PENTRONIC NEWS

PENTRONIC Scandinavia's leading manufacturer of industrial temperature

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Increasing energy consumption requires better measurement

Temperature measurement in the energy production sector is one of Pentronic's core competencies. Ultimately it's about using resources as efficiently as possible in view of the environment and future generations.

The rapid swings in the energy sector demonstrate the importance of knowledge.

Knowledge is the speciality that Pentronic delivers to its customers – manufacturers of gas and steam turbines, diesel-driven and nuclear power plants, CHP plants, and even solar and wind power plants.

Pentronic's deliveries are in the form of temperature sensors and peripheral equipment, calibration, and training. The result is increased energy production, reduced costs, more reliable operation, less maintenance, and a better decision-making basis for investments.

"Our energy customers have to know what they're measuring," explains sales manager Roland Gullqvist.

High measurement quality has long been a priority of the entire energy sector. This situation began with the oil crisis in 1973 and since then has been heightened by recurring environmental debates, which resulted in ever-tougher laws and regulations. To that can be added the industry's own quality and environment management systems, which require traceable measurements as part of their continual improvement work.

Intelligent sensors

"We have to advance along with the ever-tougher requirements," explains Pentronic's managing director, Rikard Larsson.

He gives as an example the new generation of intelligent temperature sensors with integrated electronics for better performance, easier installation and faster service. This type of measuring equipment is already being used in industry – with performance that only a few years ago was at home in a controlled laboratory setting.

"One consequence of this development is also that our accredited laboratory is doing more and more calibrations in the field," Roland Gullqvist says. "Instead of the customers sending us their reference equipment so they can in turn calibrate their process sensors, our laboratory personnel are going out to calibrate the process sensors in situ."

Environmental permits and safety

Correct temperature measurement is also a prerequisite for receiving an operating permit from the authorities. In its first issue of 2014, PentronicNews reported on the Gärstad CHP plant in Linköping. Plant management had to prove to the authorities that specific temperature levels had been achieved in order to obtain environmental permits for the plant's four boilers.

The situation is the same for nuclear power plants, where safety is an additional factor. Temperature is measured in such locations as the reactor itself and the steam turbines that run the electric generators, and also to enable the rapid detection of any leaks.

Operations are closely supervised by the authorities (in Sweden the Swedish Radiation Safety Authority) and temperature readings are among the data required.

"The nuclear power plants do their own audits of Pentronic and have approved us as suppliers in both Sweden and Finland," Rikard Larsson explains.

Speed and precision

However, it's not enough just to supply the right temperature sensor of the right quality. Delivery performance and speed are often critical in the energy sector. A nuclear power plant or heating plant cannot stop functioning in the midst of a freezing winter because the temperature sensors it ordered didn't arrive. Reliable deliveries are of vital importance to Pentronic's customers and the company is continually working to uphold a high service level. In the 2013 financial year Pentronic had a delivery performance of more than 99 percent calculated on a daily basis from the date of the first order acknowledgement.

Thanks to the experience and expertise of its sales staff, its own design department, and a production process that includes components made in-house, Pentronic can very rapidly understand a customer's requirements and then design, manufacture and deliver customised temperature sensors.

With the increasing demands for efficient energy usage in order to conserve the Earth's resources and protect the profitability of energy producers, Pentronic's products and services within the field of temperature measurement are playing an ever-more important role.

Pentronic fastest at made-to-measure sensors

Sometimes it's hard to perceive your own good points.

One example is Pentronic's delivery times. Temperature sensors made to specific measurements normally have a two-week delivery time.

"Customers have now told us that no one else can deliver that fast," says sales engineer Jonas Bertilsson.

Pentronic overlooked that advantage due to its own production routines. Whereas other companies supply standard sensors from off the shelf, Pentronic assembles special-order sensors from components in stock, many of which are made in house. In other words, Pentronic applies the "lean" principle by manufacturing individual sensors as if they were part of a whole series.

"Because we make the components ourselves, we can more easily tailor-make the sensors to suit the customer's wishes," Jonas explains.

Examples of made-to-measure variations are insertion depths, diameters, threads and extension cables.

How to create a made-to-measure temperature sensor within two weeks? The answer is to start with a standard sensor. A large range is available at www.pentronic.se. Then contact Pentronic to request alterations.

"We can satisfy many customer demands within the framework of our production system," Jonas concludes.

"Pentronic can supply made-to-measure sensors in two weeks," Jonas Bertilsson says.

Training helps heating plants cut costs

Customised industry and business training courses in temperature measurement and calibration are becoming more and more common. This spring Pentronic held two special courses for employees at heating plants. The most recent course was a two-day affair in Örebro for participants from five companies.

