PENTRONIC NEWS

PENTRONIC Scandinavia's leading manufacturer of industrial temperature sensors

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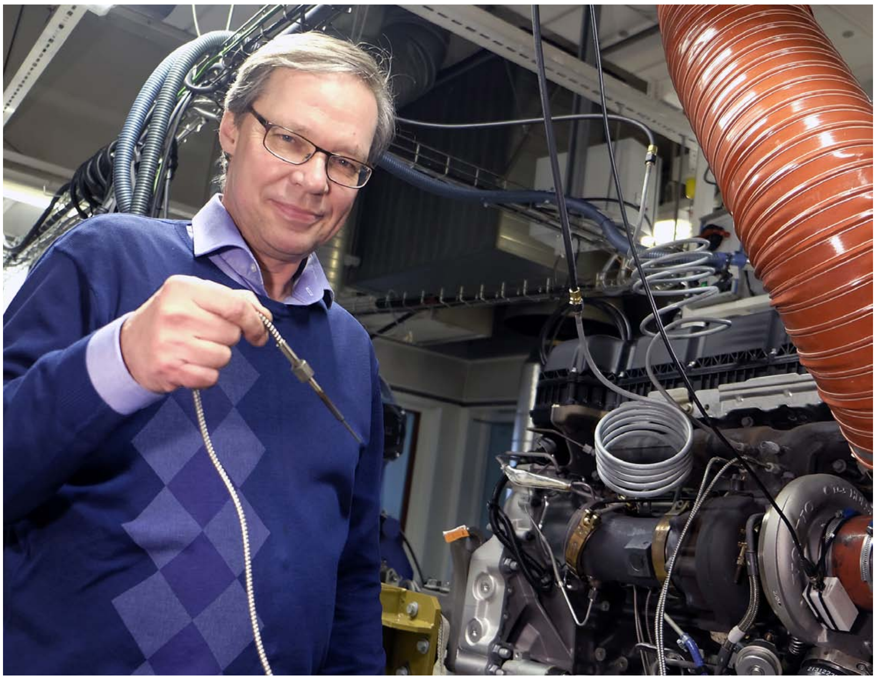
The challenge has become the measurement methods



Temperature sensors are becoming more and more critical to engine development. They must measure correctly, react quickly and tolerate sudden increases in engine revs. Volvo's Mikael Svensson holds an exhaust gas sensor developed by Pentronic.

It is becoming increasingly difficult to develop cleaner and more fuel-efficient engines. "We've now come so far that the performance of the measurement equipment is starting to set limits," says Mikael Svensson of Volvo Group Trucks Technology in Göteborg.

He works with measurement systems for the development and testing of diesel engines for trucks. The industry is under tough pressure from both the authorities and the public. They demand constantly lower emissions and reduced fuel consumption but at the same time customers expect more powerful and reliable engines.

Today's engines from Volvo meet the strictest European Euro VI emission standards and the American equivalent, US 13. The next step is further development of the Euro VI standards and no one knows what that will involve.

More and more road tests

"One challenge is to find and agree on measurement methods to verify that the standards are being met," Svensson says.

At the same time, Volvo's customers, the road hauliers, expect that fuel consumption and performance will be manifested in more than just some test results. In their business, actual fuel consumption is what counts and every centilitre affects their bottom line.

"More and more of the tests are being done on the road under actual conditions with the measurement equipment on board," Mikael says, and gives an example of how this can be done:

"The measurement equipment can be mounted in a truck in Australia that communicates with the development department here in Göteborg."

Faster response times

Previously, measurements were used to verify the properties of engines. Nowadays the results are also used as the basis for computer simulations and input data in the development of the engine control unit, a component as important as injectors and pistons.

Accuracy is not the only important requirement. Even faster response times from equipment such as temperature sensors are necessary. For temperature measurement, thinner sensors are the solution for a fast response.

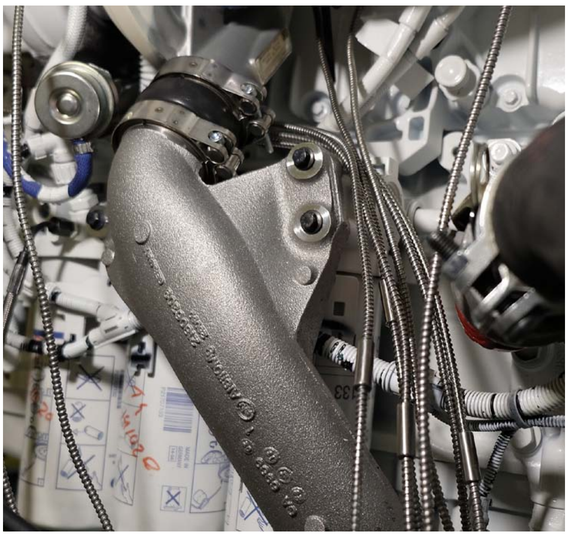
"At the same time, the sensor cannot be made too thin," Mikael says. For example, if we place a very thin thermocouple in the exhaust manifold, it will flap when the engine is revved up and break off."

