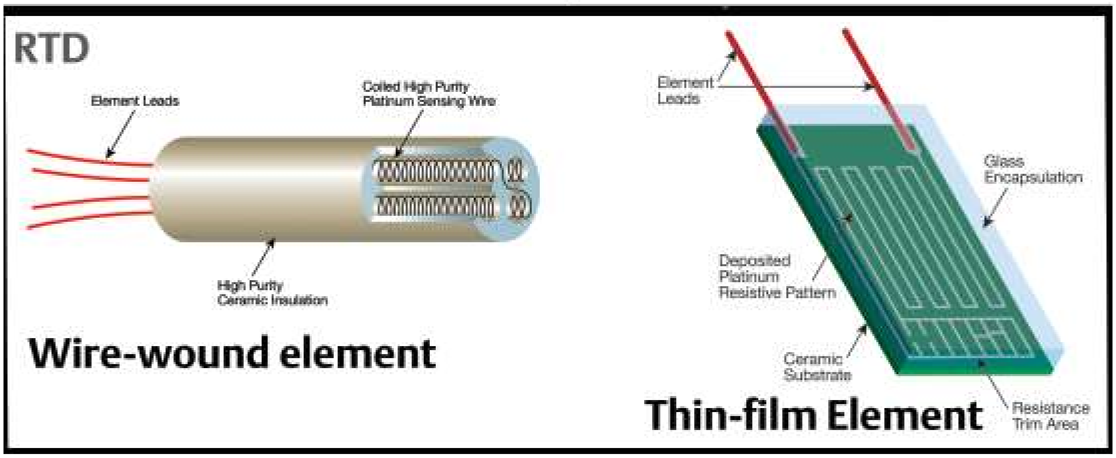
The technology behind RTDs and T/Cs is different, each having its own benefits that drive appropriate selection. An RTD is based on the principle that the electrical resistance of a metal increases as temperature increases – a phenomenon known as thermal resistivity.

In comparison, a T/C is a closed-circuit thermoelectric temperature sensing device consisting of two wires of dissimilar metals joined at both ends. A current is created when the temperature at one end or junction differs from the other. This phenomenon is known as the Seebeck effect, which is the basis for T/C temperature measurement.

Comparing the Differences

RTD's are constructed of resistive material with leads attached, usually placed into a protective sheath. The resistive material may be platinum, copper, or nickel, with platinum being the most common. The reason is because of its high accuracy, excellent repeatability, and exceptional linearity over a wide range. It also exhibits a large resistance change per degree of temperature change.

The two most common RTD styles of sensors are wire-wound and thin-film.



Wire-wound RTDs are manufactured either by winding the resistive wire around a ceramic mandrel or by winding it in a helical shape supported in a ceramic sheath – hence the name wire-wound.

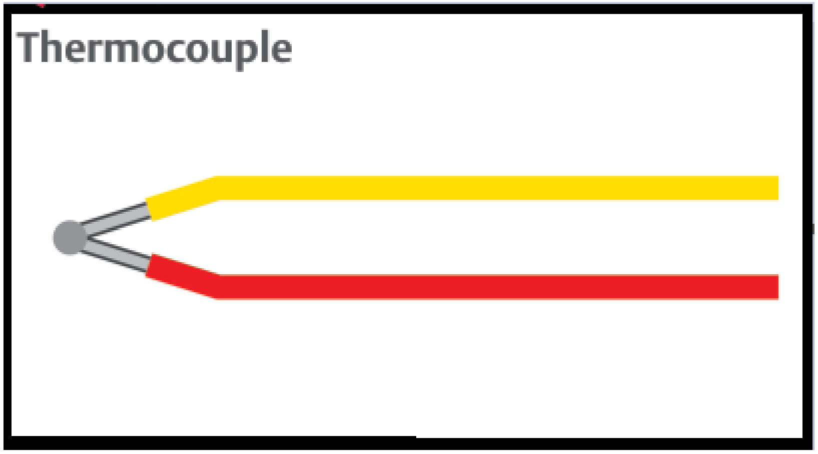
Thin-film RTDs have a thin resistive coating deposited on a flat (usually rectangular) ceramic substrate. Thin-film RTDs are typically less expensive than wire-wound RTDs because fewer materials are needed for their construction.