Interest in such courses has grown among heating plant managers because temperature has become more critical to their operations for various reasons. Environmental permits require that a specific temperature be achieved for a specific length of time. Another reason is that temperature affects the lifespan of a heating plant.

"In general the incineration temperature is too high, which shortens the lifespan of such components as bricks and tubes," explains Karoline Haneck, who was one of the instructors.

Also instructing the heating plant courses are Jonas Bertilsson and Michael Steiner. All three have experience from Pentronic's accredited calibration laboratory.

Pentronic is planning more targeted courses for heating plants, both open sessions for people from several companies, like those already held in Jönköping and Örebro, and company-specific ones. Anyone interested can contact Karoline Haneck. Her contact information is listed at www.pentronic.se.

Some of the participants at Pentronic's latest course for heating plant employees. Personnel from five companies attended.

Meet Pentronic at the trade fair

Many people met Pentronic at the fairs in Karlstad and Piteå during the spring.

The next chance will be on 10-11 September at the Euroexpo industrial fair in Falun, Sweden. "Meeting our customers face to face is important," says Jonas Bertilsson, who worked at the stand this spring.

What is unique about Pentronic is its knowledge about temperature and its ability to manufacture and supply measuring equipment that meets its customers' needs. At a quick glance, the products themselves appear no different from those of Pentronic's colleagues, so there is no major benefit from participating in traditional trade fairs. Instead, Pentronic has chosen to take part in some of Euroexpo's fairs, at places where many customers are located within a reasonable distance. These are contact fairs where the aim is to meet people rather than to display products. "This suits us very well and our customers appreciate being able to put a face to someone whom they have otherwise only met on the phone or by email," Jonas says. So keep an eye out for Pentronic at Euroexpo in Falun on 10-11 September!

New IEC standard for thermocouples

The IEC 60584 standard for thermocouples has been altered in the latest edition from 2013.

"The changes aren't major but it's good to know about them," says Pentronic's laboratory manager Lars Grönlund.

"The biggest difference compared with the 1995 edition is the inclusion of two thermocouples constructed from tungsten (W) and rhenium (Re) in various proportions," Lars continues. "They are types A and C, which have the respective compositions of W-5% Re/W-20% Re and W-5% Re/W-26% Re, where the first wire has a plus polarity. Types A and C are only standardised with a tolerance in accordance with class 2."

Thermocouples made of tungsten and rhenium are used in such contexts as extremely high temperatures and vacuum environments. The Swedish chemist Scheele was the first person to publish the discovery of tungsten (also known as wolfram) and in English it came to be called after the Swedish term "tung sten" (literally "heavy stone") due to its very high density of 19,250 kg/m^3.

"In the 1995 edition and earlier, the tolerance of the base metal thermocouples was defined with two temperature ranges," Lars explains. "The new 2013 standard defines the tolerance limits without giving the temperature of the change-over point between the constant and the sloping demarcation lines as shown in the figure. Instead, you must calculate for yourself which tolerance is the greater of the two."

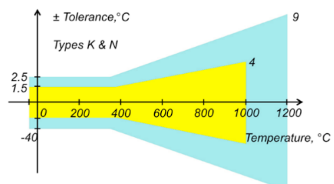

Figure 1. A graph showing the tolerances in accordance with IEC 60584 for types K and N thermocouples in class 1 (yellow) and class 2 (blue). Note that class 1 is limited to 1000 °C. Above 1000 °C a thermocouple in accordance with class 1 does not need to conform to class 2

Surface-mounted sensors as good as those in thermowells?

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

QUESTIONS? ANSWERS!

QUESTION: We want to measure the air temperature inside a steel pipe where the air velocity is high. We would prefer to avoid using thermowells inside the pipe because the air contains sharp particles that would perforate the thermowells. Can we use surface-mounted temperature sensors instead? The pipe's dimensions and current measurement data are given in Figure 1.

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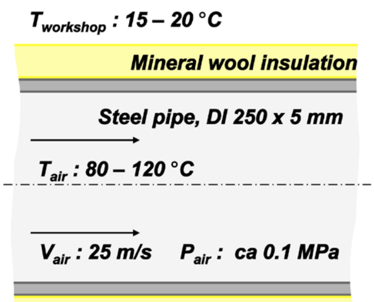


Figure 1

ANSWER: Unfortunately your question cannot be answered with a simple yes or no. The answer depends partly on the measurement requirements that must be met. Two factors that influence the answer to your question are the required accuracy and response time.

If the air temperature is fairly constant and any temperature variations occur slowly, the measurement problem can be regarded as being essentially stationary. The heat flux from the air inside the pipe out to the workshop occurs as follows: Between the air in the pipe and the pipe's inside surface, the heat transfer occurs by means of forced convection; inside the pipe wall the heat transfer occurs by means of conduction, and this also applies to the insulation. On the outside of the insulation, the heat transfer to the workshop occurs by means of natural convection and radiation. See Figure 2.