The solution

In this case Volvo worked with Pentronic to develop a sensor model that can cope with the environment. The sensor is fast enough, durable and does not disrupt the exhaust gas flow too much.

Even though more and more measurements are being done under real-world driving conditions, traditional methods of engine testing are also being used more. New fuel types, hybrid technology, regulatory requirements from various countries' authorities and many more factors are continually increasing the need to take measurement readings both on the road and in testing facilities.

"The cleaner and more efficient engines become, the more often and more carefully we have to take measurement readings," Mikael Svensson concludes.



Today's diesel engines that meet Euro VI emission standards have become so clean that it is difficult to verify any future improvements without improvements in measurement method performance.

My first year at Pentronic

A year goes by so quickly, especially if you are having fun. My first year at Pentronic has been a fantastic experience. It has been a privilege to work with a team of enthusiastic and skilled colleagues. I have also had the opportunity to experience Västervik and its extensive coastal archipelago, including a visit to the annual summer music festival and pleasant days by the seaside.

The past year featured some important events. The single biggest change for us was the merger with our sister company Gedevelop in Helsingborg. This has given us the opportunity to get to know new colleagues and to work with a wider range of products and new customers around the world.

Another noticeable development is the generational shift we are currently undergoing. A number of our colleagues who have been loyal to Pentronic for many years are changing gears in their career and will now have the opportunity to enjoy all the good things in life. At the same time we are welcoming new colleagues who can contribute a slightly different perspective and great energy to help lead Pentronic into the future.

Working with large – and in a number of cases market-leading – customers places clear demands on us as a supplier. We must constantly be at the forefront when it comes to developing new products, and we must continually improve and rationalise our production in order to meet quality goals, to deliver on time, and to deliver cost-effective solutions. Pentronic has been a leader in these areas and we are continuing to work intensively to further sharpen our abilities.

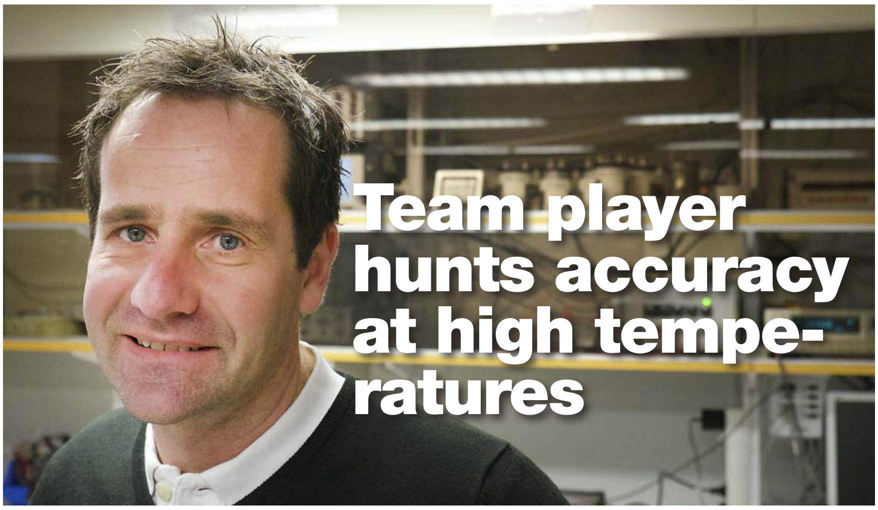
In the past year I have had the opportunity to meet a number of our customers and it is always equally interesting to see how our products are being used and to meet those of you who have had contact with us as a supplier. I believe in the value of face-to-face meetings even though nowadays we use many different IT tools for day-to-day contact.

To sum up 2014, I can say that Pentronic continues to grow in a satisfactory way and that new customers are seeking us out, while at the same time those of you who have been our loyal customers for many years continue to come back. We are all proud of this confidence in us. I hope that in the year ahead we will be able to present to you a number of new products which will make our total customer offering even more interesting.

I would also like to take this opportunity to thank all our customers and colleagues for a fantastic 2014 and I look forward with confidence to 2015.

Pentronic's Managing Director, Rikard Larsson.

