PENTRONIC NEWS

PENTRONIC Scandinavia's leading manufacturer of industrial temperature sensors

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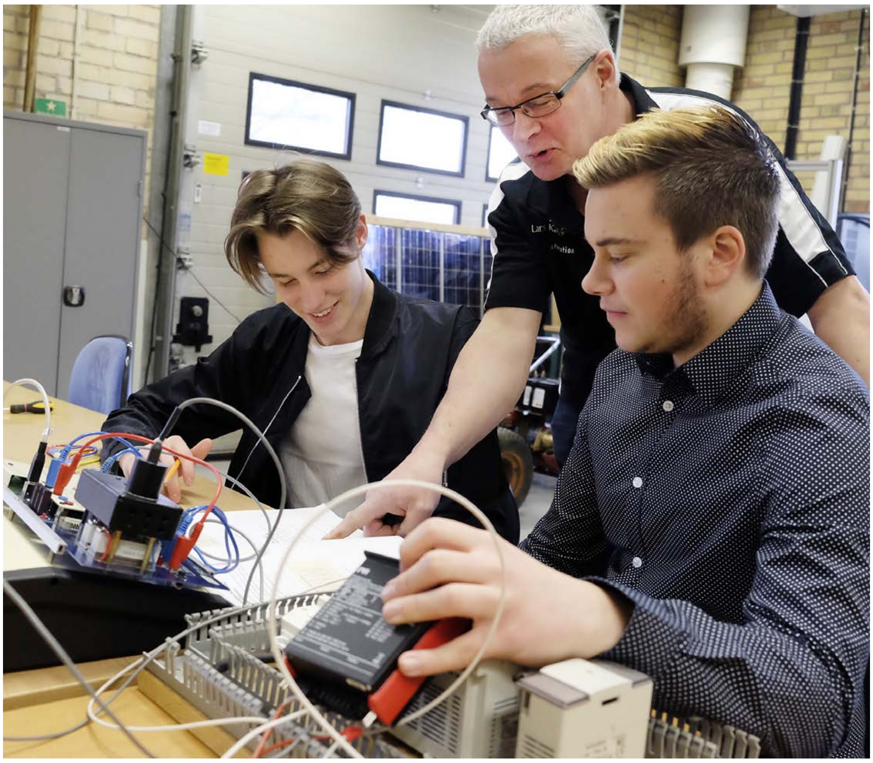
Pt100 sensors help attract future automation



"Our task is to be a bridge between the school and working life," says teacher Urban Eriksson, shown here with students Daniel Ross (left) and Jonatan Mannerlöf.

At a time when fewer and fewer students are interested in the upper secondary school vocational programme in Sweden, 72 students applied for the electricity and energy programme at Lars Kagg School in Kalmar.

One reason is that the school is investing in the same equipment as that used in working life.

"We're a bridge between the school and the world of work," says teacher Urban Eriksson.

He and Stefan Mellberg lead the programme for automation technicians, which accepts 16 students per year for a three-year period of study. The same number take the energy programme, which shares some of the same courses. Upon graduating, the students are attractive on the job market, partly because they are trained to use the right equipment and also because their educational goal is higher than just getting the right answers on exams.

"Our task is to teach the students to solve problems," Urban says.

When the educational programmes were moved to new premises, their teaching aids were also updated. The students get to work on real, though miniature-sized, systems consisting of a building system comprised of modules on wheeled tables. If the topic being studied is a heating system in a building, a number of modules are linked together and the whole system is actually started up and put into operation.

Training in temperature

For the temperature aspect of this training, Pentronic has supplied Pt100 sensors and transmitters as well as other equipment. These are the same products as those used in the real world.

"True, production equipment is made to be installed only once and not to be set up and then taken down as we do," Urban says. "But when the students get a job, there's a lot of value in them being able to recognise what they're doing."

Whilst other training centres regard thermometers as just something to take readings with, Lars Kagg School trains students in how temperature sensors function and what the sources of error are.

For example, the school discusses the differences between connecting up resistance thermometers with two, three or four wires. The instructors also present the basics of calibration. One of the students' assignments is to heat water up to 45 °C as shown on the transmitter's display and then to check the reading with a glass thermometer.

