PENTRONIC Skandinavia's leading manufacturer of industrial temperature sensors

NO. 2017-4

PENTRONIC NEWS

It's all about temperature!

FAGERHULT USES TEMPERATURE TO SCULPT LIGHT

CONTINUED ON PAGES 2-3

Season's Greetings!

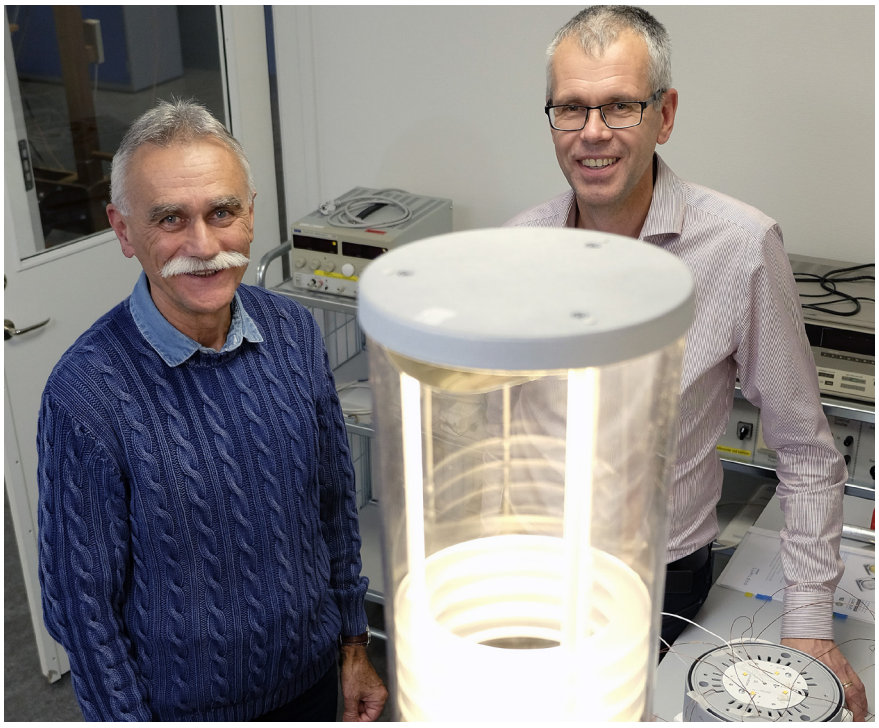
The end of the year is a good time for a little contemplation. It's easy to dream of faraway places while gazing out from our head office over the sea inlet here, where the water is gleaming and the sun is gradually rising up over the treetops. We should be thankful for the beautiful countryside in Sweden that is accessible to everyone. In a world where media channels are constantly feeding us news from around the globe we need something that balances the picture.

This year's biggest holiday in the Christian calendar is almost upon us and usually involves many preparations. Many of them involve monitoring temperature in one way or another. You can read about one such activity in Dan Loyd's Q&A column. In addition, the food must be correctly cooked and stored, the home must have a pleasant climate, and we need to wear suitable clothing when we go outdoors. In other words, it's critical to monitor the temperature.

As usual, we will make a donation to the Swedish SOS Children's Villages association instead of sending out Christmas cards.
I wish you a wonderful holiday and a happy and successful 2018.

Rikard Larsson
Managing Director

FAGERHULT USES TEMPERATURE TO SCULPT LIGHT



Peter Palinkas and Daniel Järpehult with a type of outdoor lighting. On the table is equipment for temperature measurement.

Since 2010 Fagerhult has implemented a technological revolution.

Back then, the Swedish lighting manufacturer had almost exclusively fluorescent tubes in its lighting systems; today 90 percent of them are LED.

At the same time, the company's reason for using temperature measurement has gone from fire safety to being a tool for sculpting light.

FAGERHULT is one of Europe's leading developers and manufacturers of lighting systems for public environments, both indoors and outdoors. The company began in 1945 in Fagerhult, a small community in the province of Västergötland with a view over Lake Vättern. The main factory and development department are still there today.

At first the company focused on home lighting but at the end of the 1950s Fagerhult was commissioned to supply lighting for the 26-storey-high building that housed the tax authorities in Stockholm. Since then the focus has been on lighting for public environments.

