Flame Detection – More than meets the eye

Detecting the presence of a flame in a combustion process is often more complex than might be first imagined. Mick Barstow of LAMTEC UK reports.

Flame detectors are used in a wide range of industrial, process and power generation applications. They are a critical component in safety chains that ensure systems are shut down in the event of faults, preventing explosions and other hazardous conditions occurring that potentially lead to loss of life and property.

Flame detectors range from simple ionisation probes through to complex microprocessor based flame scanners that can be 'tuned' to discriminate between one flame and another and between flames and background radiation such as glowing refractories and coal beds.

Simple combustion systems use ionisation flame detectors. These are based on the ionisation principle; a conductive rod is placed in the inner cone of the flame which contains ionised particles. These particles cause a micro-amp current to flow that can be detected and used to determine the presence of a flame.

The majority of flame detectors used in industrial applications are optically based and use various methods to detect the radiation emitted as part of the combustion process. This is where things get a bit more complicated. Firstly, the visible spectrum, the light the human eye can see, is not deemed reliable for flame detection. Radiation in the IR & UV parts of the spectrum is therefore used as the basis to determine whether a fuel is being burned or not.

The radiation emitted is determined by the fuel used. As a general rule-of-thumb, gaseous fuels tend towards UV radiation and liquid/solid fuels IR. However, most fuels produce a range of emissions across both the UV & IR spectra making device selection problematic in some cases. Surprisingly, a sensing element that successfully detects both UV & IR does not exist and so one or the other needs to be selected for each application.

There are other factors, in addition to selecting the correct spectral range of the flame, that have to be taken into account. For example, UV light is absorbed by water vapour, and so burners that use steam to atomise oil require special consideration. Contamination of the detector's lens with dust or oil also affects performance and preventative measures such as air purging and regular maintenance need to be implemented.

Systems can be classed as either non-continuous or continuous operation. Non-continuous operation requires that the burner be switched off at least once every 24 hours to confirm the flame detector is able to detect both states i.e. flame in/flame out.

Some flame detectors, such as those using UV tubes, have a non-failsafe failure mode, and their operation needs to be verified periodically. Continuous operation can be achieved by using a device containing a mechanical shutter that allows the detector to self-check by simulation of a no flame condition.

Modern flame detectors use more sophisticated methods for self-checking. A characteristic of nearly all flames is that they flicker. This is a product of the fuel type, combustion process and mechanical design of the burner. Flicker frequency tends to increase with firing rate as a result of higher air velocity and fuel mixing at the burner head or nozzle. Flicker frequency varies along the flame path dropping off significantly towards the end of the flame. This characteristic can be used to 'tune' a flame detector to discriminate one flame from another in multi-burner systems or to discriminate the flame from other background radiation.

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