

Flame Safety

a report by

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Whether your plant has a heater, thermal oxidiser (see *Figure 1*), sulphur recovery unit, incinerator, cracking furnace, waste gas boiler or any other type of combustor, one question remains: how well are your investments protected?

The National Fire Protection Association (NFPA) Standard 86 and similar international standards partially address this concern by requiring flame scanning on burners and start-up burners for combustors firing up to 1,400°F (760°C)¹ to help protect plant equipment and personnel. Flame scanners detect the presence or absence of a burner's flame in order to provide an input for a burner management system to determine the state of the burner's fuel valve – but how safe are the flame scanners supervising the burner's combustion?

It is not uncommon to hear of a plant technician or operator shaking a flame scanner in front of a light bulb to get the flame relay to pull in; taking a flame scanner off the burner and laying it on a bench, only to have the sun's rays provide enough signal to pull in the flame relay; or even performing weld inspections on an adjacent combustor, only to have the active combustor trip because the scanner's sensor is being oversaturated from the X-rays. It is also not uncommon to hear about a flame scanner indicating a flame-on condition, when in fact the scanner is reacting to the electromagnetic interference (EMI) generated from improper grounding; or hearing about a flame scanner indicating a flame-on condition when the burner is off, but is seeing the signal generated from the hot refractory. All too often these simulated flame signals can cause your safety system to become dangerously unsafe.

Flame Detection Methods

Currently, there are two methods of flame detection: physical and optical. Physical flame detection typically uses a flame rod that is biased with high voltage and is immersed in the flame when the burner is in service. In order to conduct a signal, the flame rod relies on a clean, large ground surface to allow a current loop to form through the ionisation of the flame. All too often, the rod or ground surface oxidises from byproducts of combustion (i.e. water vapour), high temperatures cause the rod to droop and ground out or the insulation on the flame rod cracks, all of which cause the flame rod

Figure 1: Typical Thermal Oxidiser Burner Application



to become inoperable. Not only is a flame rod high-maintenance, but it also requires high voltage of up to 280Vac in order to provide enough power for the current loop to form its way through the resistance of the flame. In an industry where low voltage is quickly becoming the norm, having 280Vac transmitted from the control cabinet through a cable to the flame rod in a hazardous location can seem undesirable.

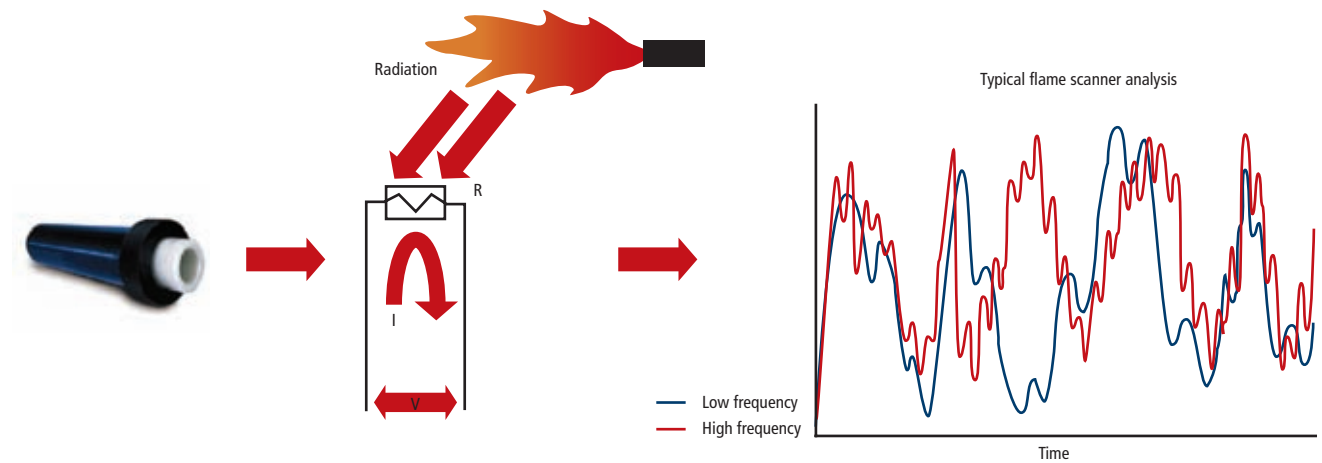
Optical flame detection typically uses ultraviolet (UV) and infrared (IR) sensors that react to the radiation emitted from a flame. UV tubes have been commonly used since the 1950s and are often biased with anywhere between 280 and 700Vac, depending on the manufacturer. UV tubes are known to fail over time and can fail in an unsafe manner, often referred to as a 'run-away' tube. Electromechanical shutters are used to block the UV radiation to the tube and allow the amplifier to check for a run-away condition. Even with an electromechanical shutter, X-ray testing can cause a UV tube to saturate and trip a live burner. These self-checking UV scanners are required on burners that continuously fire without shut-down for more than 24 hours. For burners that cycle at least once in 24 hours, a UV tube scanner without the electromechanical shutter can be used. Obviously, once every 24 hours is a long time for fuel to build in the vessel if the flame has extinguished for whatever reason.

IR scanners typically use a photoresistor to generate a signal in proportion to the IR radiation emitted from the flame (see *Figure 2*).