"In about 2010 it was clear that fluorescent lights would be phased out and replaced with LED," explains laboratory manager Daniel Järpehult.

Diodes do not function in the same way as incandescent light bulbs and fluorescent tubes. So a new way of thinking and designing was necessary. Even the process of temperature measurement gained a new field of application.

An incandescent bulb has a luminous efficiency of 10 to 15 lumens per watt, whereas today's diodes supply 170 lumens per watt. A diode's light is more focused whereas the incandescent bulb spreads light all around. Accordingly, with diodes, more light reaches its desired target with less power expenditure. The heat generated is also a fraction of what it was before. The result is major energy savings.

"Previously we measured temperature to ensure that the luminaires would not become overheated and cause a fire," says laboratory engineer Peter Palinkas.

Has temperature measurement become unnecessary in R&D work? On the contrary – it has become an even more important parameter, as Daniel Järpehult explains:

"A diode's lifetime is a function of the temperature. The better the cooling, the longer the diode retains its luminous efficiency."

After 50,000 hours, a diode can have lost 30 percent of its luminous efficiency due to excessively high temperature. In contrast, a diode that has operated at a cooler temperature is almost unchanged. The heat partly comes from the built-in electronics and is partly due to the fact that diodes have no significant heat emission but instead return most of the heat to the circuit board.

Fagerhult designs its products for an operating time of 100,000 hours. A street light can last for 50 years or more.

"In future, luminaires will be replaced for reasons of design and other features, not because they've stopped producing light," Peter Palinkas says.

Fagerhult manufactures its own circuit boards with diodes, which the company refers to as "lighting engines". Combining diodes with differing colour values and lenses opens up new possibilities.

If heat generation is kept under control, designers can have freer rein.

Temperature measurement has thus moved from stopping fires to becoming a tool of the design process. Fagerhult has one of the biggest R&D departments in the industry, with a laboratory of the same class as that of Semko (now part of Intertek), which is responsible for the S mark, previously compulsory in Sweden as a third-party safety certification mark for electrical goods. The two companies cooperate closely.

Many of the tests are done only in the context of lighting. Examples are the Ulbricht sphere test for luminous flux and colour spectrum and the Goniometer, which measures how light spreads in various directions. Fagerhult also has its own testing equipment for IP (ingress protection, i.e. protection against moisture and water) and EMC (electromagnetic compatibility).

"We do our own testing for CE marking with Semko as the inspection body," Daniel says.

One question still remains: How does LED compare with previous types of luminaire? Colour rendering (the ability of a light source to faithfully reveal the colours of objects) is measured in CIE Ra values. Incandescent bulbs remain unbeatable with an Ra value of 100. Ordinary fluorescent tubes have Ra 80 and Fagerhult is now supplying LED lighting with Ra 90. The luminous intensity is at least as good and is superior when measured as lumens per watt.

"Incandescent bulbs and fluorescent tubes now have their replacement," conclude Peter Palinkas and Daniel Järpehult.

Development is occurring in many industries with differing technological "revolutions" but the need for temperature measurement still remains and Pentronic is on hand to help solve any new problems that might arise.

"That the reason for temperature measurement is moving from minimising risk to refining performance and improving quality is a trend we're seeing with many customers," says Per Bäckström, sales engineer at Pentronic.

