Knick

INTERFACE

Condition Monitoring of High-Voltage Motors

Ensuring Safety with Temperature Transmitters containing High Electrical Isolation

Having an active predictive maintenance campaign in place for large rotating equipment can be a key strategy for maximizing process uptime. With the advent of Industry 4.0, condition monitoring programs that employ the collection and analysis of temperature and vibration data have become more and more widespread across a number of industries.

Some of this rotating equipment, such as motors and generators, find themselves operating in particularly high-voltage environments. Not only does this strengthen the case for condition monitoring, in that the failure of these systems could present an unsafe scenario, but it also creates the need for the monitoring itself to be performed safely.

This can prove especially difficult with temperature, as embedded sensors within the rotating equipment can find themselves in direct contact with high-voltage elements, creating a potentially dangerous situation.

The Challenge:
A company in the Chemical Processing Industry brought a problem to Knick's attention, in an effort to find a solution for their network of plants. What they found was that after years of operation, insulation defects in their slot mounted temperature sensors installed in high-voltage motors were exposing downstream systems and personnel to dangerous voltage levels. This created the potential for a serious hazard that needed to be eliminated.

The Solution:
The P44000 series was developed by Knick to accurately measure temperature from Pt100 RTDs in high-voltage environments, up to 11kV. The P44000 converts the RTD signal to a standard 4-20mA output that can be easily read by the majority of control systems. This measurement and conversion is performed across a high galvanic isolation barrier, where the input, output and power supply channels are safely protected against a potential transfer of dangerous voltage.

Image 1: Illustration of an open high-voltage motor

Image 2: Installation of a slot thermometer in an electric motor

High-Voltage Motors in Continuous Operation

High-voltage motors see widespread usage in a number of industries across many applications such as fan, pump and compressor control. They often carry out their service successfully for many years without failure, especially with a predictive maintenance program employed. The temperature sensors used to monitor the motor condition, often referred to as slot thermometers, are insulated in the motor stator slots. These sensors are co-located together with the windings of each motor phase and are used to detect increased temperatures due to insufficient cooling or overload.

The proper isolation of these sensors is confirmed after initial installation by a high-voltage test procedure. But even with sound installation practice and testing, the isolation is subject to influences over the course of many years of motor operation. This can lead to wear, and in the worst case scenario, to complete failure of the insulation. Even carefully implemented insulation can be heavily burdened by influences such as transient overvoltage from the power supply, voltage spikes from converters, overvoltage from reflection, or continuous mechanical and thermal loads. If the insulation breaks down, the temperature sensors can become stressed by the high potential in a phase. This puts downstream systems and personnel in serious risk.

Low Probability of Failure, but High Risk

Because conventional temperature transmitters offer no protection against high voltages, they redirect the applied motor voltage outward to the control system. Even if the probability of occurrence is low, the risk of damage, including serious personal injury, should be especially considered. For this reason, IEC/EN 61140 requires a second, equivalent and adequate isolation barrier for "protection under single-fault conditions" in addition to protection against electric shock. The temperature sensors, which are already necessary for condition monitoring purposes and are installed in the motor's terminal box, can act as this barrier. They must be designed according to standards, keeping potentially high voltage loads in consideration. When motor voltages surpass the kilovolt range, however, this presents a considerable challenge.

Adding Peace of Mind

To further protect against the risks described, a device with adequate electrical isolation can be installed between the high-voltage motor and control system. With a layer of protective galvanic isolation in place, redirection of the potential of a motor phase during a fault condition is avoided. This can perhaps be seen as a preventative measure taken for predictive maintenance!