Helps students tired of sitting

In Sweden, interest in the vocational programme offered by upper secondary schools has shrunk in recent years. Statistics from the Swedish National Agency for Education for the current year show that in the whole country, 2,600 students applied for the programmes in electrical and automation technology. In many places the courses are not filled, even though there are jobs for trained electricians and automation technicians.

In the city of Kalmar, though, there are lots of applicants. One likely explanation is that the school has gained a good reputation thanks to its teaching skills and the good job opportunities after graduation.

"Many students are really tired of sitting at a desk. Here they can start to use their hands and they usually quickly realise they also need the theory to do the job properly. It's terrific to see how they mature during their three years at the school," says Urban Eriksson, to a nod of agreement from his colleague Stefan Mellberg.

In this transformation, Pt100 sensors and transmitters from Pentronic are helping to make the students' training more attractive and anchored in real life.

Urban Eriksson shows a training module.

Logistics group ensures deliveries worldwide

The job involves being a logistics hub that receives all incoming goods and delivers the right products to the right customer on time. Delivery performance is over 99%.

Susan Stein, Roger Lingeteg and Dennis Lundberg at Pentronic.

The logistics group is manned by three experienced employees with a total of 75 years at Pentronic. They are Dennis Lundberg, Roger Lingeteg and Susan Stein Larsen.

The most important connectors, cables, standard sensors, instrumentation etc. are kept in stock. Pentronic mainly manufactures customised sensors that are sent directly from the production line for packing and then delivery from the warehouse.

"We also pack the products individually and enclose installation instructions," Roger Lingeteg explains. "These are mostly spare parts that the customers then resell."

The deliveries are customer specific and various carriers collect them during the day depending on their intended destination. Almost 40% are sent outside Sweden, largely to Europe but an increasing proportion goes to China, India and other parts of the world.

"We choose the shipping method based on what functions best for every delivery," Dennis Lundberg adds.

The logistics group also handles cutting the cables into precise lengths, both for Pentronic's own production and for customers. To ensure accuracy the measurement and cutting is done by machine.

"Right now we're handling an order consisting of 120 reels with 80 metres of cable on each reel," Susan Stein Larsen says.

She and her colleagues consider it a matter of honour to deliver on time. Every morning they bring out the day's picking lists, delivery addresses and other required information. If anything is missing they don't hesitate to go to the production department to hunt down the strays. That's one of the secrets behind Pentronic's delivery performance of over 99 percent calculated by the day from the first order acknowledgement.

Temperature sensors that give cheaper and better measurement

One of Pentronic's most manufactured sensors has a built-in transmitter. It's called the PAT1101 and offers better measurement performance at a lower cost.

In the last issue of Pentronic News we presented smart measurement systems. We now continue with more information about one of them – the analogue version PAT1101 with a 4-20mA output signal which is compatible with existing measurement systems.

The resistor is a Pt100 type connected to a high-performance built-in signal converter. The complete sensor is plugged in via a M12 connector and supplies a 4-20 mA analogue measurement signal to a superior system, PLCs or display.

"One of the ingenious features of Pentronic's product is that each individual sensor is calibrated and adjusted before delivery," explains Sales Manager Dan Augustini.

The combination of calibration and adjustment means that all the units have the same output signal at the same temperature. This means the sensors are fully interchangeable. Instead of stopping a process for several hours in order to adjust the measurement system to suit the new sensor, the replacement process goes much faster.

"The goal has been to increase measurement accuracy and also reduce the time required for installation and maintenance," Dan adds. "Time is money so these sensors save money."

"The alternative is a signal transmitter mounted in a DIN rail or a terminal head," Rikard Larsson explains. "This product cannot always replace that solution but it can be an interesting alternative in specific applications."

The sensor's design permits many possible customisation options. The probe tip and fittings can be made to customer order. The transmitter can also be moved out by using an intermediate cable in order to distance the electronics from high temperatures. Whatever their construction design, the units meet ingress protection rating IP 69, which means they can withstand being cleaned with high pressure and hot water. While it is undergoing calibration and adjustment, the PAT1101 can also be programmed with the desired measuring range, for example from 0 to 160 °C or from -40 to 200 °C. The measuring range is determined by the customer's application temperature and required increments. With a Pt100 in the tip, the maximum temperature is approx. 600 °C. Pentronic programmes the built-in transmitter before delivery.