NEW LATHE INCREASES CAPACITY BY MORE THAN ITS OWN PRODUCTION

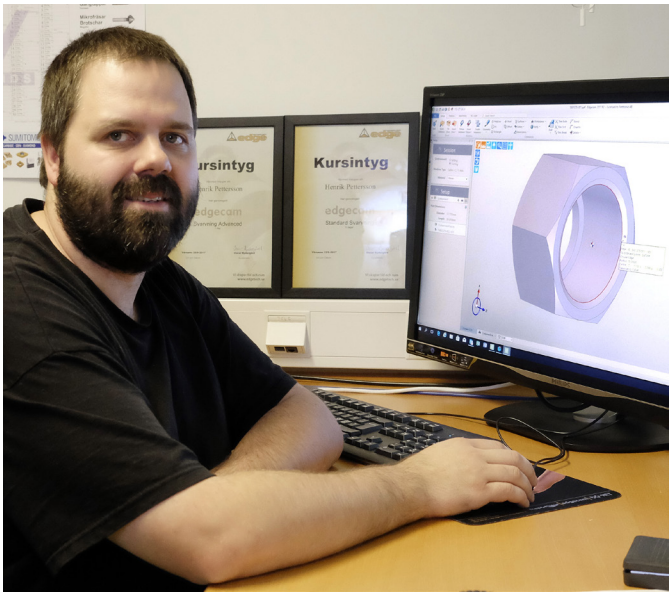
Pentronic has invested heavily in its machining department for many years. A while ago the premises were expanded to make room for more machines. Since then two new ones have been acquired and the materials handling process has been made more efficient.

"PENTRONIC'S CUSTOMERS are doing well and demand has increased strongly," says technical manager Lars Björkvik. "We're investing so we can manufacture larger volumes while maintaining our delivery reliability and shorter delivery times."

The newest lathe is designed to process larger pieces, which in this context have a diameter of up to 65 mm, in lengths up to 600 mm. The machine also includes a four-metre-long rod magazine.

The department mainly manufactures small components. Expanding the department makes it possible to optimise production better, because each machine can be used for what it is best at doing.

Pentronic has also invested in a new CAM system. Previously the programming was done directly on the machines because the department has machines with differing control systems.



"The new CAM software communicates with all our machines regardless of their control system," Henrik Pettersson says.

"We use the new CAM system to programme all the machines regardless of their control system, which increases our flexibility today and for the future," explains Henrik Pettersson, one of the employees trained to use the new system.

The new system also enables more efficient work methods in preparation and design and creates the conditions for more precise calculations.

Jesper Johansson and Lars Gutlöv in the process of starting up the new seven-axle lathe.

VISIT BY PR ELECTRONICS

JOHAN BORG-STRÖM from PR Electronics visited Pentronic in October. While here, he showed the new PR5437 transmitter to Magnus Karlsson, purchasing manager at Pentronic. This transmitter is presented in this issue's product information column.

Johan Bergström, PR Electronics and Magnus Karlsson, Pentronic.

THREE NEW FACES AT PENTRONIC

PENTRONIC IS PLEASED to present three new colleagues who joined us this autumn. From left: Göran Rälg, new inside sales rep, Karin Garplind, who was recently introduced to the Purchasing Department, and Joakim Bergs, the newly recruited group manager for electronics development.

WE SUPPORT SOS CHILDREN'S VILLAGES SWEDEN

This year Pentronic is supporting orphaned children by making a donation to the Swedish branch of SOS Children's Villages.
As our valued customer you are taking part in this gift.

Merry Christmas & Happy New Year

PRODUCT INFORMATION

www.pentronic.se

PR5437 – A SAFE TRANSMITTER FOR FAST AND ACCURATE MEASUREMENT

Pentronic presents PR Electronics' latest new product, the PR5437 HART transmitter for both single and double sensors. The unique feature of this product is that it can measure with double 4-wire Pt100s, which makes it a world first. With two inputs, the transmitter can be used for e.g. doing redundant measurements with the same unit. This means seamless transition from one sensor to the other if a fault occurs. This unit can be included in safety-rated circuits for SIL2 or SIL3 applications (full SIL assessment). Both software and hardware are tested in accordance with IEC 61508-2010 Ed2.

The PR5437 model is also future proof because it is equipped with a connector so it can communicate with future functions. Because it is a HART transmitter, it can be configured with both PR's own software plus a terminal or system that supports DDL (IEC 61804).

Read more at www.pentronic.se > News > Product information

For further information, contact Pentronic.

Article No. 15-55437

HEATING GLÖGG – A CURRENT THERMAL PROBLEM

QUESTION ? ANSWER

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

QUESTION: Christmas is fast approaching, when it is a common custom in Sweden to offer guests hot mulled wine called glögg. Unfortunately the glögg is often lukewarm and not at all hot. What is an easy way to ensure that the glögg really is hot when it is served?