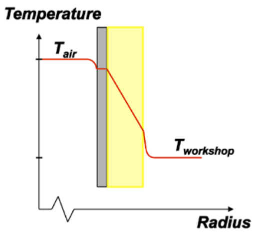


Figure 2

Let us assume that the air temperature inside the pipe is 100 °C and the temperature inside the workshop is 15 °C. If the insulation's thickness is 40 mm we can calculate the temperature on the pipe's outside surface to be 98.7 °C and if the insulation's thickness is 80 mm the corresponding temperature is 99.3 °C. When the temperature sensor is placed on the outside of the pipe, the measurement error is just over 1 °C and just under 1 °C respectively. Whether or not the measurement error is acceptable must be decided from case to case. Note that even a sensor inside a thermowell will produce some measurement error and that a thermowell will always disrupt the flow.

With an uninsulated pipe, the temperature on the pipe's external wall will be 84 °C and the measurement error will be 16 °C. The insulation's thickness is thus decisive to the size of the measurement error. During installation it is essential to achieve a good close contact between the sensor and the pipe wall. A poor contact increases the measurement error, as does an oxide layer between the pipe and the sensor. Regular inspection of the installation is therefore necessary.

At a rough estimate, given a stepwise temperature reduction of 10 °C of the air inside the pipe, almost four minutes will pass before the sensor displays the temperature of 95 °C. One reason for the long response time is the limited heat transfer coefficient between the air and the pipe wall in combination with the thickness of the steel pipe.

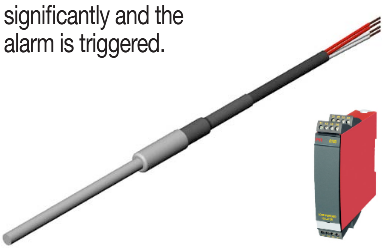
An external surface-mounted sensor has several advantages. One is that it is easy to install. Another is that it does not disrupt the flow inside the pipe. In the case of a fairly stationary measurement problem, we can often accept the measurement error. In this case the sensor's weak point is its long response time.

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

Flow detector from a double Pt100 sensor

A simple flow detector can be created from a double Pt100 sensor and a transmitter. The sensor must be mounted in the tube whose flow is to be indicated such that the probe tip will be at a sufficient depth in the flow.

One of the Pt100 circuits is connected to a source of constant voltage or current. This heats up the probe tip to well above the flow's temperature when the tube is empty. The other circuit measures the same temperature via a temperature transmitter with an alarm function. When the flow, which is colder than the heated sensor, reaches it, the sensor is cooled significantly and the alarm is triggered.



STRAIGHT FROM THE LAB

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Avoid calibration omissions with our new form

Sometimes Pentronic receives equipment for calibration that lacks important information which is necessary for us to do the job and return the equipment.

For this reason, Pentronic has created a form that can be downloaded as a Word file from www.pentronic.se. The form can be found under the heading "About Pentronic". Then click on "Returns" and "Calibration of equipment". The form itself is called "Calibration".

"Customers do not have to use the form but it is designed so they can give us the information we need," explains laboratory manager Lars Grönlund.

Important details include a description of the calibration task to be performed, the customer's name, the name and contact details of the relevant contact person at the customer's, and where Pentronic should send the invoice and the calibrated equipment respectively. Pentronic would also like to know if the equipment has been installed and that it is not contaminated, so it can be handled without protective equipment.

"Sometimes we've received equipment where the company name and address on the tape were the only way we could trace it back to the customer," Lars says. "It's also happened that the customer has been a big company where the same type of instrument is used at fifty or sixty different places around Sweden."

So if you want your instrument to be calibrated the way you'd like it to be and also returned to you, please use the form!

In situ calibration of types K and N thermocouples at high temperatures (2)

In the last issue of Pentronic News we described how type N thermocouples produce lower calibration errors at high temperatures than type K. Previously we also asserted that it is better to replace base metal thermocouples with new ones than to invest time in doing unreliable calibration. However, if you must still verify that a thermocouple lies within a tolerance range, one method that can work is in situ calibration.