In conclusion, the PAT 1101 provides better temperature measurement at a lower total cost.

PAT1101.

The PAT1101 with a cable.

Various probe tips.

Sensor placement and response time

Questions should be of general interest and be about temperature measurement techniques and/or heat transfer.

QUESTIONS ? ANSWERS !

QUESTION: We are planning to rebuild the control equipment in our process facility and review all our sensor installations at the same time. To measure the temperature in an existing district heating pipe, a temperature sensor has been installed in a thermowell as shown in the diagram. Is this the best place to put the temperature sensor or do we need to move it?

Kim Å

ANSWER: Unfortunately it is impossible to answer your question with a simple yes or no. The answer depends on what you want to achieve by measuring the temperature – generally in this case 90 – 110 °C. If you want to achieve a short response time when the temperature changes, you should avoid using your existing installation of the temperature sensor.

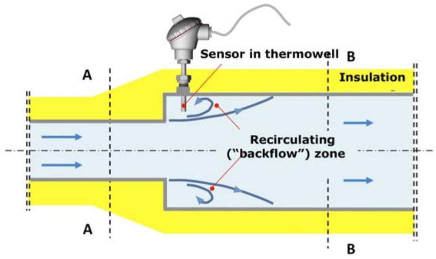
Downstream from where the pipe's diameter increases, a wake occurs that is characterised by low velocity and recirculating flow – " backflow". Due to the low velocity, the water in this zone slowly adapts its temperature to that of the main flow. A low velocity around the thermowell also makes the sensor react slowly. [Ref 1]. One advantage of the present installation is that it creates a minimal extra pressure drop.

If you want to achieve as short a response time as possible, you should install the sensor in section A, where the velocity is greatest. The thermowell should also have as small an outer diameter as possible. However, the pressure drop will be slightly larger than with the existing installation. The flow velocity in section B is lower than that in section A. The sensor installation in section B therefore causes a slightly smaller pressure drop but also a slightly longer response time than the sensor installation in section A.

In many cases the pressure drop caused by the thermowell is of limited significance to the flow. How pressure drop and other disruptions caused by the thermowell affect the flow must be assessed from case to case. To determine the response time and pressure drop requires doing a measurement or a calculation. Influencing factors include the properties of the sensor, thermowell, pipe and flow. If you want to minimise the pressure drop in the pipes you must also replace the straight transition fitting between the pipes with a conical transition fitting.

The water used in the pipes that supply district heating in Sweden is very clean and normally it is not necessary to worry about the thermowell getting dirty. This is more of a problem when you work with dirty fluids. You must then be careful when installing thermowells and other components that disrupt the flow. One example is discussed in [Ref 2].

In cases when you want to avoid using thermowells that disrupt the flow, you can consider using a sensor that lies on the outside of the pipe. The sensor should then be installed in section A where the flow velocity is greatest. The response time will be longer than for a sensor in a thermowell and the measurement error can increase. You must decide from case to case if this type of installation is an acceptable solution to the measuring problem. See [Ref 3].



References, see www.pentronic.se > News > Pentronic News > PN Archive

[Ref 1] PentronicNews 2001-1 p 4 & 2008-5 p 3

[Ref 2] PentronicNews 2008 - 1, p 4

[Ref 3] PentronicNews 2009 - 5, p 3

If you have questions or comments, contact Dan Loyd, LiU, dan.loyd@liu.se

A faithful servant bows out

The spare parts for the non-contact MM55 moisture gauge are now definitely no longer available. The lamp is the only spare part still available because it is also used in the 710e gauge developed later.

"We recommend that customers replace their MM55s with the 710e to avoid risking quality deteriorations in their production if the moisture readings stop," says Per Bäckström, who is responsible for moisture measurement products.

"Despite everything, the MM55 has served customers for almost 20 years, which is a long time for electronic measurement equipment and for supplying reserve parts," he adds. "The newer 710e model offers far more accurate and faster readings and also has modern data communication with such features as bus connection."

The NDC 710e replaces the discontinued MM55 moisture gauge.

ATTENTION QUALITY MANAGERS!