Nils J

ANSWER: We assume that the hot glögg in the serving vessel has a temperature of 50 °C and the glögg mug has a room temperature of 20 °C. When the glögg is poured into the mug, heat from the glögg is transferred to the mug via convection. The thermal resistance between the glögg and the mug's inner wall is small, which means that the temperature rapidly equalises.

When the mug's surface temperature becomes higher than the room temperature, heat is transferred from the glögg to the surroundings via convection to the mug, thermal conduction inside the mug wall, and then onward from the mug via convection and radiation. Heat is also transferred directly from the glögg surface to the surroundings via convection and radiation. The glögg is further cooled via the evaporation (a phase transition that requires heat) occurring from the surface of the liquid. The glögg temperature is constantly falling. The temperature sequence is shown in Figure 1.

Figure 2.

To determine the glögg temperature after the temperature equalisation, perhaps the simplest method is to measure it. You can also very roughly estimate the glögg's temperature with the aid of the following equation:

$$m_{mug}\, c_{pmug}\, (T_{glögg} - T_{room}) = m_{glögg}\, c_{pglögg}\, (T_{serving} - T_{glögg})$$

where, m is the mass in kg, c_p the specific heat capacity in Ws/(kg K) and T the temperature in °C.

As an example we can study a ceramic mug – Figure 2 – with a weight of 0.14 kg and a specific heat capacity of 850 Ws/(kg K). We pour in 100 ml (0.1 kg) of alcohol-free glögg with a serving temperature of 50 °C and specific heat capacity of 4200 Ws/(kg K). If the room temperature is 20 °C the glögg temperature will be 43 °C.

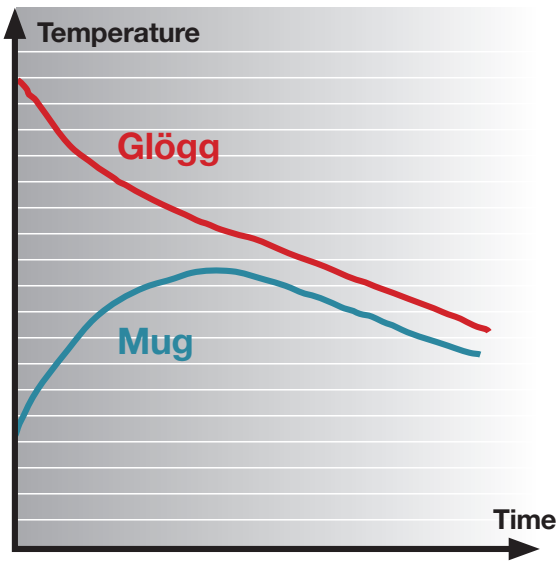


Figure 1.

The temperature reduction relative to 50 °C is so great that it is noticeable.

If the glögg mugs are heated to 50 °C there will be no temperature reduction when the glögg is poured into the mug. Preheating the mugs with hot water is a simple method of achieving the desired temperature. Another method is to increase the glögg's serving temperature to achieve the desired glögg temperature after the temperature equalisation. If you use glögg that contains alcohol, however, you must not increase the temperature too much – alcohol boils at 78 °C.

The heat flow to the surroundings means that after the temperature equalisation, the glögg temperature falls fairly quickly. In a preheated mug of the same type as the above example, we can measure a temperature reduction of just under 1 °C per minute. When the glögg contents in the mug are reduced, the glögg cools faster.

If the glögg is to be served in a thin plastic mug, the initial temperature reduction will be very small but the cooling-off speed will be higher than for the ceramic mug. If you use two plastic mugs with one inside the other, you create a small air gap between the mugs, which increases the thermal resistance and slows down the fall in temperature. So it can be worth considering which type of mug to use when it's time to heat your glögg!

Merry Christmas and Happy New Year!

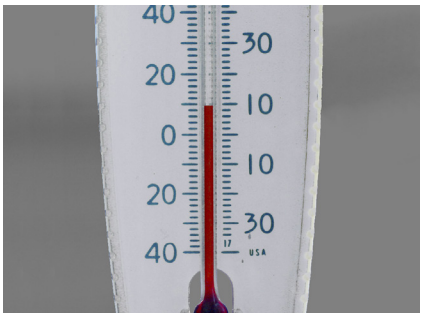
If you have questions or comments, contact Professor Dan Loyd, LiU, dan.loyd@liu.se

Temperature is measured with various instruments that transform heat – thermal energy – into detectable quantities. The most common instruments in industrial contexts are thermocouples, resistance thermometers, thermistors and radiation pyrometers.

