10 TIPS ON CHOOSING A

Temperature Transmitter

While there are many practical and economic advantages to using temperature transmitters, the most basic are to ensure measurement integrity and to convert a temperature sensor's low-level (ohm or millivolt) signal to a standard 4 to 20 mA current signal that can be readily accepted by a monitoring and control system.

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Advancing technology has made the use of temperature transmitters affordable even in cost-sensitive applications. Here are few things to consider when choosing one.

TIP 1: Distance Determines Back of Panel or Local Installation

Perhaps the most fundamental consideration when specifying a temperature transmitter is the environment in which it will be installed. If the distance between the sensor measurement and the control room is relatively short and free of plant electrical "noise," temperature transmitters can be installed inexpensively in the control room with sensor extension wires leading to them. These transmitter configurations are called DIN-style or rail-mount housings (figure 1). For economy reasons, multiple high density DIN-style transmitters are installed on a mounting rail in a multi-unit protective enclosure and powered by a common power supply.

Figure 1. Rail-mount housings typically are mounted on a surface or in a multiunit protective enclosure.

If a long distance exists between the sensor and the control room, or if plant noise will adversely affect the sensor's relatively weak low-level signal, the temperature transmitter should be installed as close to the sensor as possible. This will allow the sensor signal to be conditioned and converted to a more robust 4 to 20 mA signal that is better able to withstand long-distance transmission through an electrically noisy plant.

For these applications, transmitters are installed individually in field-mountable enclosures called connection or thermowell heads (figure 2). To accommodate corrosive, caustic, hazardous, hose down or just plain nasty weather conditions, connection heads are offered in many shapes and materials, including aluminum, stainless steel, iron and plastic. Where ambient conditions permit, the sensor is connected directly to the transmitter with a thermowell protecting the temperature sensor when it is inserted into the process. For surface (skin) measurements such as on a tank, pipe, motor, compressor or reactor, the sensor also may be clamped, strapped, bolted or welded directly to the measurement point with the transmitter mounted nearby (figure 3).

TIP 2: Let Your Sensing Needs Determine Fixed Range vs. Universal

If you always use the same sensor type — for example, a Type J thermocouple — and measure the same temperature ranges — say those between 0 to 400°F (-17 to 204°C)

HOT SHEET

KEY BENEFIT
Temperature transmitters ensure measurement integrity in electrically noisy processing environments

EQUIPMENT COVERED
Temperature transmitters, temperature sensors, temperature controllers

INDUSTRIES SERVED
Chemicals/petrochemicals, electronics, finishing, food, packaging, pulp/paper, pharmaceuticals, plastics, textiles

— in every application, and you are positive this will never change, a fixed range transmitter is probably fine.

Usually less expensive, fixed-range transmitters are ordered from the manufacturer to accommodate just one sensor type and one fixed temperature range. In most cases, you have limited or no adjustability within the temperature span. Consequently, you may have to sacrifice some accuracy if you are interested in measuring a narrower span within the transmitter's allowable range — for instance, 50 to 200°F (10 to 93°C) within the 0 to 400°F range. The narrower the span measured, the more accurate the overall temperature measurement will be. One drawback with fixed-range transmitters is that if you change to a different sensor type, the transmitters must be replaced.

Microprocessor-based universal transmitters offer an array of operational advantages over their fixed-range counterparts. Most important of these is their ability to be set up to handle a range of sensor types and temperature ranges. This may include thermocouples (J, K, E, T, R, S, B, N and C) and RTDs (two-, three- and four-wire; platinum, copper and nickel; 10 to 1,000 Ω), and temperature ranges within -328 to 1,562°F (-200 to 850°C). Universal transmitters can be set to monitor any range within the sensor's established curve, so users can set the transmitter to concentrate on the exact range important to your process. In addition, one transmitter type can be specified and stocked to handle every application in the facility.

TIP 3: Take Advantage Of Setup Flexibility Offered By 3 Configuration Methods

Available universal temperature transmitters can be configured using on-board controls, hand-held configurators or PC software. On-board controls provide the advantage of not having to rely on external devices to perform setup. However, the configuration options using on-board controls sometimes are limited.

Hand-held configurators usually are associated with "smart" instruments such as smart Hart temperature transmitters. They are able to reconfigure the transmitter from any termination point along the 4 to 20 mA loop. The disadvantages are that hand-helds can be less than intuitive, may be expensive and sometimes can be used with only one type or class of instrument.

