Flame detector selection – Which technology to use in gas turbine enclosures?

Which flame detection technology should I use in a gas turbine enclosure? This is a common question when a fire protection engineer is looking to protect a high value asset or where fast detection is needed due to the escalation potential of a fire.

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Fire and Gas Events

Turbine fires are common occurrences, but they often go undetected by the fire detection system. The reasons for this have been well understood for some time now, but this experience is rarely acted upon. To ensure the detection rate is increased, it is critical to ensure the detection employed is suitable for the application. In a limited number of instances, lessons are learned, and detection systems are specified based on the hazard types. The reported performance of these systems has shown that the detection rate is far better. Gas turbine enclosures are fitted with gas detection, but it is known that there are significant numbers without flammable 'liquid' detection. Flammable liquid detection in the form of oil mist detectors are fitted to some turbine enclosures usually in the enclosure exhaust duct. Oil mist detection would help improve the detection efficiency of flammable liquid leaks, both diesel and lube oil. Specifically, it would provide an early warning of flammable liquid leaks.

▼ Natural gas powered electrical power plant turbine.

Fundamentals

In a typical turbine application, there are three fundamental functions that the fire and gas detection system should perform.

1. Detection of fire inside the turbine enclosure.
2. Detection of external gas being ingested via the turbine ventilation system.
3. Detection of fuel gas released within the turbine enclosure.

Underlying Causes of Fires and Explosions in Enclosures

Gas turbines are housed in enclosures and there typically a number of exposed hot surfaces. Most turbines are dual fuel and run on diesel at least part of the time. Unfortunately, oils (diesel and lubricating oil) have auto-ignition temperatures (AIT) significantly lower than gas and combined with the large hot areas in the turbine enclosures form a high-risk scenario. The AIT of diesel and lube oils are ~240°C whereas methane is 530°C, and the external surface of a combustion chamber can reach ~200-400°C. If diesel or lube oil contacts surfaces at these temperatures, ignition will almost certainly occur. This is confirmed by the record of fires and explosions in gas turbines in the [UKCS 1, 2]

A good practice is seen as fitting oil mist or vapour detection instruments into turbine enclosures exhaust ducts to provide early warning of oil leaks.

Optical Flame Detection

Another source of fire could result from a fuel gas release and ignition within the turbine enclosure. In a typical turbine, due to the pressure of the fuel gas, it is nearly impossible to have small fires, and rate compensated heat detection provides a cheap and reliable way of detecting such events. It is widely recommended that heat detectors are installed within the turbine enclosure and in the enclosure ventilation exhaust ductwork where the hot gases from the fire will be transported to.

Optical Flame Detectors are often installed because they are most sensitive to flaming fires and provide greater area coverage.

Infrared or Ultraviolet Flame Detection

A major hazard in the turbine enclosure is the potential for a high-pressure release of lube oil. If a UV flame detector was employed in this application and the oil was to coat the lens, the oil would absorb the ultraviolet light being emitted from any occurring fire and render it blind. These challenges have been well documented over the years.

IR Flame Detectors pose different challenges in that they are negatively affected by black body radiation from the hot equipment within the enclosure. This has been known to cause certain IR flame detectors to false alarm, where-as others will be blinded and will therefore present an unrevealed fail to danger scenario. IR flame detectors do provide a faster response to fuel gas fires than heat detectors, however, this benefit would be insignificant in terms of reducing damage in this type of event.

▲ FDS301 Intelligent Visual Flame Detector.

Intelligent Visual Flame Detection

Intelligent Visual Flame Detectors (iVFD) have been used since the late 1990's and were developed to combat false alarms due to reflected flare radiation. iVFD detectors employ a video imaging-based technique utilising a CCD array and advanced algorithms that process live video images for flame like characteristics. More recent developments use dual CCD arrays with one array being exclusively used for flame detection whilst the other offers a live video feed. Having stated this, it is a popular misconception that iVFD's are only used when a client wants to see a live video feed, in fact some iVFD's have no video output at all.

iVFD's monitor for bright burning fires, the limitation with the technology is that it cannot detect invisible or virtually invisible fires such as pure methanol, hydrogen, and sulphur.

A major advantage of iVFD detectors is they cannot see hot CO2 emissions or the heat emanating from hot processes; the technology therefore does not become desensitised and it does not cause a false alarm due to the exhaust gases from gas turbines / diesel generators and black body radiation. It is for this reason that iVFD is the recommended flame detection technology for use in turbine enclosures.

FM Global Recommendations

In 2011, an independent review from FM Global [3] recommended that visual flame detection systems be applied as the default technology for the following applications:

Outdoor, open areas such as oil rigs, oil fields, mining operations, and forest products

Indoor locations such as industrial plants, boiler or other large vessel protection, turbines, and some clean/chemical rooms

The study also recommends using radiant energy-sensing detectors to match the radiant emissions expected from the source to be detected, as required by the applicable occupancy-specific datasheet. Since each fuel emits unique spectra, not all detectors can detect all fuels. For example, the use of an IR3 flame detector to detect a methanol fire (special hazard).

Summary

In summary, the fire types that can be encountered in a typical turbine enclosure can be detected by oil mist detectors, rate compensated heat detectors and intelligent Visual Flame Detection applied and mapped correctly.

For more information, go to www.micropackfireandgas.com

References

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