LESSON 4 TEMPERATURE SENSORS

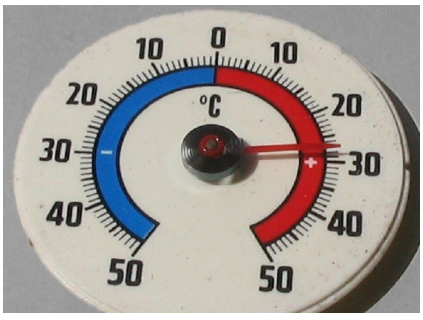
SPIRIT THERMOMETER

The function of a spirit thermometer is based on the fact that the volume of a liquid increases with its temperature. The liquid is encased in a glass that usually has a bubble at one end. To make it easy to take readings, the glass is drawn out into a narrow tube with a scale alongside it. This type of thermometer is normally used for manual readings. Previously mercury was used as a liquid but mercury thermometers are now banned in Sweden as the metal is environmentally hazardous.



BIMETALLIC THERMOMETER

A bimetal is two metals that are joined together and that have different thermal expansion coefficients. When the bimetal is heated it bends. This type is common for simple thermometers that measure e.g. air temperature and the temperature inside a refrigerator. The bimetallic thermometer is also used as a thermostat in regulating systems.



THERMOCOUPLE

At the beginning of the 19th century T J Seebeck discovered that an electric current will flow in a closed circuit composed of two different metal alloys if the joints in the circuit have different temperatures. He also found that the current increased with the temperature difference.

Today "the Seebeck phenomenon" refers to the temperature-dependent electric voltage that a thermocouple generates in an unloaded condition, that is, if a voltmeter with infinite resistance is connected to the circuit.

Example of a type N sheathed thermocouple.

Seebeck presented his theories in 1821 and this was the starting point of the development of the thermocouple. As electronics advanced the thermocouple was improved, as were the possibilities of using it. Today it is the most widely used industrial temperature sensor.

Research still continues into the material properties of thermocouple wires, insulation materials and protective casings. The latest standardised type N is one result of such targeted research, as is the ongoing activity based on type K to develop improved versions with the same high signal output as type K.

The thermocouple has several advantages: it is a simple and durable construction with a large measuring range. Thermocouples require no electricity supply. With the materials being used today, thermocouples cover the range from under –200 °C to over 2300 °C.

The main disadvantage of the thermocouple is that the Seebeck voltage that occurs at temperature gradients can be generated along the entire length of the thermocouple. If the thermocouple is not homogenous along its entire length up to the instrumentation, the signal output becomes somewhat uncertain. Despite this, the thermocouple will probably continue to be used for industrial measurements for many years to come.

PLATINUM RESISTANCE THERMOMETER

The resistance thermometer is also a child of the technological advances of the 19th century. The first theories were presented in 1891 by H C Callendar. They are based on the fact that the resistance of all metals changes according to the temperature. Resistance thermometers therefore require an electricity supply. The noble metal platinum is one of the most stable materials known and is therefore particularly suitable for measuring temperature.

With the introduction of ITS 90, the platinum thermometer took over the thermocouple's place in the international temperature scale. The platinum thermometer is now used to realise the entire range from 14K to 962 °C (i.e. from fixed point 2 at –259 °C to the freezing point of silver). See Lesson 3.

The platinum sensor has long-term stability and is characterised by high accuracy. Compared with the thermocouple, there is probably more development potential in this field. Today the limitations are a closer temperature range than that of the thermocouple, more sensitive construction and a longer response time.

Example of a DIN standardised industrial Pt100 model.

The next step for industrial platinum sensors is an expanded measuring range. The wire-wound versions already have varying accuracy up to approx. 600 °C. Thinfilm resistors, which can easily be mass produced, do not achieve as high a temperature with retained stability. Manufacturers are now investing large development resources to expand the measuring range because there is much to be gained. The hope is to achieve a greater measuring range at a lower price per produced resistor.