Package deal on system calibration of hand-held indicator and sensor

"We're offering 50% off the handheld indicator if we system calibrate it with the sensor in conjunction with delivery," says Dan Augustini, Sales Manager at Pentronic.

"Many of our customers have calibration instructions that specify requirements for the calibration points, method, frequency and documentation," Dan explains. "This also applies to new purchases. We help our customers to meet the requirements by documenting the calibrations we perform at the temperatures the customer wants. We do this at our accredited laboratory with a short delivery time, normally two weeks."

The background is that Pentronic wants to help customers take measurements that are more reliable. This in turn creates credibility with their own customers. The employees who use the measurement equipment also gain knowledge about the deviations and measurement uncertainty associated with the equipment as specified in the calibration certificate.

From stock articles to custom manufacture

"When Pentronic gets a request for temperature sensors our sales engineers start with our stock articles, which are almost all presented on our website," says Lars Björkvik, Manager Mechanical Design and Production at Pentronic.

The stock articles are premade with specified measurements and peripheral components such as terminal heads, connectors etc. for each specific article number. The articles can normally be dispatched immediately.

If a customer wants a different measurement setting or other peripheral components, blueprints already exist and can easily be adjusted.

"The data sheets at our website often show such possibilities, which we call "built to order", on their second page," Lars continues. "The modified product is assigned a unique article number, which is saved and can then be used for the next order. Delivery time can vary but for most of the year it is two weeks."

If complementing an existing article cannot satisfy the customer's needs, Pentronic designs a new sensor to meet the requirements as long as this is technically and financially possible. Such a sensor can often be based on experience gained from previous designs. The requirements normally not only include measurements and peripheral components but also the durability, response time, materials, calibration ability, possible testing and size of the production series. The number of sensors can determine the manufacturing method. In this case, too, the product, which is finalised after consultation with the customer, is given a unique article number that is customer specific.

"New construction is common because machinery manufacturers need large series of sensors for inclusion in their products," Lars concludes.

Keep thermocouple extension cables outside hot zones!

Now that all fewer technicians have to care for and maintain more and more measuring devices, it's not easy to keep track of how everything functions. Frequent questions to Pentronic concern the extension cable and how it influences the measurement results as it passes through varying temperature zones.

See the connection arrangement in Figure 1. A thermocouple measures the temperature in a warming oven. The extension cable to the thermocouple passes through a number of cooling zones before it reaches a temperature indicator at room temperature. The thermocouple measures the temperature difference between the measuring junction in the probe tip and the connection to the indicator. A signal or thermo emf (voltage at the µV level) is only created on the sections of the thermocouple that lie in a temperature gradient that is different from zero. In the figure these sections are marked with red circles.

Overall, where the temperature curve in the diagram is horizontal (the temperature gradient = 0) no signal is created at all. Normally, the thermocouple's tip would be calibrated and the depth of the calibration bath or oven would usually then determine the location along the tip where its properties are determined, i.e. calibrated. In the figure, the calibration location can very well coincide with the red circle that marks the passage through the insulated wall. In this case the contribution will be the temperature difference [°C] times the thermocouple's sensitivity [µV/°C]. With inserted values, approximately (120 – 80) x 40 µV. See the grey facts box and Figure 2.

In the thermocouple's insulated connector joint (or connectors) the sheath material in the probe tip is replaced by an extension cable (also type K), which is marked by the green colour of the insulation. The cable itself is seldom calibrated so that its properties are apparent from the thermocouple's inspection certificate. For want of anything else, we are left with the tolerance limits in the IEC 60584 standard. Within the temperature range [0…120 °C] the relevant tolerances are ±1.5 °C (class 1) and ±2.5 °C (class 2) respectively for a new cable. Since the temperature gradient = 0 and the temperature is therefore constant at the insulated connector joint, the measured value is not affected here.

In contrast, between zones 2 and 3 at the red ring there is a gradient different from zero. To estimate the maximum error that can occur via the extension cable, we can use the above-stated tolerance limits. If, for example, we assume that the probe tip's calibration is at, say, maximum plus tolerance, and the extension cable's is at maximum minus tolerance, we get a difference of ±1.5 °C, that is, 3.0 °C. Normally the entire length of the extension cable comes from the same manufacturing batch, and it´s sensitivity can be regarded constant over length. This means that the thermocouple contributes (120 - 80)/(120 - 20) = 40/100 of the measured value that is correct according to the calibration and the extension cable contributes the rest (80 - 20)/(120 - 20) = 60/100. In other words, the error caused by the extension cable will affect the measured value by 60%. In our case (class 1) this means that the maximum error is 60 x 3.0/100 = 1.8 °C, which should be clearly visible on an indicator with 0.1 degree of resolution.

