JUMO plastoSENS – Rethinking Measurement Technology

Sensors made from plastic are real all-rounders

Fig. 1: Plastic granulate

It's actually quite straightforward to build a temperature probe. You need a sensor, a metal tube, and a conductive filling material to seal the assembly. For several decades, almost all temperature probes throughout the world have been manufactured in this way. But what if there were a completely different way – one that opens up brand new possibilities for sensor technology? JUMO has discovered it – and it all revolves around plastic.

The idea initially sounds very simple. Almost any form can be manufactured in any quantities using modern injection molding machines. So surely it should also be easy to injection mold a temperature sensor with plastic, right? The initial difficulty is that plastic has a low thermal conductivity and is therefore not ideally suited for temperature measurement. The extreme environmental influences in the injection molding process are also a factor. Plastic reaches temperatures of up to 360 °C in its liquid form, the machine's closing pressure is up to 100 metric tons, and the pressure in the injection molding tool reaches up to 1,200 bar. That significantly exceeds the water pressure in the Mariana Trench, the deepest part of the world's oceans. It goes without saying that these are not exactly ideal environmental influences for a sensitive temperature sensor.

Fig. 2: Model injection molding machine

Plastic as an all-rounder

Despite the challenges, JUMO plastoSENS T demonstrates that it is possible to manufacture fully functional temperature probes from plastic. To solve the thermal conductivity problem, the new products use special plastics that have particular additives. There is barely a difference from metal probes in the final product. Another benefit of these special mixtures is that a plastic that is precisely tailored to the respective application can be developed for each individual customer. This is because colorants, light stabilizers, flame retardants, and reinforcement fibers can also be used with the applied thermoplastics along with the additives.

In addition to the material mixture, an enormous amount of expertise in the area of injection molding technology is required to manufacture the JUMO plastoSENS T products. PGT Thermprozesstechnik GmbH, a JUMO subsidiary with many years of experience in the plastic industry, provides this expertise.

Total design freedom

The biggest advantage of plastic sensors is the total design freedom. The days when a probe was always a straight metal tube have long been consigned to the history books. JUMO plastoSENS T products can be adapted to the respective installation conditions. This means that a temperature sensor can be integrated into the complete housing of a blow-dryer. Alternatively, it can be round, spiral-shaped, or have an angle – the sky's the limit!

Other advantages of measurement technology made from plastic include reduced weight and excellent reproducibility. Batches of any desired quantity can be produced much faster than before. In addition, the plastic has an extraordinary insulation resistance. This means that it can now easily be used

in environments with very high currents and voltages (e.g. electric motors or transformers).

Fig. 3: Computer model of potential JUMO plastoSENS T products

Fresh thinking for the design

Depending on the plastic mixture, JUMO plastoSENS T sensors can be used in a temperature range from -50 to +200 °C without any problems. However, the manufacturing process requires a certain degree of rethinking compared to the conventional temperature probes. The required injection molding tools are individually manufactured so that the initial investment costs are higher than for conventional probes. This means that plastic temperature sensors are not automatically cheaper than comparable products made from metal.

Of course, due to the design, it is difficult to produce individual sample items. That is why JUMO uses modern software that makes it possible, for example, to simulate the response behavior and thermal conductivity of the planned sensor in advance, while taking into account the installation conditions. Tests with conventional probes have shown that this software delivers very good results. Samples are manufactured using 3D printing to conduct assembly tests and to evaluate the geometry.

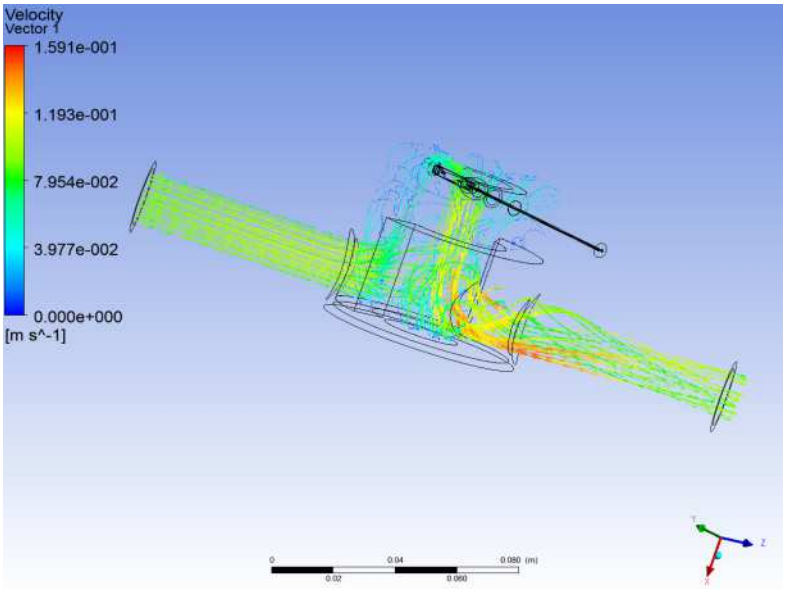

Fig. 4: Simulation model

Custom-made instead of mass-produced

All this means that JUMO plastoSENS T products are not "off-the-shelf" items, but rather customized measurement technology developed in close collaboration with our customers. The process starts with a feasibility test and a design proposal, followed by the design and simulation of the sensors to ultimately lead to the construction of the tools. The tests start after a sampling phase and, at the end, we are left with a functional prototype and series production can begin.

What does the future hold? JUMO plastoSENS temperature probes are the first step on a journey that will open up many strategic opportunities for the JUMO corporate group. The products can be used in various industries and the first customers have already become aware of the new possibilities. Efforts are also being made to examine whether other measurands, such as pressure or analytical measurement technology, could be implemented using the new technology.

First JUMO plastoSENS T examples

Fig. 5: A JUMO plastoSENS temperature probe with which two plastics with different heat conductivity were processed.

JUMO plastoSENS T probes are custom developments rather than standard products. Currently three approaches are being pursued with interested customers:

Transformer probe
As you can imagine, a transformer is a poor location for a metal temperature probe. The maximum insulation resistance of 2.5 kV is often insufficient to be able to successfully withstand the voltages occurring there. That is why JUMO has developed a plastic probe with an insulation resistance of 5 kV, which can be used at a continuous service temperature of 200 °C. Probes like this can be used in electric motors or other "high-voltage" environments.

Push-in probe
There are also particularly harsh environmental influences in vehicle or machine motors. The major problem here is the vibration. With conventional probes it is often difficult to place the temperature sensor in the probe tube so that it is really in a secure position. However, in the case of JUMO plastoSENS T, the sensor is completely embedded in the plastic. A vibration-resistant push-in probe for oil media is currently being developed for one customer. Initial tests have shown that the product can withstand force of up to 20 g without any problems. This is an impressive statistic because even the fastest rollercoasters only exert a maximum force of 6 g on the riders.

Sterilization probes:
The combination of moisture, pressure, and high temperatures causes sensor stress in sterilization applications. Leak tightness often constitutes a problem for conventional probes. JUMO plastoSENS T also provides an ideal solution here. The reason here is that special plastics form a substance-to-substance bond during the injection molding process. This is an invaluable advantage, particularly for the critical point of the cable outlet from the probe.

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