The Basics of Flame Sensors

All flames have certain characteristics in common that include:

- Production of heat
- Expansion of gases
- Production of by-product of combustion
- Emission of light (infrared or ultraviolet)
- Ionization of the atmosphere in and around the flame

Flame detection systems have been developed to incorporate several of these characteristics. The detection device, coupled with a suitable flame control mechanism produces a signal. That signal then issues in a physical action, which allows the system to continue to run in the presence of a flame, or shutting down the system in an orderly manner in the flame's absence.

Many flame detection devices designed for domestic heating systems use the thermal effect of the flame (heat) as the method of detection. Considerable time is required for the sensor to either heat, as well as a similar time to cool on loss of flame. This system's response time , when used on larger burners, may present a dangerous or unacceptable risk.

Flame rods depend on the flame's ability to conduct a current when a potential is applied across it (flame ionization). Flame rods are generally used to detect gas flames. Oil flames are not suitable for the application of flame rods. Flame rods have the following advantages:

- Quick response to flame failure.
- Proves flame at the point of ignition. Because of the

flexibility of positioning a flame rod, a pilot flame can be proven at the point of intersection with the main flame.

- It is essentially "fail safe". If abnormal situations exist – such as open circuits, short circuits, and leakage resistance to ground – a flame rod will fail "safe".
- Flame rods can withstand high temperature for a long time.

Optical flame sensors are divided into three groups depending on which range of the total radiation band they are designed to detect:

- Visible light sensors
- Infrared sensors
- Ultraviolet sensors

Visible light sensors are typically referred to as rectifying photocells. Photocells work on a rectification principle, where alternating voltage is applied to the F (flame sensing) terminal and the G (ground) terminal of the primary flame control. It is the flame detector's job to permit the flow of current, as well as to convert alternating current to direct current when it senses the presence of a flame.

The rectifying photocell has one particular advantage over conventional non-rectifying optical flame sensors: The system, which is protected against a false flame signal due to the presence of a high resistance short, will fail in a safe mode.

Photocells are generally only used on commercial and industrial oil burners where a "fail safe" sensor is required. Well-adjusted gas flames may not emit sufficient light for a photocell to work.

The following rules apply to the application of rectifying photocells:

- The photocell must have a good view of the flame.
- The photocell must be protected from the light emitted from hot refractory.
- Temperature at the photocell must remain under 165oF.
- Proper lead wire must be used for the flame lead.

Infrared sensors, unlike rectifying photocells, may be used with either gas or oil flames. Since more than 90% of the flame's total radiation is infrared, these detectors receive ample radiation of quite high intensity and will operate with either very weak or very hot flames.

Special application requirements for infrared detectors can be summarized as follows:

1. The cell must have a good view of the flame.
2. The cell must be protected from excessive hot refractory.
3. The cell must be protected from temperatures in excess of 125oF.
4. Correct wiring procedures must be used for the flame detector leads.

Ultraviolet sensors depend on the sensing tube's ability to respond to ultraviolet radiation, as well as remain insensitive to radiation in the infrared or visible light spectrums. This makes them, by far, the most popular selection for today's industrial gas burners.

Ultraviolet tubes are, however, sensitive to some cosmic, gamma, and x-ray radiation, as well as non-flame related UV light sources. Examples of these other sources include refractory surfaces above 2500o F, sparks from ignition or welding sources, various types of lighting, bright flashlights, x-ray machines, high voltage condensers, and more.

Application requirements for UV detectors can be summarized as follows:

- The detector must have an unobstructed view of the first third of the flame envelope being detected.
- The detector should not sight the ignition spark.
- The detector must be protected from excessively high temperatures.
- Proper wiring techniques must be sued for the flame detector leads.

One of the major drawbacks of conventional ultraviolet detectors is that they are not fail safe. Under rare circumstances, the sensing tube may produce a flame signal when a flame is not present. Therefore, it is wise to check for a false flame signal during each burner cycle. Prior to the ignition cycle, standard UV sensors are acceptable for burner cycled at least once every 24 hours.

For those processes where the burner is rarely cycled, self-checking UV scanners are available that incorporate an oscillating shutter mechanism which interrupts the detector's line of sight at specific intervals. Since there is circuitry in the burner control system, check to see that no flame is present during the shutter's "closed" cycle while not interrupting the burner operation.

This article only touches briefly on the various types of flame detectors used in today's industry today. There are numerous"'gotchas" associated with each type of flame detector. Please consult your BDC representative to discuss your application and just what flame sensing approach best fits your needs.