Becoming green and the challenges for optical flame detection

We are all too aware of the drivers to become greener. In some cases, the introduction of new equipment and the transition to alternative fuels is bringing significant challenges for optical flame detection. This article will highlight just a few of the new challenges, we at Fire & Gas Detection Technologies Inc. (FGD) have seen, and we will present some of the new solutions we have developed to meet the rising challenge.

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The introduction of hydrogen blended gas streams

Hydrogen has been seen by many as a way of reducing society's dependence on fossil fuels. Many natural gas distribution companies are already exploring the possibility of introducing hydrogen into gas streams and whilst the transition to a totally non-carbon-based gas network may be some years off, we are starting to see signs of a shift towards this goal.[1,2] This shift can have implications for the safety products used within the distribution network and studies need to be undertaken to address these concerns.

One such concern relates to the use of infrared (IR) flame detectors. Today, IR flame detectors are arguably the most used optical flame detector for natural gas fires. These detectors essentially monitor a narrow band of radiation that focuses on the emission of hot carbon dioxide from a fire. This band is particularly useful as the sun's radiation is absorbed by the earth's atmosphere, and so the detectors are not affected by sunlight.

The introduction of hydrogen into a natural gas stream has the desired effect of reducing the carbon content, but it means the detection distance for the same size fire will also be reduced. This may lead to flame detection coverage gaps in a facility. What is more, if the blending continues to the point that hydrogen replaces natural gas completely, the same IR flame detectors will no longer be able to detect a fire.

▼ Figure 1. IR flame detection and carbon dioxide.

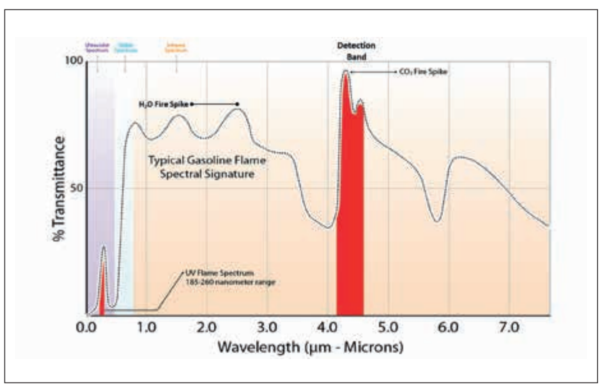

Table 1: Detection distance by flame detector technology to different gaseous fires.[3,4,5]			
Fire Type	FLS-IR3 (Hydrocarbon)	FLS-IR3-H2 (Energy Transition)	FLS-UVIR (Energy Transition)
Methane fire	45m (148ft)	20m (66ft)	18m (59ft)
70% Methane / 30% Hydrogen fire	38m (124ft)#	22m (73ft)#	18m (59ft)#
30% Methane / 70% Hydrogen fire	30m (98ft)	25m (82ft)	18m (59ft)
Hydrogen fire	No response	30m (98ft)	20m (66ft)

In all cases, the fire test was a plume 80cm (32in) #Estimated value

We at FGD recognised this challenge and have taken steps to provide choice to fire-protection system designers through a range of independently tested flame detectors.

From table 1, we can clearly see a significant reduction in the detection distance for a standard IR hydrocarbon flame detector when hydrogen has been blended with natural gas. This reduction would necessitate a review of the safety case for the facility using this product. On the other hand, the specialist detectors we have designed for the Energy Transition market show an enhancement in sensitivity, with our FLS-IR3-H2 becoming significantly more sensitive to a pure hydrogen fire. It's useful to note that infrared flame detectors are generally more robust to optical contamination and have longer detection distances than their UVIR equivalents. The combination of these points means that fewer FLS-IR3-H2 flame detectors are needed to cover the same fire risk and they will need less maintenance over time.

Hydrogen fires – seeing the invisible

Hydrogens flames are invisible to the naked eye, and it is worth noting that methane fires can also be difficult to see in bright sunlight too.

The absence of a visible flame poses a risk to plant operators who may need to verify the presence of a fire before acting. FGD has again enhanced its flame-detector offering with an improved near-infrared camera embedded into its FLS-IR3-H2-HD detector.

The new unit can clearly show moving hydrogen flames and explosions at 30m[6] and even in bright sunlight. This enhancement allows operators to direct site personnel more safely around a facility.

The FLS-IR3-H2-HD detector can also record the fire event for up to four minutes, this valuable information can be used for post incident investigation.

Airlines – improved fuel efficiency and reduced CO_2 emissions.