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Figure 2: Solid-state Sensor Signal Circuit



These photoresistors do not fail in the same way as UV tubes, but are more subject to EMI and radiation from hot refractory. EMI can generate a signal that can be processed by the amplifier to think there is a flame present when the burner is actually off or has been extinguished. Radiofrequency interference (RFI) can affect an IR

Second, the iScan flame scanner uses a single solid-state sensor to detect both UV and IR radiation from a flame. In the industrial market, this is an important feature since a single scanner can be used in place of using one IR scanner for the oil flame and one UV scanner to monitor the gas flame. Because waste gases change BTU without notice, having a fuel-flexible sensor monitoring the flame is a real benefit. The use of a solid-state sensor also eliminates the need for an electromechanical shutter, since self-checking is carried out electronically and the solid-state sensor does not over-saturate in the presence of X-rays.

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scanner by disrupting the signal stream and causing the flame scanner to trip. Hot refractory generates a significant amount of IR radiation and can cause an IR scanner to indicate that a flame is present when the burner is actually off.

Combining the sensor and amplifier into one housing, while using solid-state sensors, allows the iScan flame scanner to eliminate a large number of risks that cause conventional flame scanners to become unsafe. However, it is the signal processing that is truly innovative. The sun, the operator, and the hot refractory can all still trick a flame scanner into indicating that a flame is present when it is actually not. Coen's iScan flame scanner is the only scanner on the market that truly addresses these sources of simulated flame signals.

There are many different sources that can simulate a flame signal, causing nuisance trips and putting equipment and personnel at risk of being harmed or destroyed. However, one flame scanner has been ingeniously designed to safeguard against these simulated signals: Coen Company's iScan (see Figure 3).

This flame scanner also monitors the rate of combustion by analysing the flicker frequency, or the fingerprint, of the flame. Peak flame intensity is at stoichiometric combustion and drops off in a bell curve as the combustion becomes rich or lean. As the fuel and air mix and

Advanced Flame Detection

Years of troubleshooting these problems has led engineers at Coen to design a flame scanner that actually differentiates real flame signals from simulated flame signals. First, Coen's iScan® flame scanner combines the amplifier with the sensor. This allows Coen to eliminate the special 'signal' cable previously required to run between the scanner and amplifier, since the signal cable acted as an antenna for electrical interference. Having the sensor combined with the amplifier eliminates issues with EMI and RFI, and allows for a more pure flame signal to be processed. Combining the sensor and amplifier also allows the iScan flame scanner to work off 24Vdc; this eliminates the need for high voltages to run through cables, which often jeopardised hazardous location areas and put service technicians at risk of being severely shocked.

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combust under the right amount of heat, heat and radiation are emitted in proportion to the fuel/air ratio. Since the flame is always burning back to the fuel source, the flame is always in motion. This motion allows the intensity of the flame to vary across a flame flicker-frequency spectrum. The iScan flame scanner analyses the flame flicker-frequency spectrum to determine what the fingerprint of the

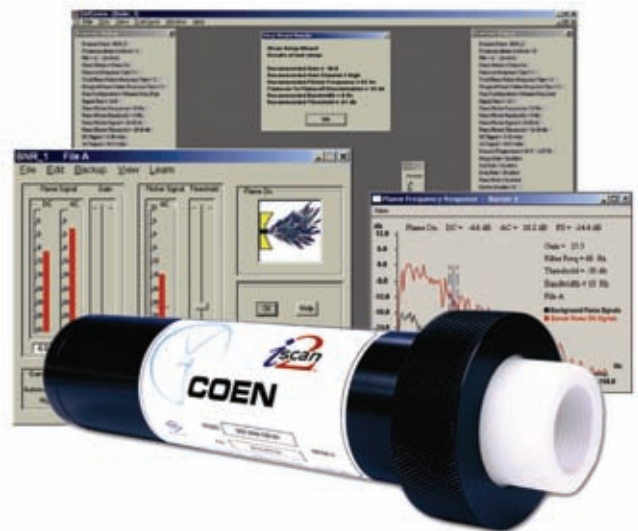
flame actually is. This flame scanner then compares the fingerprint of the flame with any other signals, whether real or simulated, to safely determine whether the flame relay contact should be energised.

The iScan flame scanner's safety aspect really comes into focus because of four rules that work in combination with the fingerprint of the flame. The first one is the 'mains rule', and ensures that ground loops or improper grounding cannot simulate a flame signal since the line voltage frequency is concentrated at either 50 or 60Hz. The second rule is the 'flame rule', which ensures that only flame signals that are linear (starting at a high intensity and low frequency and ending at a low intensity and high frequency), are recognised as a flame signal. The third rule is the 'solar rule', which ensures that the radiation from the sun will not be detected by the sensor as a flame signal. The 'rail rule' safeguards against operator error in that a high-gain setting in combination with the high intensity from the flame will not allow the iScan flame scanner to indicate flame-on. No other flame scanner incorporates these safety measures in its equipment, triggering the concern of how safe your current scanners are.

Conclusion

Coen engineered the iScan flame scanner with safety in mind, and designed it to operate reliably in harsh environments. Some of the vessels can become very hot. Premature failure due to excessive temperatures is one of the single largest contributors to maintenance expenditures. The iScan flame scanner has an internal scanner temperature sensor, allowing you to monitor the effectiveness of the cooling air and take corrective

Figure 3: Advanced Flame Scanner



action before the scanner succumbs to the excessive temperatures. Our standard model protects you from nature's elements with our NEMA4x (IP66) rating, while our Class 1, Div 1 and 2, Groups B, C, and D (ATEX) model gives you protection in explosion-proof environments. Remote communications allow you to analyse the combustion and troubleshoot ignition problems, stuck dampers, fouled nozzles or any other combustion related issues. The time is right to meet 21st century requirements with 21st century solutions; the iScan flame scanner is leading the way in safety and technology. ■

1. National Fire Protection Association 86: Standard for Ovens and Furnaces, 2007 Edition, Quincy, MA: NFPA.