A number of error sources exist that can lead to very unreliable calibration at high temperatures of about 1000 °C. One is the SRO phenomenon, which affects both types K and N thermocouples but in different temperature ranges and with different amounts of error. The error will be particularly great when a long thermocouple passes through a furnace wall, say 2 metres from the probe tip, and when the same thermocouple is calibrated in a separate block calibrator only 0.2 metres from the probe tip. SRO is a hysteresis phenomenon whose effect on the temperature signal varies according to the previous history of the measuring device with regard to warm-up times and temperature level. [Ref 1]

Another problem is that the probe tip is located in what is basically a constant temperature environment whilst the wall passage where the measurement signal is generated has a temperature gradient from room temperature up to the 1000 °C level. This normally means that the thermocouple degenerates differently – develops a different sensitivity – where the calibration is done compared with where the measurement occurs. The difference between these two becomes a calibration error. [Ref 2]

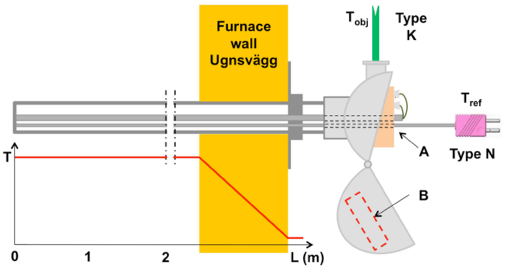

Figure 1. Thermoelectric voltage is almost always only created inside the furnace wall where the temperature gradient slopes (≠ 0). Both the measurement object T_{obj} and the reference thermocouple T_{ref} take measurements under conditions that are as identical as possible. There are terminal blocks equipped with an extra hole for inserting the reference thermocouple into position, see A. When using a transmitter the solution can be to mount it inside the lid, see B.

Calibrate at the right place

It is therefore important to calibrate where the signal is actually physically generated. We must achieve a temperature gradient almost identical to that inside the furnace wall. This is scarcely possible when doing a stand-alone calibration outside the furnace. So what should we do?

The solution is called "in situ calibration" (calibration in place). We already have the furnace. What is needed is a little planning to leave room for a reference thermocouple beside the calibration object, which will remain in place. See Figure 1. The outer protection tube keeps both thermocouples at the same temperature, which is essential for a reliable calibration. It is of course important to lock the reference thermocouple's use only to a specific protection tube length. Otherwise there is a risk that both the SRO phenomenon and different amounts of ageing inside the furnace and in the wall can worsen the calibration's accuracy.

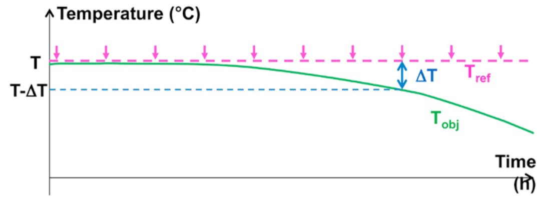

Figure 2. The pink dotted line is the reference temperature T. The solid green line shows the calibration object's degeneration over time. If we take brief measurements (say 15 minutes) at regular intervals with the reference thermocouple, its operating time will be very short and its properties will be stable. We can then monitor the degeneration and decide at what ΔT the calibration object must be replaced.

Short-term effect

In this example we presume that we can use a sheathed thermocouple. We use a type N thermocouple as the reference whilst the calibration object is a type K. It is also possible to use a type K as the reference. The point is that the reference thermocouple is used for a short time compared with the process thermocouple. See Figure 2. The reference thermocouple can therefore be regarded as stable whilst the furnace thermocouple might operate for hundreds of hours and thereby have the time to degenerate significantly. By regularly calibrating the furnace thermocouple in situ, you can follow the changes in its output signal over time. If you have a maximum ΔT that cannot be exceeded, you can easily see when the limit value is reached and then replace the thermocouple.

Practical tips

Furnace thermocouples with terminal head can be equipped with a terminal block with extra hole for a reference thermocouple. If you use a transmitter you can choose to have a terminal head with a lid mounting for transmitters. The thermocouple can then be terminated with a terminal block with extra holes. See A and B in Figure 2. If you only have a protection tube inside the furnace into which a sheathed element with a connector has been inserted, you probably can also easily find room for a reference thermocouple with a connector inside the protection tube. If there is no such protection tube it will be more difficult to arrange for identical temperatures and insertion depths. It may be possible to tie the probe tips together or place them in a piece of metal with suitable holes bored in it. The metal distributes the temperature well. See Figure 3.

In situ calibration requires some extra preparation when furnaces are being designed. It is nevertheless completely clear that in situ calibration reduces the uncertainty of the calibration result.

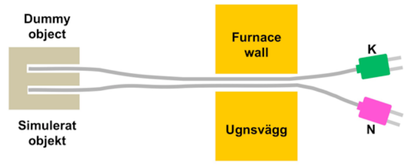

Figure 3. If there is no protection tube, we can use a dummy measurement object in metal with two bored holes. The heat transfer will be almost identical to that inside a block calibrator. Even in this case we must control the thermocouples' lengths to ensure that the wall passage for the calibration event is the same as it is during normal operation.

References see www.pentronic.se > News > Pentronic News > Pentronic News Archive
[Ref 1] Pentronic News 2014-2 p 4
[Ref 2] Pentronic News 2012-1 p 4

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