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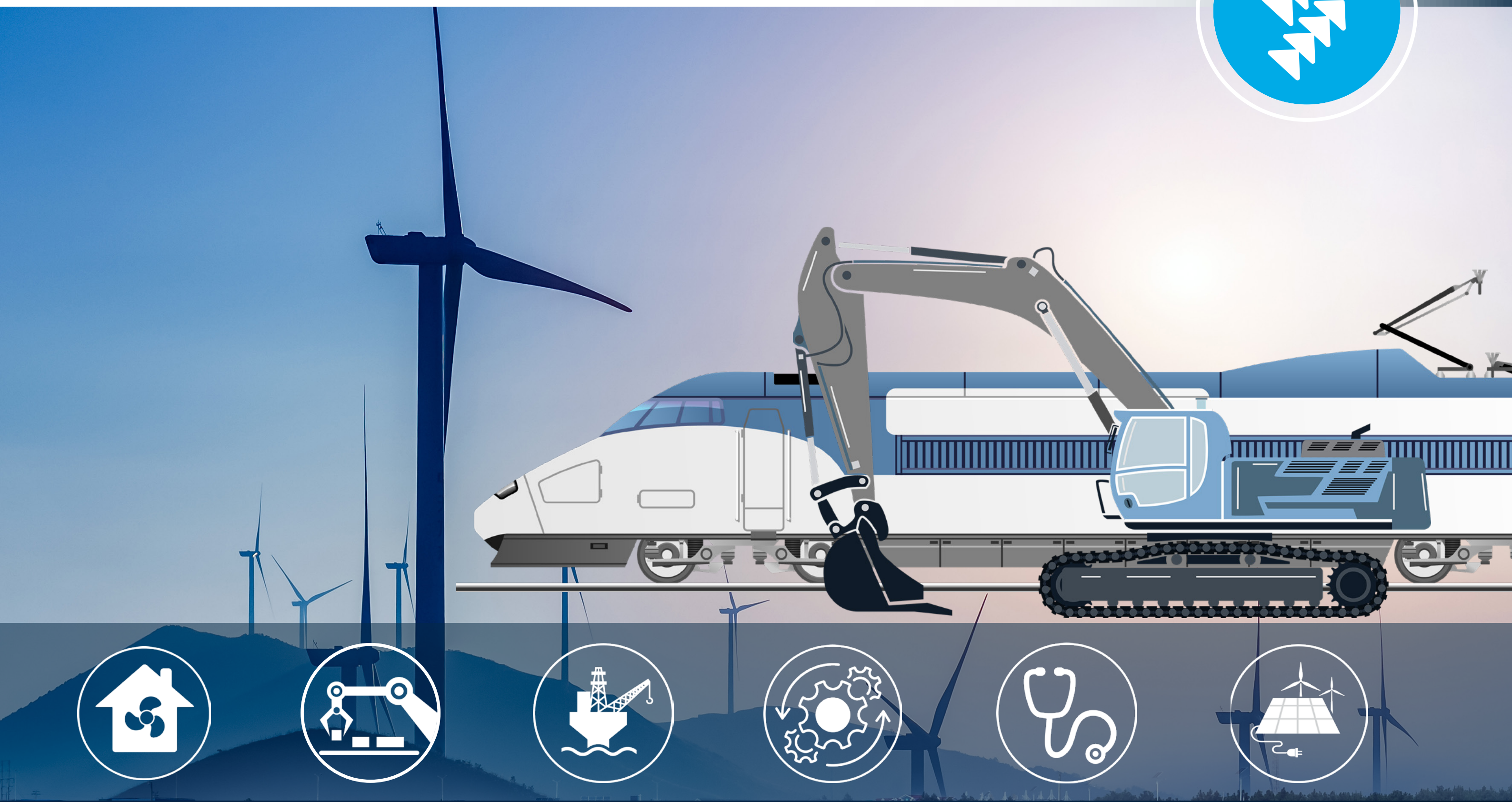

WHITEPAPER

Oil leakage detection and low flow monitoring

The ability to quickly detect leakage from a remotely controlled, autonomously operated machine, transformer, compressor or similar can avoid unplanned and costly repairs. An OOL module from IST AG enables such preventive maintenance, makes it feasible to plan, and protects against unscheduled downtime.