Benefits of RTDs over T/C's include:

- RTDs are much more repeatable
- They have better sensitivity
- The long-term drift is predictable, while a T/C drift is erratic
- Less frequent calibration is needed, and therefore lower cost of ownership
- Finally, RTDs provide excellent linearity. When coupled with the linearization performed in a quality transmitter, a precision of about 0.1 °C is possible which is much better than what is possible with a T/C.

T/Cs, in comparison, are a closed-circuit thermoelectric temperature sensing device consisting of two wires of dissimilar metals joined at both ends.

The most common types are “J”, which uses iron and Constantan, and “K”, which uses Chromel and Alumel. T/Cs have faster response times and higher temperature ranges than RTDs but are also less accurate.



T/Cs have heavy gauge wire construction for durability, and therefore can withstand high vibration. The following chart compares the key sensor characteristics.

Attribute	RTD	Thermocouple
Accuracy Interchangeability	Class A: ± [0.15 + 0.002 (t)] Class B: ± [0.30 + 0.005 (t)] Per IEC 60751	Typical is ± 1.1 °C or ± 0.4% of measured temperature (Greater). Depends on Type and Range. Degraded by extension wire.
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Calibration	Easily recalibrated for long service life. Best accuracy with Sensor-Transmitter Matching.	Limited to in situ comparison to “Standard T/C”.
Potential Temperature Range	-200 to 850 °C	-270 to 2300 °C
Life Span	Many years. Shorter at higher temperatures.	Degradation indicates frequent replacement. Much shorter at high temperatures. Higher life cycle costs.
Installation Considerations	Use standard copper wire. Good EMI and RFI immunity.	Requires expensive matching extension wire. Low level signal is very susceptible to EMI and RFI.
Vibration Tolerance	Thin film design is very good.	Larger wire diameters are very good.
Life Cycle Cost	Lower.	Higher.
Purchase Cost	Thin film design about the same. Wire wound higher.	Types R and S most expensive.
System Performance with Transmitter	Always better below 650 °C.	Order of magnitude lower.

Choosing the Right Sensor Technology

When choosing the right sensor for your process and application, a few basic questions should be asked. The answers will provide valuable insight for selecting the appropriate sensor.

- **What is the temperature range you are trying to measure?**

When selecting a sensor, it is important to determine the correct temperature range. If the temperature is above 850°C you must use a thermocouple. If it is below 850°C, you can select either an RTD or T/C. Also, keep in mind that wire-wound RTDs have a wider temperature range than thin-film RTDs. (See Chart B)

- **What is your required sensor accuracy?**

Determining the level of accuracy needed is also an important factor in the selection process. RTDs are generally more accurate than T/Cs, and wire-wound RTDs are more accurate than thin-film RTDs. Assuming there are no other factors driving the selection of one technology over the other, this guideline will help you find the most precise sensor technology.

- **Is process vibration a concern?**

The amount of process vibration also needs to be considered when selecting a sensor. Thermocouples have the highest vibration resistance of all of the sensor technologies. If you have a known high vibration, thermocouples will give you the highest reliability. Thin-film RTDs are also resistant to vibration; however, they are not as robust. Wire-wound RTDs should not be used in high vibration environments.

The Right Choice Brings the Best Results

The key to success is asking basic questions and matching the information with the right sensor for your applications and process. An example would be adding a temperature measurement to a pipeline where the measurement is under varying conditions with constant vibration and a process temperature variance of 200-300°C. Your goal is to have the best possible accuracy despite these challenges.

To determine what type of sensor to use, first consider the differences between thermocouples and RTDs. The temperature range makes both sensor technologies feasible for this application. T/Cs are known for their higher vibration tolerance, at first glance, thermocouples would appear to be a good option. However, in this specific instance, the measurement requires the best possible accuracy. The right choice for this application would be a thin film RTD. Thin-film RTDs are known for their higher tolerance to vibration than wire-wound RTDs and will provide higher accuracy than a thermocouple.

A second example would be the temperature in a reactor that ranges between 550-900°C with little vibration. Your goal is to gain accuracy within 5°C. RTDs provide consistently accurate measurements, especially in environments with little vibration. However, don't forget the temperature range. RTDs typically should not be used above 850°C. Since the process temperature can range up to 900°C, a T/C would be selected. Sensors are more susceptible to failure and inaccurate measurements when used in improper temperature ranges. That is why it is critical to select the correct sensor.