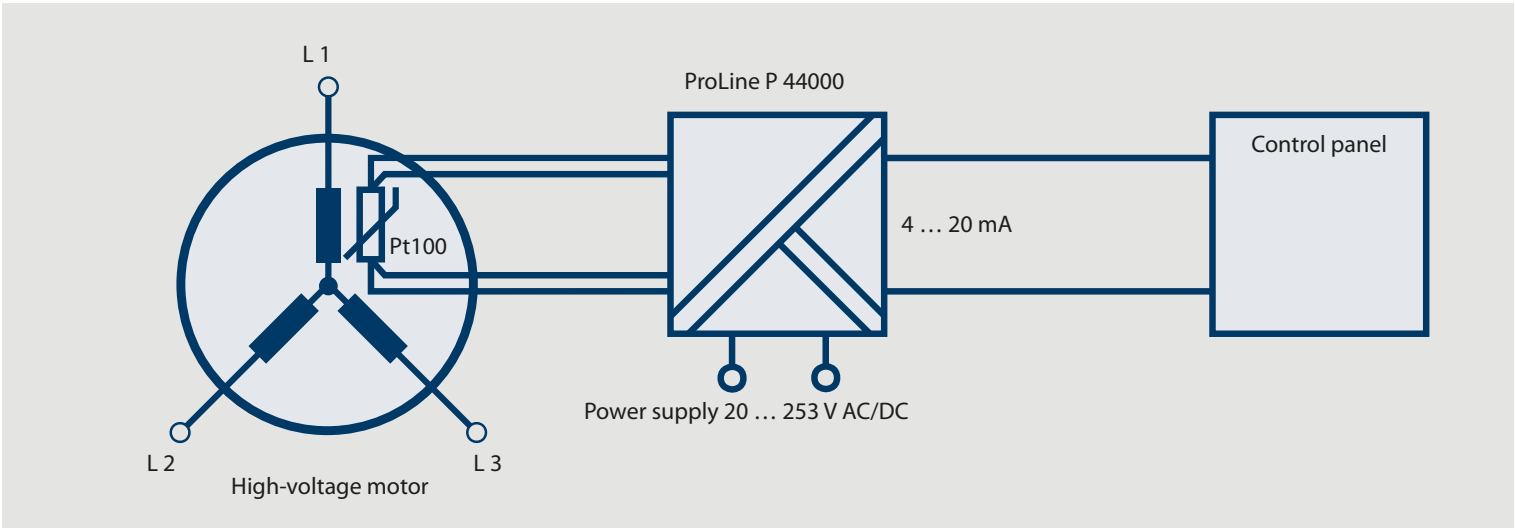

Image 3: The galvanic isolation of the slot thermometer by the P 44000 temperature transmitter provides protection in the event of insulation failure. The device also ensures interference-free transmission of temperature information to the control panel, even over long cable runs.

Why Knick?
Knick has decades of experience with development of measurement solutions for challenging applications seen across many industries – from Rail Infrastructure to Heavy Industrial Manufacturing, and from Energy Production to Vehicle Electrification. Often times these applications require some combination of measurement performance and high electrical isolation. With the P44000 series of transmitters, Knick has now brought this pairing of quality measurement and high-voltage isolation to temperature. This means that a solution for the safe monitoring of high-voltage motors can be effectively implemented.

P44000 Series – Overview of Features
The P44000 family of high-voltage temperature transmitters provides measurement capability for typical motor temperature ranges, to 300 °C. This is performed with an accuracy of ±0.5 K. The temperature signal is converted to a standard 4-20 mA across robust galvanic isolation. Pt100 RTD sensors can be connected in 2-, 3- and 4-wire circuits.

P44000 versions with a continuous working voltage isolation of 6.6 kVAC/DC are tested using test voltages of 15 kVAC. Depending on the supply type, this means that protection for motors with up to 11kV phase-to-phase voltage is possible, (with phase-to-ground then calculated at 11kV/1.73 = 6.4kV). Despite the high isolation, P44000 transmitters are still very compact, coming in at a width of only 67.5 mm. This size, combined with the ability for DIN-rail mounting, brings flexibility to installation.

Vacuum encapsulation of components ensures mechanical stability and high insensitivity against external influences. The P44000 can be used in extreme environments, as evidenced by its ambient temperature rating of -40 to +85 °C. A universal power supply of 20 – 253 VAC/DC is found within the transmitter. Unstable power or reversed polarity do not affect its operation.
For medium isolation requirements at working voltages up to 2kVAC/DC, (motors up to 3 kVAC,) an even more compact 22.5 mm wide version of the P44000 is available. Regardless of what P40000 version represents the correct solution for the application, all devices are guaranteed to perform, evidenced by Knick's five year warranty.