FLOW MODULES

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Contents

1.0 Motivation

Drips, leaks, seeps, and weeps all describe oil used for lubrication and cooling, passing excessively through sealings, e.g. in axle- or gearboxes. Bearings wind turbines, trains and other machines with common cold starts and temperature change exposure are continuously stressed to their limit.

Overlooking warning signs on remotely, autonomously operated machines, transformers or compressors can lead to severe complications. The main reason for installing leakage detection sensors is to determine whether the oil leakage is severe enough to warrant immediate action and thus the prevention of costly unforeseen repairs rising costs for raw materials and energy increase machine time value. Therefore, the need for reliable process control has become more significant than ever.

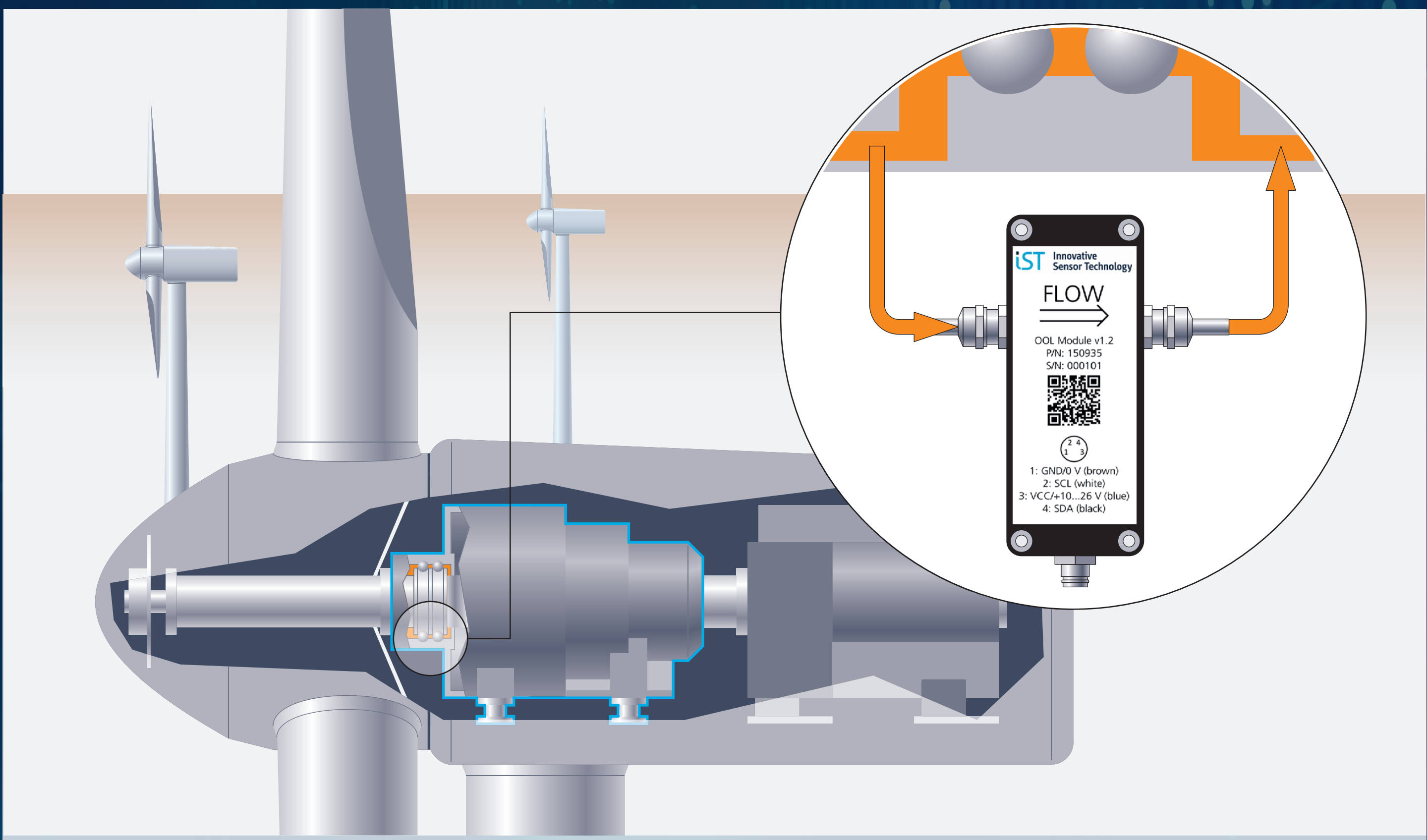


Figure 1: Application example with wind turbine and detail of a bearing around the generator axis sampling port in bearing (Source: © IST-AG, 2023)