The most common model of the platinum sensor is the Pt100, which has a resistance of 100 Ω at 0 degrees.

RADIATION PYROMETER

At temperatures above 962 °C it is the radiation pyrometer that realises ITS 90. The pyrometer's big advantage is that it takes totally non-contact readings. However, the measuring conditions are highly variable according to the temperature and materials, so the radiation pyrometer's Achilles heel is that it must adjust to the prevailing conditions such as the emissivity of the material. One version of the pyrometer is the thermographic camera, which measures the temperature (via infrared radiation) at such a large number of points that an image can be built up. The thermographic camera is often used by firefighters, electricians and house builders to detect temperature differences rather than to determine a precise temperature. The price of good thermographic cameras has fallen sharply in recent years.

Examples of IR radiation pyrometers.

FIBER OPTICS

Another advancing form of technology is the use of optical fibers, which enable very fast and accurate measurements. One advantage is that this light conductor is insensitive to all types of electrical disruptions. However, for the foreseeable future both pyrometers and fiberoptic measuring devices are expected to remain niche instruments to be used when nothing else works.

THERMISTOR/SEMICONDUCTOR SENSOR

The thermistor has the useful ability to deliver a higher output signal compared with that of a platinum resistance thermometer. As a result, the associated electronics do not have to be highly sophisticated and expensive. The disadvantage is that the temperature range is limited, as is the linearity. In addition, there is no standardisation for thermistors, which means that customers must depend on the manufacturers' informal standards. A thermistor needs an electricity supply. There are two types of thermistor: Positive Temperature Coefficient (PTC) and Negative Temperature Coefficient (NTC). They are mainly used in electronic equipment having relatively low requirements for accuracy.

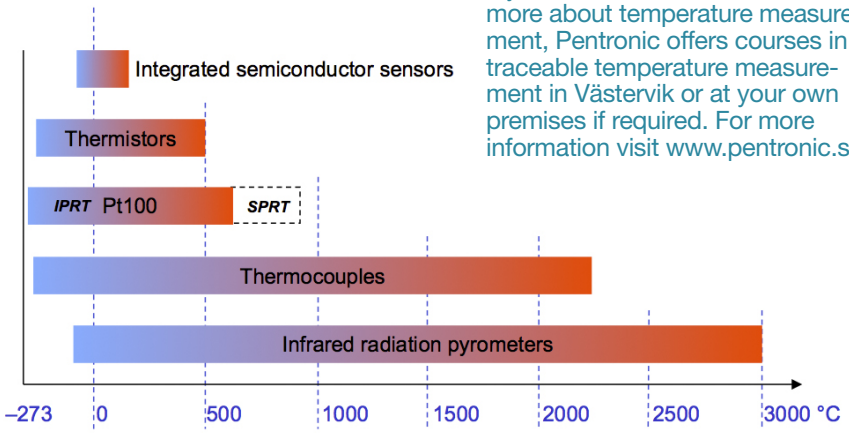
OVERVIEW OF TEMPERATURE SENSORS

The figure below shows the most common versions of industrial temperature sensors with their possible measuring ranges. Rarely can a single sensor cover the entire possible measuring range.

Thermocouples and resistance thermometers like the Pt100 have the advantage of being standardised by bodies such as the IEC. This means that they are interchangeable in terms of their signal with deviations that are indicated in the standards. So far the other sensor types are manufacturer dependent.

In order for new temperature sensor technology to be adopted, the sensor must function across a large temperature range and must also be stable and inexpensive. The great mass of temperature sensors will probably consist of thermocouples and platinum resistance thermometers for the foreseeable future.

If you would like to discover even more about temperature measurement, Pentronic offers courses in traceable temperature measurement in Västervik or at your own premises if required. For more information visit www.pentronic.se



Overview of temperature sensors and measuring ranges. IPRT Pt100 stands for industrial platinum resistance thermometers. SPRT Pt100 stands for standard platinum resistance thermometers and is used as a reference in laboratories, when it has an expanded temperature range.

PENTRONIC
Bergsliden 1, SE-593 96 Västervik
Tel. 0490-25 85 00, Fax. 0490-237 66
www.pentronic.se