PC configuration is the most versatile, easiest and fastest to use (figure 4). All operating parameters, including complex custom sensor linearization tables, can be selected from a software window and downloaded to the transmitter in a few minutes. A PC may cost less than many hand-helds and can be used for other purposes. The drawback is that the transmitter must be taken to the PC — or a laptop must be taken to the transmitter — for configuration.

Figure 2. Field-mount housings accommodate corrosive, caustic, hazardous, hose down or just plain nasty weather conditions.

SURFACE MEASUREMENTS

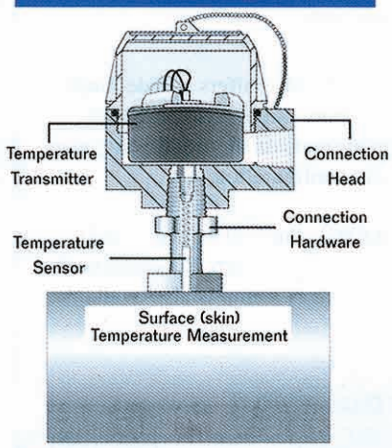

Figure 3. For surface measurements, the sensor and transmitter may be clamped, strapped, bolted or welded directly to the measurement point.

TIP 4: Read the Fine Print Regarding Sensor Accuracy and Stability

Temperature transmitters differ greatly in measurement accuracy. At the low end, you can expect accuracies of ±1°F. At the high end, some transmitters deliver accuracies of ±0.025°F.

Many factors can influence overall accuracy: input accuracy, output accuracy, resolution, linearity, load effect, line voltage effect, cold junction compensation (for thermocouples), repeatability, ambient temperature effect, electromagnetic interference/radio frequency interference (EMI/RFI) effect, and sensor lead resistance effect. Complicating matters, the method used to calculate stated accuracy differs from manufacturer to manufacturer.

When making accuracy comparisons, keep in mind that some vendors use the term linearity in place of accuracy. Others will state that the accuracy specification includes linearity and repeatability and assumes errors caused by fluctuating ambient temperature conditions. Still other specifications are stated in terms of a selected temperature range, temperature reading or measurement span. Be sure to read the fine print so that you can properly determine the accuracy of a given transmitter under the conditions it will operate. The degree of accuracy required for your application, of course, depends on the nature of the process itself. In general, the higher the accuracy is, the more certain the outcome of nearly every process.

While accuracy is the level of uncertainty of a transmitter's output at a given time, stability is the uncertainty of a transmitter's or sensor's output over a period of time.

Stability — usually specified as a percent of temperature span per year — will help you tell how often your system will need routine calibration. Typical long-term stability specifications provided by manufacturers range from six months to five years.

TIP 5: **Ask Your Transmitter Supplier For Help with Sensor Selection**

Your temperature transmitter supplier should be able to recommend the best sensor for your application. In general, an RTD will give you a more accurate, stable temperature measurement than a thermocouple, provided the somewhat-more-fragile RTD can withstand the environment.

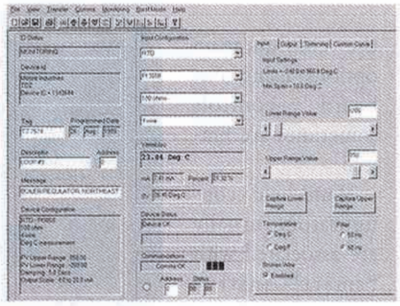

Figure 4. PC software allows transmitter configuration in just a few minutes.

An RTD or thermocouple output will change due to temperature cycling, temperature swings, corrosion, lead-wire degradation, moisture and contamination. Where possible, use four-wire RTDs and specify a temperature transmitter that is able to accept a true four-wire RTD input. The advantage is that the fourth wire in an RTD circuit effectively cancels out errors due to resistance imbalances between the leads. Every ohm of imbalance in an RTD's lead wires results in as much as a 4.5°F (2.5°C) measurement error.

TIP 6: **Protect Against EMI/RFI and Isolate the Signal**

Always specify a transmitter with a stated EMI/RFI immunity specification. The effects of EMI and RFI can cause unpredictable and unrepeatable degradation in transmitter performance and accuracy, and even complete instrument malfunction.