Team player hunts accuracy at high temperatures



Jonas Bertilsson is Pentronic's specialist in measuring at high temperatures. But he emphasises that it involves teamwork in which the customer is a key player.

What can ice hockey bring to high temperature measurement?

"In both cases teamwork leads to results," replies Jonas Bertilsson, a sales engineer and specialist in measurement at high temperatures at Pentronic.

Jonas used to be an active hockey player himself and coaches young members of the local ice hockey club as well as being a loyal supporter for many years of the Leksand team in the Swedish Hockey League.

He takes an equally long-term approach in his professional career. He has worked for 25 years at Pentronic and began by helping to set up the laboratory for final inspection and testing.

He then moved on to Pentronic's accredited laboratory at a time when it was developing with new methods and fixed points every year.

Began at the lab

"After five years at the lab I moved to sales," he says, adding that his job there is a form of teamwork. "Our customers are engineers and know the field of temperature. We often solve a problem by working together."

Jonas has contributed to customers' high level of knowledge as an instructor at Pentronic's training courses. Nowadays most of the training he offers is in the form of customised courses in high-temperature measurement.

At the limit of measurement technology

"Many companies who measure at high temperatures now have external demands on them that are so high they border what is technically possible," he explains. "As well, it's vital to ensure a product's quality early on in the process, instead of discovering faults during final inspection and then being forced to scrap or rework the product."

The only response to such demands is teamwork, with Pentronic and the customer jointly refining the technology and methods based on past experience.

"We have the advantage of working with a variety of technological solutions," Jonas says. "No single method meets all the demands of high temperature measurement. Sometimes conventional temperature sensors are best and other times there are advantages in using temperature profiling tracker systems or IR pyrometers."

Pentronic has another high temperature specialist, Morgan Norring. He is based in Karlstad, in the heart of Sweden's steelworking industry. Pentronic Karlstad is also a branch of Pentronic's accredited calibration laboratory. Morgan has served the steel industry for many years, including with calibration. Morgan and Jonas complement each other in terms of their knowledge and experience and are Pentronic's natural contacts for customers with high temperature measurement issues.

Measurement error when gas flow temperature increases

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

QUESTIONS ANSWERS

QUESTION: In one of our process machines with a very difficult measurement environment we monitor the gas temperature during operation with a sheathed thermocouple in an outer protection tube. The gas's velocity is low and the average velocity where we measure the gas temperature is about 2.8 m/s. The outer protection tube has an outer diameter of 12 mm and a length of 250 mm. During startup the temperature increases over a 20-minute period to reach the operating temperature, which is just over 600 °C. During startup the gas is mainly air. Is it the protection tube's outer diameter that has the biggest influence on the measurement error?

Joakim J

ANSWER: Figure 1 shows how the measured temperature and the measurement error theoretically vary during a startup procedure in which the gas temperature is changed in the form of a ramp. The measurement error and response time are affected mainly by the temperature sensor's design and the flow around the sensor. If we assume that the temperature difference inside the protection tube and the sheathed thermocouple is disregarded, the measurement error ΔT can approximately be obtained from the equation

$$\Delta T = (cmB) / (Ah) \qquad (1)$$

where c is the specific heat capacity in (Ws)/(kgK), m the mass in kg, B the gas's temperature change in °C/s, A the protection tube's heat transferring area in m^2 and h the heat transfer coefficient between the gas and the protection tube in $W/(m^2K)$. The heat capacity is an average value for the protection tube and sheathed thermocouple. Both the mass and the area depend on the diameter of the protection tube. The heat transfer coefficient depends on the flow velocity but also on the diameter. Simplified, the equation (1) can be written as

$$\Delta T = (c\rho DB) / (4h) \qquad (2)$$

where D is the diameter in m. The density ρ in kg/m^3 is an average value for the protection tube and the sheathed thermocouple. See [Ref 1].

If only the protection tube's outer diameter D is reduced from 12 to 10 mm, the measurement error ΔT is reduced in accordance with the equation (2) to 10/12 (83%) of the original measurement error. In reality the measurement error becomes even less, 75%, because the heat transfer coefficient increases when the diameter decreases.

READ MORE *Read the extended article at www.pentronic.se > News > Technical Information > Technical Articles > Examples of heat transfer.*

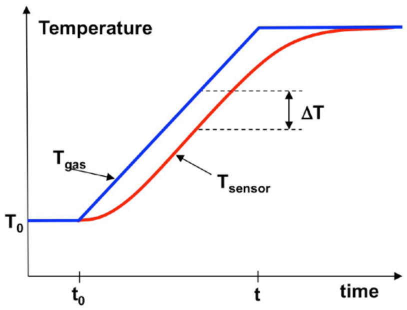


Figure 1. The gas temperature and sensor temperature when the gas temperature is changed in the form of a ramp.