2.0 Technology

IST AG's Out-Of-Liquid (OOL) thermal mass flow sensor technology is designed to measure low flow rates of corrosive liquids. The OOL sensor design was optimized for reliability with platinum thin-film elements immovably positioned on the outside of a stainless-steel tube. Operated in constant temperature anemometry (CTA) mode, the power required to drive the sensor is directly related to the liquid flow, as convective thermal transport is evaluated.

With a design adaptation facilitating decoupling the sensor elements, the flow range of the standard OOL flow module (0.1 to 20 kg/h) could be adjusted to allow highly sensitive flow detection in g/h (ml/h) range. This low flow OOL module has been evaluated effectively to measure at a flow rate-level, allowing to distinguish drips from leaks.

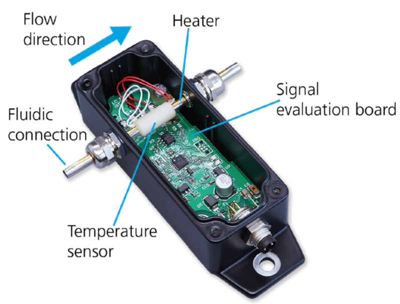


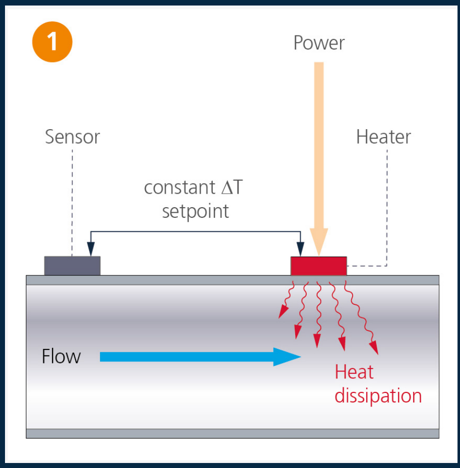
Figure 2: OOL flow module for leakage and low flow applications based on platinum thin film elements and constant temperature anemometry, order-code:153331 (Photo: © IST-AG, 2023)