Even if you think your environment is free of electrical noise, adequate protection is still a good idea. Consider just a few of the sources of possible EMI/RFI interference: mobile and stationary radio, television and hand-held (walkie-talkies) transmitters; transformers; AC and DC motors; large solenoids or relays; and even fluorescent lights. What plant does not have at least a few of these sources in proximity to its sensors and controls?

TIP 7: **Consider Upgrading for Better Diagnostic Capabilities**

Temperature transmitters, even simple fixed-range analog ones, are capable of providing basic diagnostics in the form of driving their 4 to 20 mA output upscale or downscale on loss of sensor input. This is to alert you of a sensor burnout.

Temperature transmitters with intelligent diagnostic capabilities are able to go a step further. In addition to upscale/downscale drive, they contin-

FIGURE 5. USE A PC TO CONFIGURE

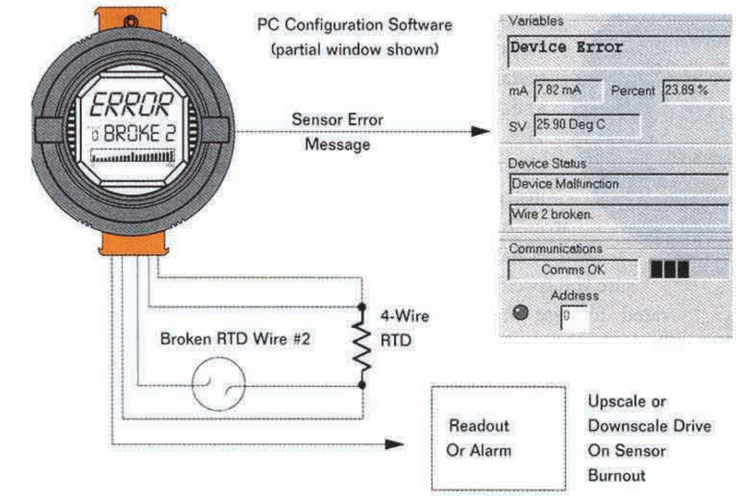

Figure 5. Some transmitters provide specific fault messages that speed diagnosing the exact sensor problem.

ually monitor the sensor. If a wire breaks or the sensor otherwise stops sending a signal during operation, it can show you which wire has broken via an error message on an integral digital display or using the PC configuration software. Specific fault messages eliminate the work of removing the sensor or checking all of the lead wires to diagnose a problem (figure 5).

TIP 8: Will Digital Communications Benefit Your Process?

Most temperature transmitters installed — and still being specified — use 4 to 20 mA signals for interface with a control device or system because it is standard, simple and trusted — and it works.

This is changing as users realize the benefits of implementing digital protocol strategies such as Foundation Fieldbus, Hart and Profibus. The most visible advantage includes the ability to "multidrop" multiple transmitters onto one twisted pair, which saves wiring and installation costs. A second important advantage is that digital communications allows the transmitter to deliver loop-diag-

WHAT PLANT **DOES NOT HAVE** AT LEAST A FEW OF THESE SOURCES IN PROXIMITY TO ITS SENSORS AND CONTROLS?

nostic information directly to the system. This can be used to alert the user about sensor and transmitter problems or about potential problems for preventive maintenance. The drawback is that in addition to new, all-digital communicating transmitters, you must purchase a control system that is able to accept digital communication protocol data.

TIP 9: For a Hazardous Environment, Select the Proper Device

Hazardous area certifications are usually not a choice but a requirement. Worldwide agencies such as Factory Mutual (FM) and Underwriter's Laboratories (UL) study the instrument design, test it and certify or list it as being safe to install in hazardous areas. If you are installing the instrument in an area that is classified as hazardous, be sure you specify one that is rated for use in that area. Typically, this is signified by a coding system that identifies the instrument's hazardous area rating.

Figure 6. Special functions such as a customizable display help meet unique application requirements.

TIP 10: Find the Special Functionality Your Process Needs

It should come as no surprise that temperature, being the most measured process variable, would have dozens, if not hundreds, of unique, application-specific requirements. Fortunately, market demand has led temperature transmitter manufacturers to address these needs with specialized features. These may include integral digital displays that can be programmed to show application-specific operating parameters (figure 6); the ability to build custom linearization tables for nonstandard sensor inputs; and advanced sensor trimming techniques that result in measurement accuracies of up to ±0.025°F. If you need it, it probably is available. PH

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