

Continuous humidity measurement in gas-insulated switchgear



01 Wika model GDHT-20 transmitter for gas density, temperature, pressure and humidity of SF₆ gas

Tobias Jung

For the network operators and equipment manufacturers, the topics of smart grid and online monitoring are therefore gaining more and more importance. Particularly in the area of gas-insulated switchgear, the interest in continuous and digital monitoring has risen strongly. If the critical phases of both parameters are not identified in good time, the operational safety can be compromised.

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So that SF₆-filled equipment is always optimally insulated, its gas content must be monitored permanently. For this, in most cases, the operators use mechanical gas density monitors with switching functions. When the SF₆ amount has dropped to a particular level, the measuring instrument sends an alarm signal and automatically shuts down the equipment using a second contact.

The round-the-clock monitoring also has an ecological basis: The specific global warming potential of SF₆ is 22,000 to 24,000 greater than that of CO₂. The F-gas regulation limits, or even prohibits, the use of the gas in most applications. However, the power industry cannot operate without SF₆ due to its phenomenal insulation properties. The European switchgear manufacturers have therefore signed a voluntary commitment. Within it are defined limit values for leak rates for the systems, which are binding and must be documented. According to this, medium-voltage equipment should not lose more than 0.1% of the gas per year and high-voltage equipment not more than 0.5 % of the gas per year. With previous mechanical and electronic solutions, however, detection of such values has only been possible to a limited degree, due to insufficient accuracy.

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Humidity content of the gas

A further factor that strongly influences the equipment safety is the humidity content of the gas. Each switching operation releases enormous amounts of energy, which breaks the SF_6 molecules into their atomic constituents. The decomposition products of sulphur and fluoride recombine after a short period into their original condition - so long as the gas is dry. However, with the increasing time-in-service of the equipment, the penetration capability, and with it the humidity level, increases. Humidity and oxygen, as unavoidable reactants, in turn, prevent the recombination of sulphur and fluoride. This leads to highly toxic and corrosive compounds such as HF and SO_x in the insulating gas, which can significantly affect the equipment safety and attack the internal surfaces of the gas tanks.

Such decomposition products are generally measured and investigated by maintenance staff using portable analysis instruments. Depending on the results, the reusability of the gas will be decided and a recycling process initiated if necessary.

The limit value for the humidity content specified in IEC 60376 is $-36\text{ }^\circ\text{C Td}$. Its checking demands a relatively tightly-scheduled maintenance cycle with the corresponding costs - as a result of personnel, equipment, travel and, not least, switching the equip-

ment off. This significant expense can be clearly reduced through continuous monitoring of the condition. For these reasons, the demand for control systems with online dew-point measurement has risen sharply in recent years.

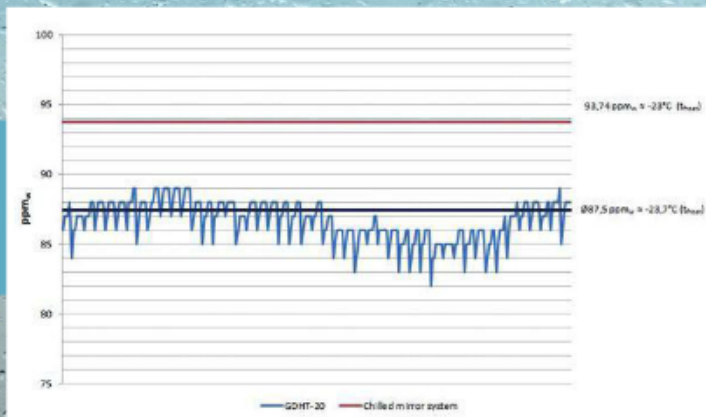
Precisely measuring

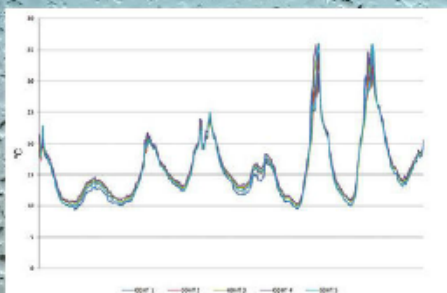
The new GDHT-20 from Wika is capable of measuring the relative humidity, pressure and temperature precisely over a wide measuring range. This high-accuracy transmitter enables a continuous and digital monitoring of gas-insulated switchgear to be set up. Even the best monitoring system only provides the operator something if the hardware works accurately. The innovative sensor is set apart from previous products, not only through the high-accuracy pressure and temperature measurement and the density evaluation, but also through a new calculation model for humidity content.

During the transmitter project, Wika and the sensor manufacturer (E&E) investigated the accepted calculation models scientifically and subsequently optimised them. The sensor can determine the dew point within $\pm 3\text{ K}$. The accuracy of the pressure signal in the positive temperature range is $\pm 0.06\%$ of the measuring range and in the negative temperature range is $\pm 0.2\%$. The density calculated from the

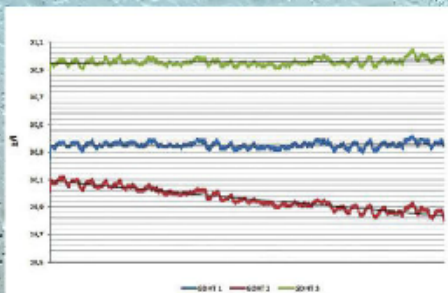
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02 Comparative measurement between a chilled-mirror dew point meter and a GDHT over 24 hours on a switchgear system





03 Outdoor measurement with 5 GDHT's in different positions on a gas tank



04 Trend analysis with the GDHT-20 on a switchgear system

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pressure and temperature is indicated by the instrument with an accuracy of 0.75 % and typically better than 0.6 %.

The high accuracy of the new instrument and the possibility of trend analysis using the measured data delivered were among those substantiated through a field test on the world's largest gas-insulated switchgear system in the Itaipu hydro-electric power station in Brazil. A chilled-mirror dew point meter served as a reference for the humidity measurement, since this measurement method is regarded as one of the most accurate. The deviation from the chilled-mirror dew point meter averaged under 0.7 K. With the density measurement, using trend analysis, a leak on one of the gas chambers was identified that had not been detected by conventional mechanical instruments. This illustrated and confirmed the formidable performance of the transmitter.

Proactive monitoring

The multi-functionality of the sensor ensures continuous, and at the same time proactive, monitoring. With this, trends can be identified and maintenance planned in a targeted manner. This ultimately leads to a move from a time-based maintenance strategy to a condition-based one.

However, the benefits are not exhausted with this. Digital technology generally leads to a much lower installation cost than its analogue equivalent. The GDHT-20 features a standardised RS485 interface and an established Modbus protocol. With analogue

measurement technology, all signals must be routed through an evaluation unit, while thanks to the bus system, up to 247 sensors can be coupled together. This saves on installation and cabling costs.

Against the call for digital solutions for optimised SF₆ monitoring – also in the face of rising cost pressures – the GDHT-20 delivers a clear answer. It presents a combined solution for the monitoring of the most important parameters in condition monitoring, such as density, humidity, pressure and temperature. Operators save themselves several measuring points or complicated and uncoordinated assemblies from different individual sensors. Measuring error sources and potential leaks that can come from the combination of the individual components are kept to a minimum. The high-accuracy transmitter provides the stable basis for a cost-efficient online condition monitoring with maintenance on actual demand.

www.wika.com



About

Company name: WIKA Alexander Wiegand

Headquarter: Klingenberg, Germany

Turnover: 730 Mio. €

Employees: 7,300 worldwide

Products: pressure measuring instruments, temperature measurement, thermowells, level measurement, calibration technology