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Fabry-Perot industry ready

After years of research and development, intrinsically safe, fiber-optic sensing technology has matured to the point that it is ready for use in industrial applications.

John Berthold and Richard Lopushansky of Davidson Instruments in The Woodlands, Texas, wrote about the advances in fiber-optic sensing technology at the most recent ISA technical conference.

Low-power fiber-optic process control instrumentation is ideal for use in refineries, chemical plants, power plants, oil production facilities, or in other hazardous environments, because the sensors pose no danger even in hazardous areas where explosive vapors may exist.

These fiber-optic sensors operate with less than 1% of the power level deemed intrinsically safe by safety standards.

Instrumentation installation and maintenance costs are lower because low-power fiber-optic sensing systems do not require explosionproof conduit and containment.

FIBER OPTICS IMMUNE

Fiber-optic sensors can operate at temperatures up to 1000°F and down to -55°F. This allows fiber-optic sensing technology to make direct and accurate measurements of process conditions that simply cannot happen with conventional electronic sensing technology.

It also allows fiber-optic sensors to operate well in severe cold, where impulse lines, capillary tubes, and the associated weatherization programs can be eliminated. Significant process improvements and increased margins of safety will eventuate through the application of this enabling technology.

Fiber-optic sensors are immune to electromagnetic interference and are suitable for use near high-voltage electrical systems. Because optical fibers cannot conduct current, fiber-optic sensors eliminate problems associated with lightning and ground loops. They are tolerant of high concentrations of hydrogen and corrosive environments.

The small size and lightweight characteristics of fiber-optic sensors make these sensors ideal for most industrial applications. Fiber-optic sensors can measure temperature, pressure, differential pressure, vacuum, linear and rotary position, strain, vibration, and acceleration.

BEST FOR PROCESS CONTROL

The signal conditioners can adapt for high resolution, quick dynamic response, and/or for long transmission distances. One can configure the signal conditioners to communicate with any open architecture ranging from digital to 4-20 mA analog.

The signal conditioners can hook to a single sensor for high-speed data acquisition, or they can multiplex with a variety and large number of sensors to drive down the installed cost of a system.

Rugged cabling and multipoint connectors transmit the optical signals from the harsh environment to nonhazardous locations where the signal conditioners can reside safely and reliably. Safe, economical, and reliable-fiber-optic instrumentation is rapidly becoming recognized as the best technology for industrial process control.

CHANGE IN THE ENVIRONMENT

Fiber optics has become the standard for the telecommunications industry because of the many technical advantages that fiber optics offers.

For many of the same reasons, fiber-optic sensing systems will also become the standard in the future for industrial process control.

The fundamental advantages that fiber-optic sensors offer and that conventional electronic sensors don't include:

- safe in Class I, Division 1 explosion hazardous areas
- immune to electromagnetic interference (EMI)
- lightweight with a small cross section
- insensitive to lightning strikes and grounding problems

Fabry-Perot displacement sensor technology drives these sensors. In its most basic form, a Fabry-Perot optical sensor consists of two reflective surfaces closely spaced and parallel, creating a Fabry-Perot gap. With a fiber-optic Fabry-Perot sensor, one of the reflective surfaces is typically on the end of the fiber; the other reflective surface can be a second fiber, a diaphragm, or a vibrating beam. At the sensor, two reflections occur, one from each reflective surface. These reflected signals travel to the opposite end of the fiber, where detection occurs and processing takes place.

NANOMETER DISPLACEMENTS

For each individual measurement parameter, such as temperature or pressure, the transducer measures the displacement that results from a change in that parameter. For example, a temperature sensor takes advantage of the difference in the coefficient of thermal expansion between two materials for its displacement mechanism, while the pressure sensor minimizes the thermal effects and uses a deflecting diaphragm as its displacement mechanism.

One can quickly see that temperature, pressure, vacuum, density, strain, acceleration, rotary and linear position, and vibration are all measurable by designing the sensor to have a change in displacement in response to a change in the environment.

The full-scale displacement of these fiber-optic sensors is less than five ten-thousandths of an inch. Because these displacements are so minute, the stress on the sensor components is well below the strength of the materials and results in sensors with little hysteresis and very good repeatability.

The deflection is so small that for most pressure sensors, the maximum stress at design pressure is less than 25% of the elastic limit of the diaphragm material.

The optical interrogators inside the signal conditioners are capable of resolving nanometer displacements over a range of displacements exceeding 12,000 nanometers. This resolution gives the systems great dynamic range and accuracy that is more than adequate for most industrial applications, i.e. 1:10,000. **IT**

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