Exhaust gas temperature probes by EngineSens. The TS-200 (right) is an open design that can withstand exhaust gas temperatures up to 950°C. The Pt200-HTS (left) is a fully enclosed model that is not affected by soot particles.

Getting A Sense Of Sensor Demands

Stefan Carstens, CEO of EngineSens Motorsensor, discusses diesel engine sensor technology for fuel consumption and emissions

In the field of measuring exhaust gas temperature, a key feature for reducing fuel consumption and consequently CO_2 emissions, said Stefan Carstens, CEO of EngineSens Motorsensor GmbH in Germany, is that modern diesel engines utilize mainly two types of sensors. The first one is resistance temperature probes and the other is thermocouples.

"Platinum resistance temperature probes are based on the principle of measuring the electrical resistance. A thin platinum wire has 200 ohm at 0°C, and at 850°C it would be 774 ohm," said Carstens. "The tricky part is to put the wire into the exhaust gas sensor. But this problem can be solved with the newest methods of semiconductor production. Herewith, alumina ceramics is used as substrate and carrier material due to the fact that it has a high insulation resistance even at high temperatures."

The Pt200 resistance temperature probe by EngineSens utilizes platinum as a precious metal substrate because of the characteristic that its value of electrical resistance increases continuously as the surrounding temperature increases. By applying resistance measurement, the engine's electronic system can easily determine the surrounding temperature at the measuring point.

"For resistance temperature detectors, two different designs for casings have proven to work best. One is an open-perforated housing and the other is a fully enclosed and hermetically sealed housing," said Carstens.

"With an 'open' exhaust gas temperature probe such as our type TS-200, the sensing element itself is in direct contact with the exhaust gas flow up to 950°C, like an oxygen sensor or lambda probe.

"The tip of the probe always points downward to ensure that no condensate, which might precipitate with cold temperatures, can creep into the interior of the probe and have a corrosive effect there," said Carstens.

On the other hand, sensors with a closed housing are usually utilized in applications with exhaust gas temperatures up to 800°C.

"Our HTS exhaust gas temperature probe is an example of fully enclosed and hermetically sealed housing," said Carstens. "This high-temperature sensor has no installation restrictions and can also be installed with the sensor tip pointing upward. In particular, exhaust gas, even heavily loaded with particles, cannot affect this type of sealed temperature probe; also soot has no effect."

As soot can oxidize only from 550°C upward in oxygen atmosphere, this sensor type is of particular interest for equipping diesel engines. Among its main applications is the control of SCR systems and exhaust gas recirculation.

"Another well-proven method for measuring exhaust gas temperature is the measurement by thermocouples. At the same time, this is the oldest known method of electrical temperature measurement," explained Carstens.

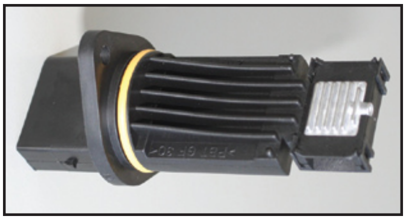
"The Seebeck-effect — so called after the physicist that discovered it — says that between the two ends of an electrical conductor, an electrical voltage is created if different temperatures exist between the two ends of the conductor.

"Unfortunately, in practice it is not possible to place one end of a metallic conductor into the exhaust gas and the other end into the engine compartment for measuring the voltage in between. Therefore a trick is used: creating thermocouples."

A thermocouple can only measure temperature differences, therefore to measure any temperature, the surrounding ambient temperature must also be known. The measurement of ambient temperature is usually done with resistance temperature probes like the Pt100, Pt1000 or Negative Temperature Coefficient (NTC) types by EngineSens.

There is then another family of sensors: differential pressure sensors, which are usually applied in filter systems and in combined heat and power plants to contribute to emissions monitoring.

"With some degree of experience,



Air mass flow sensors such as the PB-LMS by EngineSens work on the principle of the hot-film anemometer. The manufacturer said that they are often used in cogeneration plants to monitor the soot in the exhaust gas duct in the area before the heat exchangers.

the loading of filters can be determined relatively accurately with modeling techniques. If — in case of a malfunction — more soot is accumulated than predicted, the best solution is to detect an early rise of the exhaust gas backpressure with a differential pressure sensor. In addition to that, the ash remaining in the filter system after successful regeneration can be determined more precisely," said Carstens.

"In cogeneration plants, often the exhaust gas duct is followed by a heat exchanger. Due to the intense cooling-down of the exhaust gases in this area, a considerable soot effect can occur. The differential pressure sensor can be used to monitor the soot and consequently optimize the operating time between maintenance interventions."

Finally, another family of sensors — air mass flow sensors — are utilized again mainly in cogeneration plants and for maintenance purposes. Products such as the PB-LMS air mass flow sensor by EngineSens work on the principle of the hot-film anemometer.

"For this purpose, two temperature sensors are used, one has a low nominal resistance and works as a heater element. Now if the nonheated element, for instance, measures the air temperature as 15°C, the other element gets loaded with an electrical current in a way as to achieve a temperature difference against the nonheated element of 40°C, so its actual temperature then will be 55°C," explained Carstens.

"In order to keep this 55°C constant, particular amperage is needed. If the engine is started now, the air mass which passes the heated element takes energy away from it, which thus tends to cool down. In other words, an increase in amperage will help to keep the temperature difference constant. As a consequence, the required amperage is a measure for the air mass flow.

"This type of measurement is particularly suited to achieve precise adjustment of the fuel-air ratio under constant conditions," said Carstens. "Thanks to modern semiconductor technology, an air mass flow sensor can be manufactured with two hot-film anemometers applied mirror-inverted on an ultra-thin foil. This helps to easily determine the returning airflow."

This type of product by EngineSens Motorsensor is offered to cogeneration plant operators and for after-sales businesses as well.

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