How A Tiny Fiber Can Prevent A Large Explosion

Optical fibers offer a flexible way to detect sparks in hazardous and hard-to-reach areas

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Sparks or hot particles present a fire and explosion risk for any industry that machines, processes, transports, or dries a combustible material. For coal processing, wood mills, fertilizer plants, grain elevators, and even coffee processing plants, a tiny spark can lead to a catastrophic event of fire or explosion that could harm workers and destroy an entire facility.

Although explosion suppression or sprinkler systems offer reactive measures to put out a fire or explosion, many facilities use spark detection and extinguishing because it is one of the few preventative measures available.

Spark detection and extinguishing systems are based on a series of sensors to detect and then extinguish hot embers or particles well before they can ignite a fire or explosion. The main challenge when designing and implementing spark and flame detection systems is that many sensors themselves can be the cause of such a risk due to their electronic-based layout that comes with the risk for electric short circuits. Other challenges may arise from environmental particularities such as high temperature, high pressure, or tight spaces.

Fiber optics can help with these challenges by offering an electric-free, safe, flexible, customizable, and efficient way to transfer light from a free-to-select position to a sensor kept up to several meters away from the hazardous environment. By allowing the sensor to be placed outside of a pipe or flue, fiber optics also make it easier to perform maintenance, updates, or replacement of the sensor.

**FIBER OPTICS OFFER FLEXIBILITY FOR FIRE/FLAME PREVENTION**

Although spark and flame detection systems are used by many industries, we’ll examine a few where fire/explosion prevention is particularly critical. One of them is wood mills, where a tiny spark or single hot ember can rapidly ignite a flame that spreads to the combustible wood filling these facilities. The pipes that transfer fine dust vacuumed from around the saws are at a particularly high risk for flames and fires. These pipes are narrow and long, making them difficult to access or monitor along the whole length of the pipe. This tight environment is challenging for sensors, not just because the dust inside can be hot and the suction system creates pressure in the pipe, but also because the narrow, compressed space increases the risk coming from an electric malfunction of a normal sensor head.

The small size and flexibility of fiber optic light guides allow them to be positioned in a “cold” non-electric condition anywhere within a long pipeline to transfer the light detected from a spark to an electronic sensor kept outside. Additionally, optical fibers aren’t susceptible to vibrations and pressure created by the suction system. The high temperatures found in these harsh environments require the use of glass, rather than polymer-based, fibers.

Coal power plants are another industry with a high flame/fire and explosion risk because of the fine combustible coal dust formed during processing. In this setting, it’s important to monitor the inside of large flues to look for any sparks. However, it is difficult to place a sensor in the middle of a flue that might be up to 3 meters wide. Also, any sensor placed inside the flue would be very difficult to access for maintenance and would be susceptible to...
high temperatures. Fiber optics can be easily placed in the middle of the flue while keeping the sensor in an area out of reach where it won’t be damaged and is easy to maintain.

Optical fibers are also useful for detecting hot spots on turbine blades found in airplane and other types of engines. Optical fibers can reach into very tight spaces inside engines to observe turbine blades that run at high speeds, thus facing friction effects. Early detection of problems, especially on prominent spots along the blade, helps prolong the lifetime of the turbine, allowing blades to be replaced before they cause a dangerous failure, and secures a convenient vibration-free engine run. For this type of maintenance application, fiber optics are used in conjunction with a heat-sensitive camera. When testing or designing turbines, fiber optics can be used to transfer a light signal to a hot spot detection sensor to reveal whether potentially structure-threatening sparks are formed when foreign objects strike the turbine blades, for example.

**BUILD A SYSTEM THAT MEETS YOUR SPARK AND FLAME DETECTION NEEDS**

There are many considerations when incorporating fiber optics into a spark and flame detection system. Fiber optic bundles are typically used for spark detection because of their excellent transmission in the visible to near-infrared wavelengths. Although fibers that transmit visible light can be used to detect the first glow of the spark, fibers operating into the near-infrared and beyond allow earlier detection by sensing at wavelengths that are hidden to the human eye - before a glow becomes visible.

The diameter of the bundle is determined first and foremost by the amount of light being detected and the sensor used. For example, a very dark environment combined with a less sensitive spark sensor would require a larger bundle of fibers. Large bundles also enable earlier detection by detecting the smallest spark or flame. Multiple bundles can even be used to bring signals from multiple detection sites to a single sensor, preventing the technology and commercial-affecting need to implement multiple sensors to cover different areas.

Sheathing and end terminations are also of significance. SCHOTT provides a wide range of sheathings and end terminations that allow an entire system to be designed to meet specific conditions and detection needs. Metal is most often used to protect the fibers in the harsh environments found in spark and flame detection applications, but plastic can also be used for applications with lower temperatures and tight spaces. A clear, often coated, protective window placed on the end of a fiber bundle can help protect the fiber optics and keep dust from blocking the view. If the window gets damaged, it is easy to screw off and replace.

The resolution of the fiber optic bundles depends largely on the application. Fibers with high numerical apertures in combination with adequate lenses can be used to monitor a large area for threats. For trouble spots such as a bend in a pipe where dust might collect, smaller numerical aperture fibers and lenses with a narrow field of view can be used to focus detection on a small area.

Fiber optic light guides offer a flexible, tailorable, and effective way to keep facilities on the watch, preventing circumstances that can lead to fires and explosions. SCHOTT can use its experience in glass and fiber optics to design a high-performance situative fiber optic system that meets your specific detection needs even in challenging or hazardous environmental conditions.
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