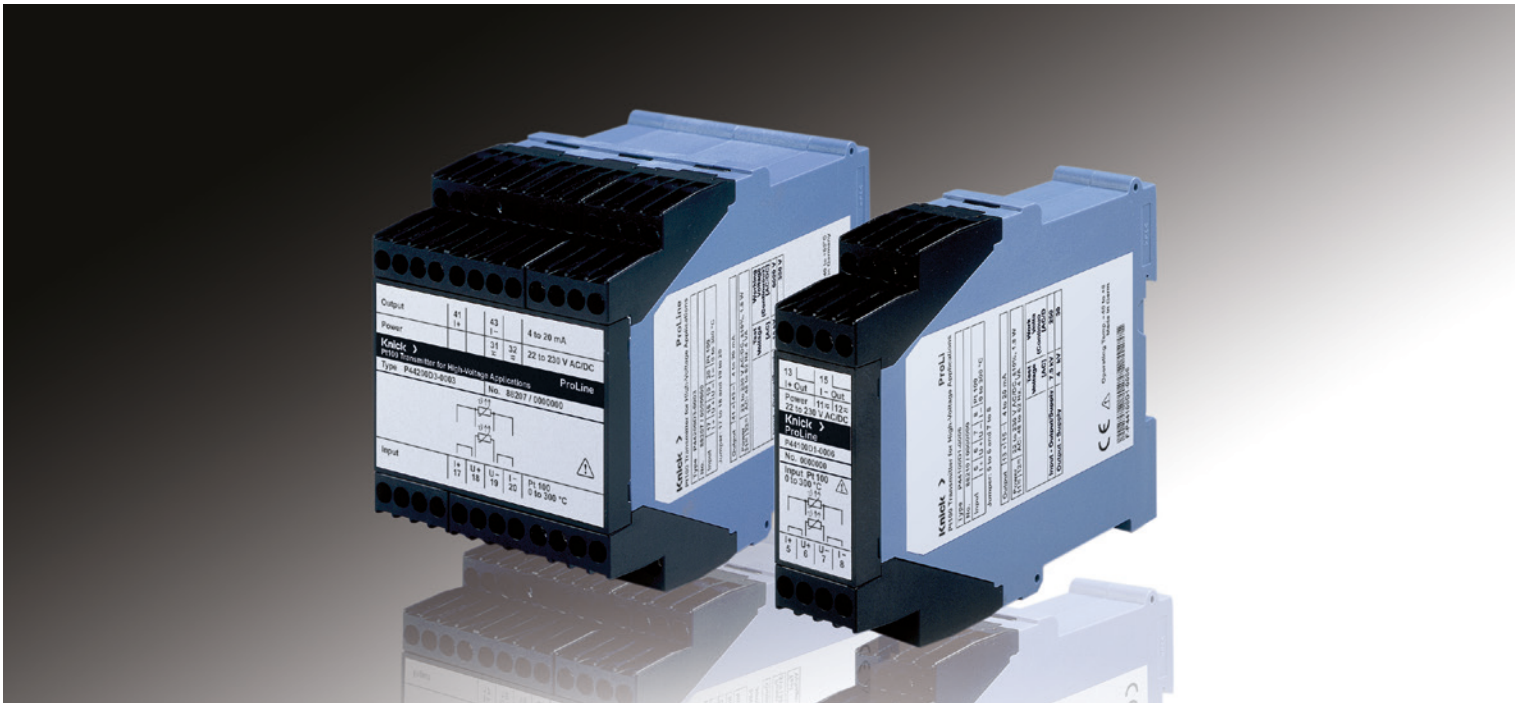

Image 4: ProLine P 44000 in the 67.5 mm housing for 6.6 kV and in the 22.5 mm housing for 2 kV working voltage

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