Airlines have been challenged to improve fuel efficiency and reduce CO_2 emissions. One of the most impactful actions airlines are taking to reduce emissions is via the use of more fuel-efficient and emissions-reducing aircraft. One such aircraft is the Airbus 321 New Engine Option (NEO). It has been documented that this aircraft can bring about an up to 20% fuel improvement per seat.[7]

The use of NEO-powered aircraft has however drawn an unwelcome side effect, this being an increased number of false alarms from optical flame detectors.

We have already seen in this article that IR radiation emitted by a hydrocarbon fire, in this case aviation fuel, is more intense at the wavelengths being used to monitor the emissions of combustion gases. The challenge posed by the NEO variant is not limited to the amount of combustion gases being produced but also the temperate at which it is generated. If we review Table 2, we can see that the NEO engines operate at nearly double the temperatures of the current engine option.

FGD has developed a detector variant specific for challenging applications where hot combustion gases can be present. The CO_2L (pronounced cool) detector differs from our regular IR3 flame detector by using optimized filtering and a refined configuration for heavy hydrocarbon fuels, such as aviation fuels, diesel, gasoline and plastics. The CO_2L device has a limited response to hot carbon dioxide (CO_2), which is why we have given this product the acronym CO_2L (carbon dioxide limited response).

The CO_2L detector has already been independently tested and approved by Factory Mutual[9] to the stringent requirements of FM3260. The detectors have already been tested at airports where false alarms have been reported using NEO aircraft and in other applications where hot combustion gases have caused false alarms.

▲ Figure 2. IR3-H2-HD flame detector.

Table 2: Operating temperature of the current and new engine options.[8]				
	V2500 CEO Engine		PW 1100G NEO Engine	
	°C	°F	°C	°F
Take-Off (5 mins)	625–635	1157–1175	1083	1982
Maximum Continuous	610	1130	1043	1909
At start-up	635	1175	1083	1982

Figure 3. Two FLS-IR3 detectors looking into a pit of partially processed solid waste.

Municipal waste recycling centres

We are all by now familiar with the benefits of recycling. When we recycle, materials are converted into new products, thereby reducing the need to consume more natural resources. These new products can be manufactured using less energy and we reduce the need for extracting, refining and processing raw materials. When we recycle, less rubbish is sent to landfill sites, which reduces emissions of methane, a powerful greenhouse gas.

Recycling is big business in some countries and as more and more recycling centres are built and brought into service, we are seeing a substantial increase in the number of fires at these facilities. Many of these fires are directly attributable to lithium-ion (Li-ion) batteries.[10] These so called 'Zombie' batteries are regularly found discarded in general waste where they may become damaged during the collection or processing of the materials.

Li-ion batteries present a considerable fire hazard. If a Li-ion battery is damaged, short-circuited or exposed to high temperatures, a reaction can occur resulting in a rapid and extreme temperature rise, causing the battery to catch fire. This fire can quickly escalate to nearby materials, potentially leading to widespread damage and revenue loss.

A survey released in May 2020 looking at the characteristics of fires caused by batteries in electrical and electronic equipment (WEEE) showed that 'the average cost of all incidents in 2018 was estimated at EUR 190k (USD 250k), which can represent a significant burden for an individual company. The most severe fires occurring at respondents' facilities in the last four years gave rise to an average reported cost of damages of EUR 1.3m (USD 1.5m).'[11]

The main area of interest requiring detection is the waste transfer station and these come in many forms. A waste transfer station is a light industrial facility where solid waste is temporarily staged during its eventual journey to be recycled, landfill or waste-to-energy facility.

Vehicles are unloaded at the main transfer building. Solid waste may be dropped onto the "tipping" floor, into a pit, or immediately onto another vehicle.

Detecting fires quickly is one of the key components to help contain a fire. Many facilities are protected by optical flame detectors in combination with a suppression system. A variety of different suppression systems are available. Most are manually controlled, but some manufacturers are using IR flame detectors to automatically direct water cannons to provide reliable, rapid-fire detection and accurate fire suppression, directly on the source of the fire. Determining the location of a fire within a facility is a goal that FGD is actively pursuing, and we anticipate releasing more new products in the coming months.

Summary

This article has highlighted that in efforts to become more environmentally friendly, some solutions may be introducing unexpected fire-safety challenges. We at FGD have risen to this challenge with a range of updated and recertified optical flame detection products. We are, of course, not finished there. We will continue to develop innovations meeting the demands of industry in terms of improved performance via fire sensitivity, speed of detection and false-alarm immunity, as well as product usability and robustness.

For more information, go to https://www.fg-detection.com/

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