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

[Ref 1] PentronicNews 2012-1, p 3.

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

Halogen-free extension wire for type K thermocouples

Pentronic supplies an extension wire with halogen-free insulation material for type K thermocouples. The extension wire can be used when building new equipment or when placing sensors in such locations as road tunnels. The halogen-free insulation normally replaces PVC. In the event of a fire PVC can release chlorine. The chlorine then reacts with the fire water to create poisonous hydrogen chloride gas.

The halogen-free extension wire consists of conductors with seven strands. The conductors are twinned against low-frequency disturbances and are surrounded by a screen that can dampen high-frequency disturbances. The maximum placement temperature is 90 °C.

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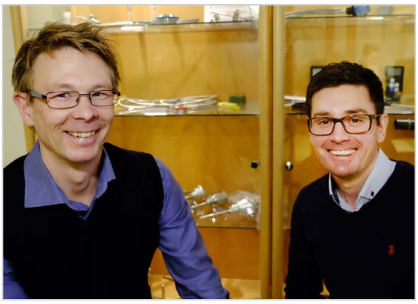
Two new sales engineers



Pentronic has been experiencing a generational shift for some years now. Here are two new faces: Dan Augustini (left) and Christophe Zaninotti. They both have relevant education and experience from industrial companies and will work in technical sales.

STRAIGHT FROM THE LAB

SWEDAC ACKREDITERING 0076 ISO/IEC 17025

All brands welcome at the laboratory

The accredited laboratory is frequently asked if it also calibrates temperature sensors and instruments from other manufacturers than Pentronic.

"Yes, we're an independent unit within Pentronic and supervised by the Swedish Board for Accreditation and Conformity Assessment, Swedac," answers laboratory manager Lars Grönlund.

The laboratory was founded in the mid-1980s as a knowledge driver for Pentronic. Becoming accredited in 1988 meant that it became a resource for everyone as part of the Swedish calibration organisation under the supervision of Swedac.

"We conform to the current standard for calibration laboratories, ISO/IEC 17025, and use methods that are inspected and approved by Swedac," Grönlund says.

As part of Sweden's national measurement organisation, the laboratory must be impartial and calibrate equipment regardless of its brand. One consequence of this is that final inspection of Pentronic's own products is done in a separate laboratory with traceability to the one monitored by Swedac.

"The only limits to the commissions we accept are the physical dimensions and technical properties of the equipment to be calibrated," Grönlund explains.

The parts of a process sensor

For the uninitiated it can be hard to understand what components are required in a temperature sensor. Suppliers describe them in various ways. In this article we present the basic building blocks of a process sensor.

The introduction already mentions a difficult term – process sensor. In general this terms refers to a temperature sensor that measures within a process. A narrower definition, as depicted in Figure 1, is a sensor with a terminal head that is designed to measure temperatures in e.g. pipes and tanks.

The external part of a temperature sensor is called the housing. The housing can consist of a terminal head, a neck (tube), and a flange or a threaded plug for mounting onto a pipe or tank wall. Below the plug the housing's protection tube that comes in contact with the process provides sufficient protection against the process medium.

The sensor as a staircase

The threaded nipple can be placed at any distance between the housing's terminal head and the probe tip that is in contact with the process. The dimensions of the protection tube above and below the nipple can also be selected to suit the insertion depth into the process and the insulation's thickness. Some customers want to protect the insulating mat outside their process furnace's wall or roof by using large and robust necks that can be walked or climbed on.

Of course a temperature sensor must contain a sensor, which in the case of Pt100s must be sheathed in a measurement insert. See Figure 2. Thanks to the outer protection tube, the measurement insert can be replaced as necessary without leakage occurring in the enclosing wall of the process. No additional thermowell in the wall is required. Figure 3B shows most clearly that the measurement insert is screwed into the base of the terminal head with two springloaded screws. When these and possibly also the signal cable are disconnected from the terminal block or transmitter the measurement insert can easily be pulled out via the terminal head.

For temperatures up to max. approx. 600 °C wire-wound Pt100 sensors can be used [Ref 1].

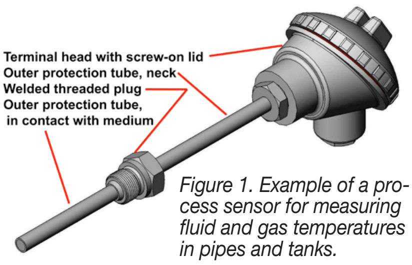


Figure 1. Example of a process sensor for measuring fluid and gas temperatures in pipes and tanks.