However, the most important thing is to completely avoid laying uncalibrated extension cables in zones with higher temperatures. Let the calibrated thermocouple's probe tip cover as much as possible of the temperature gradients above room temperature. You can thereby avoid being concerned about the error contributed by the extension cable and are free to focus on more important tasks.

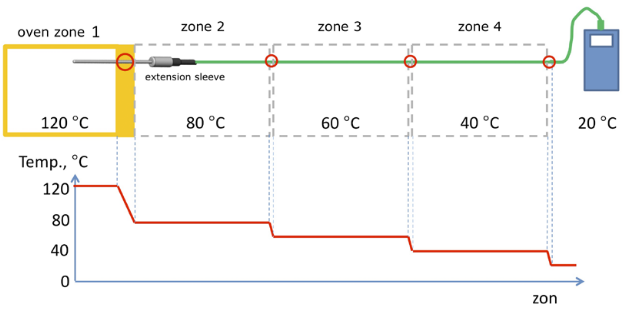


Figure 1. A calibrated thermocouple measures the temperature inside an oven. The thermocouple's extension lead passes through a number of zones with different temperatures on its way to the temperature indicator. How does this affect the measured value?

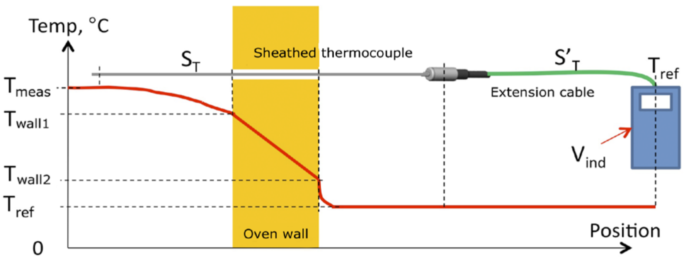


Figure 2. A general diagram of where in a thermocouple circuit the temperature signal is created. The most accurate measurement is achieved if the temperature gradients are located only along the length of the calibrated thermocouple.

If you have questions or comments, contact Hans Wenegård: hans.wenegard@pentronic.se

FACTS

General calculation of the total signal from a thermocouple. The example concerns a sheathed thermocouple that is inserted in an oven. The red curve in Figure 2 shows the temperature distribution along the thermocouple, which is connected via an extension cable to a temperature indicator.

The general formula for a thermocouple output signal is:

$$V_{IND} = S_T\,(T_{MEAS} - T_{REF}), \qquad (1)$$

where
V_{IND} = The thermo emf voltage in the indicator [°C]
S_T = The Seebeck coefficient for the thermocouple [µV/°C]
T_{MEAS} and T_{REF} = the respective temperatures at the measuring junction and reference junction [°C]
The reference junction's temperature can be the same as the ambient temperature but is not always.

Equation (1) applied to Figure 2 gives after breakdown by vertical lines, where S'_T is the unknown (uncalibrated) Seebeck coefficient for the extension cable and (T_{REF} – 0) the indicator's compensation for the reference junction's temperature:

$$V_{IND} = S_T\{(T_{MEAS} - T_{WALL1}) + (T_{WALL1} - T_{WALL2}) + (T_{WALL2} - T_{REF})\} + S'_T\{(T_{REF} - T_{REF}) + (T_{REF} - 0)\} \qquad (2)$$

$$V_{IND} = S_T\{T_{MEAS} - T_{REF}\} + S'_T\,T_{REF} \qquad (3)$$

If in equation (3) $S_T = S'_T$ then $V_{IND} = S_T\,T_{MEAS}$ where we can resolve $T_{MEAS} = V_{IND} / S_T$
If $S_T \neq S'_T$ then there is a measurement error. In Figure 2 there is no temperature difference across the extension cable. Therefore no voltage is introduced across it. See the second-last term in equation (2), which is zero.

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