Product Spotlight

Quality thermocouple wire can mean the difference between success and failure

Minimizing sensor errors and unnecessary validation study re-runs

Answering the Unexplained Failure

Have you ever experienced a failed validation run and couldn't explain why? One run passes its criteria with the next run producing bad results. Does the culprit lie in the process or the validation equipment or the sensors? The problem may well be a combination of material and environment.

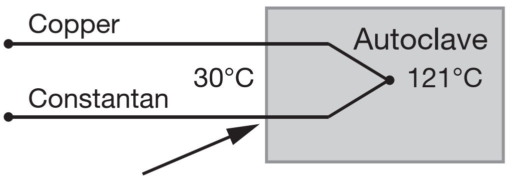
Before starting the study, you calibrated the thermocouples. After the study, you verify that the thermocouples were still within limits. Yet, the study produced results that didn't meet your acceptance criteria. What went wrong?

It may be that one or more of your thermocouples had been damaged. During normal use, thermocouples are subject to significant abuse. They are dropped, wound up, tied, stepped on, and rolled over. Eventually they get damaged.

Repeated bending of a wire at a single point or slamming in autoclave doors are typical causes of sensor damage. Overstressing the wire in this way is called cold working. But damage alone does not affect measurement results.

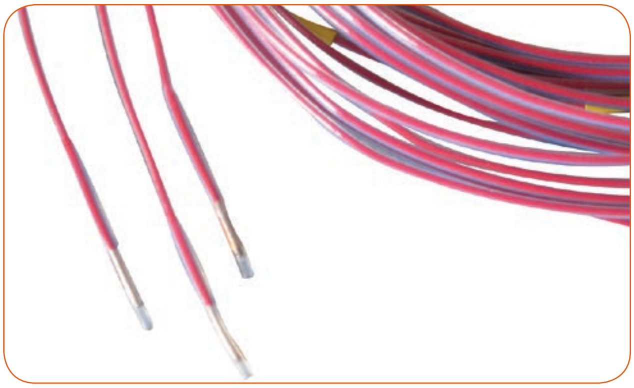
An error is introduced when the damaged section of wire is subject to a temperature gradient such as occurs at the wall of an autoclave. You're not aware of these errors at calibration time because there is no temperature gradient. Contrary to popular belief, not all errors are corrected during sensor calibration.

Type T Thermocouple



Temperature gradient of 91°C between the inside wall and the outside.

Potential errors exist at the gradient
When the damaged (stressed) portion of a thermocouple wire is used in a large temperature gradient, your validation data will have errors. How much error is determined by the manufactured quality of the wire.



Which Costs More: Material or Time

While quality wire does cost more, the cost of unnecessarily repeating a single validation study far exceeds the price of the wire (time, lost productivity, equipment downtime). Without understanding the effects of cold working, you could lose a validation study and not know why. And the risk of it happening again is still present. This could explain why many companies discard their wire after only a few studies. In any case, specifying high-purity wire and handling your sensors more carefully is always a good practice, and will result in more accurate process measurement.

Minimizing the Risk of Damage

Using stranded wire will reduce the likelihood of cold working over that of solid core wire. Thermocouple durability improves as the number of strands increase and the strand diameter decreases.

Minimizing a Source of Error

Thermocouple accuracy is directly related to the purity and homogeneity of the metals used. Accuracy varies widely among the different grades: standard, premium, and ultra premium.

The higher the wire purity, the lower the potential error if stressed. While cold working of any thermocouple can produce errors, the error from stranded, high-purity wire is significantly less than experienced with solid wire.

Minimizing Sensor Errors and Unnecessary Validation Study Re-runs

Quality Assurance

Kaye thermocouple wire is manufactured with the highest purity and uniformity available to the industry. Quality control and testing of every wire spool and thermocouple probe ensures consistent measurement results. Each spool of wire includes a Certificate of Conformance — your guarantee that it meets the accuracy specifications listed. Each Thermocouple is leakage vacuum tested.

Determining Your Thermocouple Wire Quality

To ensure your measurements are as accurate as possible, we encourage you to benchmark the wire you presently use against a Kaye ultra-premium grade wire. Here are three ways to do this.

Compare the quality and purity of two uncalibrated thermocouples:

- Attach a sample of Kaye ultra-premium wire to one channel of your Validator® system (set to type T thermocouple and 0.01°C resolution).
- Attach a length of wire you presently use to a second channel of your Validator system.
- Set your temperature reference to a known value such as 121°C.
- Place the measuring tip of both uncalibrated thermocouples into your temperature reference.
- Place a temperature standard in the temperature reference.
- Wait for all sensors to stabilize. On your validation system, read the difference between each thermocouple and the temperature standard. The greater the difference between sensor and standard, the lower the consistency and purity of the thermocouple wire.

Compare the impact of damage by cold working:

- With the sensors still attached to the instrument, stress a section of each wire either by repeated bending or smashing it with a hammer.
- Produce a temperature gradient using a heat gun over the stressed area.
- Do this for both sensors, noting any change in instrument readings.

Compare their workability:

- Flex, bend and coil each wire, noting how easily the wire distorts or resists returning to its original shape without damage.

Tips to Minimize Errors From Thermocouples

Use type T thermocouples — Type T thermocouples are the most accurate in the temperature range of -200 to 400°C, providing more accurate, repeatable results in the validation environment.

Calibrate sensors before your validation studies. This will eliminate any hot junction conformity errors. Then verify them after the study is complete.

Use one continuous wire length — no connectors or extension wire.

Use the highest quality wire available — high purity wire is less prone to errors from temperature gradients that exist in the validation test (but are not present in sensor calibration).

Use stranded wire rather than solid wire to minimize material degradation errors due to cold working.

Kaye Teflon® Thermocouple Wire Specifications				
Wire grade	Ultra-Premium		Auto-Bond Ultra-Premium	
Model	3-Strand	7-Strand	7-Strand (AL)	7-Strand (AS)
	K0258	K0255	K0259	K0263
Gauge	27 AWG	22 AWG	22 AWG	26 AWG
Example of configured Thermocouple (40feet/12m) labeled				
	3ST1WY-40	7ST1WY-40	AL-7ST1WY-40	AS-7ST1WY-40
Accuracy				
@ 121°C	± 0.3°C	± 0.25°C	± 0.25°C	± 0.25°C
Approximate Size				
Size	0.042” (1.07 mm)	0.095” (2.41 mm)	0.042” (1.07 mm)	
	0.074” (1.88 mm)	0.120” (3.03 mm)	0.074” (1.88 mm)	
Maximum variation within group for all wire				
@ 40°C	± 0.05°C maximum; ± 0.03°C typical			
@ 121°C	± 0.1°C maximum; ± 0.05°C typical			

Warranty and disclaimer:

The information in this document is based on our current tests, knowledge and experience. Because of the effect of possible influences in an application of the product, they do not exempt the user from their own tests, checks and trials. A guarantee of certain properties or a guarantee for the proper suitability of the product for a specific, especially permanent application can not be derived from our data. Liability is therefore excluded to that extent permitted by law. Any proprietary rights of third parties as well as existing laws and regulations must be observed by the recipient of the product on his own responsibility.

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Advanced Sensors

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