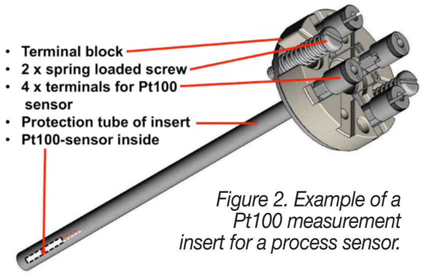


Figure 2. Example of a Pt100 measurement insert for a process sensor.

Above that, thermocouples must be used [Ref 2]. The Pt100 sensor in the measurement insert is linked by two, three or preferably four conductors to the terminal block. See Figure 3. The maximum temperature of the conductors' insulation limits the measuring range. The material PTFE can normally be used up to approx. 250 °C and metal-sheathed probes up to approx. 600 °C.

A four-wire connection is also preferable from the terminal head's terminal block to the peripheral instrumentation in order to reduce measurement error due to the cabling. See [Ref 3].

To facilitate customers' own inventory management, Pentronic supplies three options for the process sensor's signal termination, which apply to both Pt100s and thermocouples. See Figure 3. The most common termination is a terminal block (3B) or a transmitter (3C) on the measurement insert in the terminal head. There are various types of transmitters, so customers purchasing this equipment must remember to specify the measuring range and any signal bus. For customers wanting to be able to mount a transmitter or terminal block later there is the option (3A) with stripped wires.

Four-wire connection most reliable

Pentronic supplies as a standard four-wire-connected Pt100s up to the terminal block. If you do not have subsequent signal processing intended for four wires, just avoid connecting any one of the four terminals and you get a three-wire connection. To adapt to a two-wire connection, you connect in parallel the white and red wires respectively, each pair to its own terminal. The double wire area then halves the measurement error resulting from the wire resistance [Ref 3].

The process sensor's construction can worsen the heat transfer to the resistor due to the existence of an air gap (typically 0.5–1 mm) between the outer protection tube and the measurement insert. The powder filling around the Pt100 resistor inside the measurement insert can also cause interference. Pentronic has always equipped such sensors with metal casings with a good fit between the outer protection tube and the insert, and inside the insert to the resistor to facilitate the heat transfer. This gives a rapid response time and also more accurate readings when using short insertion lengths. See Figure 4 and [Ref 4].

The process sensor with replaceable measurement insert originally had standardised dimensions according to the German DIN standard. Many other versions have been developed to meet various needs. For example, there are sensors with no outer protection tube in contact with the process. Instead, a conical thermowell is welded onto the vessel wall that seals against processes with high pressure and high flow velocity. The measurement insert is then mounted in the thermowell with the sensor's threaded plug. See Figure 5. For examples of process sensors, see [Ref 5].

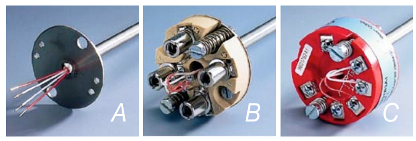


Figure 3.
A) Measurement insert with stripped wires for later mounting of a terminal block or transmitter.
B) Measurement insert with mounted terminal block.
C) Measurement insert with mounted transmitter

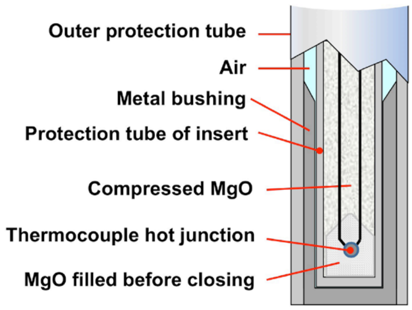


Figure 4. Probe tip on Pentronic's process sensor with a thermocouple

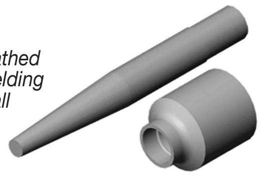


Figure 5. A fully lathed thermowell for welding into the vessel wall using a mounting boss

References, see www.pentronic.se > News > Pentronic News > PN Archive
[Ref 1] See PentronicNews 2013-1 p. 4.
[Ref 2] See PentronicNews 2011-3 p. 4.
[Ref 3] Link: http://goo.gl/ZyqhUK
[Ref 4] See PentronicNews 2009-5 p. 4.
[Ref 5] Link 1: http://goo.gl/ZkpqzT
Link 2: http://goo.gl/OcGwxV
Links: Use the address bar for the Short URLs.

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

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