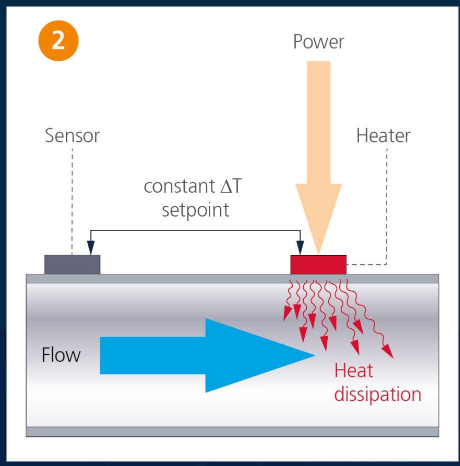
3.0 Measurement Result

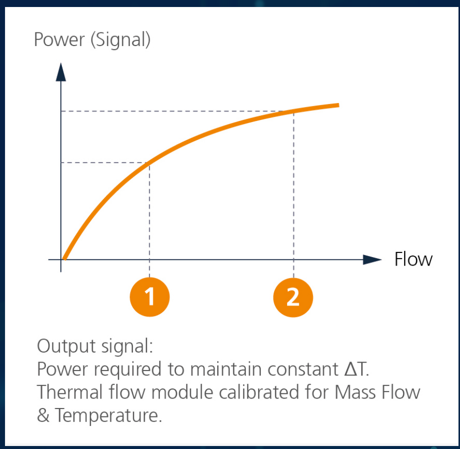
The sensitivity of an anemometric flow measurement can be tuned to the analyzed medium by setting the target temperature difference. When switching from water to oil-based media, this means operating the flow sensor with a higher ΔT between the heater and temperature sensor. Please see figure 3 for a comparison measurement. The higher viscosity of oil further extends the laminar flow profile range, which favors signal-to-noise-ratio and thereby helps shifting the detection limit to lower flow rates. Low thermal conductivity and thermal capacity can be translated into slow heat dissipation from the heater, which on the on hand causes a slight delay in recognizing the switch from no flow to low flow conditions when the sensor is filled with oil. On the other hand, distinguishing between empty and full state is very sensitive, which makes this measuring technique predestined for leakage detection.

The robust construction design of the stainless-steel sensor with well coupled sensing elements outside the media allows the OOL flow sensors to run reliably over several years, even with chemically aggressive and hot media, including gear oils with unidentified additives.

Anemometric Measuring Principle







(Source: © IST-AG, 2023)

The flow characteristics are shown in figure 3 as a function of flow for water and oil. In spite of the thermal parameters of water and oil being significantly different (see table 1), the OOL-sensor can be used for both liquids, because the heater temperature can be adjusted with respects to the liquid. The temperature difference between heater and temperature is set to 8K for water and 18K for oil. Their respective sensitivity is comparable while the resolution is better than 5 ml/h.

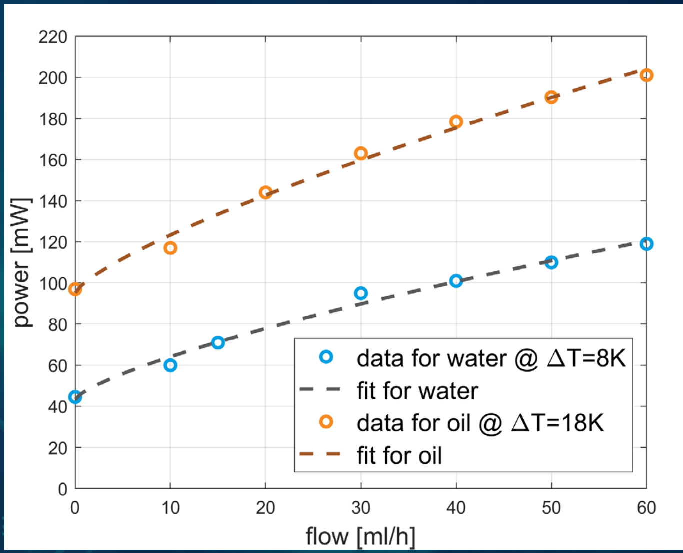


Figure 3: Flow characteristics of the OOL sensor for low flow. It shows the heater power as a function of flow for water and oil, where the temperature difference between heater and temperature sensor is set to 8 K and 18 K, respectively (Source: © IST-AG, 2023)

	ρ [kg/m^3]	c_p [J/(kg K)]	λ [W/(m K)]
H2O	1000	4187	0.61
OIL	919	2200	0.17

Table 1: Density, specific heat capacity and thermal conductivity for water and oil

4.0 Outlook

The OOL flow sensors have been characterized and successfully industrialized for high volume production. A signal evaluation board with a standardized digital I2C bus interface has been developed. Evaluation modules for application tests are available upon request.
IST AG offers OEM sensor solutions such as assemblies with custom fluidic, electric, and mechanical interfaces. These assemblies can be integrated into measurement devices, actuators, or as auxiliary monitoring components.

Co-create your next sensor with IST AG!

Get more technical information about IST AG's OOL mass flow meter

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