# COMBUSTION GAS TECHNOTE

The measuring of combustion gas temperature, via infrared radiation, has never been as reliable as with HEITRONICS' new KT19.69. KT19.69 measures infrared emissions from hot gases in a very narrow spectral response, which lies somewhere between 4 to 5 microns. This "proprietary" spectral response was determined during extensive incinerator trials. As of today, many installations have been made on both incinerator and fossil fuel fired boilers.

*Theory Background*

All matter above zero Kelvin emits infrared radiation. Solid matter, such as steel, bricks, etc. emit and reflect infrared radiation. Solids such as glass, can not only emit and reflect infrared radiation but also transmit. Hot combustion gas reflects a negligible amount of infrared radiation and leaves us to deal with emissions and transmission.

Infrared radiation pyrometer KT19.69, is a passive device which receives infrared radiation from within its optical field of view. It requires the width of the gas stream to be great enough in dimension and in radiation intensity to make the measurement. Consider the following.

If the human eye were to view a clean and clear glass window pane, and if there were no surface light reflections, we would not "see" the glass itself. Now imagine looking at a 25 ft. thick glass object similar to a decorative glass block window which contains irregularities on its surface and within its mass. You will now see the glass and very little of what is behind it.

KT19.69's proprietary narrow spectral band lies between 4 to 5 microns, the region of the infrared spectrum where carbon monoxide and carbon dioxide give off significant levels of radiation. Since the burning of all fossil fuels and trash give off carbon monoxide and carbon dioxide, KT19.69 is an excellent choice for large scale boilers.

Because combustion gases are semi-transparent, KT19.69 receives infrared radiation from a "stacked-column" of gas molecules oriented towards the center of the gas stream. Hotter gases are proportionately favoured more than cooler gases which makes the "end" of the stacked column (the end farthest from the pyrometer) favoured more than the near side. Another way to describe this is to say that at some distance, there is an extinguished depth of penetration. A point where the pyrometer can "see" no further.

The maximum penetration into a natural gas combustion stream would be about 25 ft. and occurs when making the minimum 600°F reading. The extinguished depth would be less than 10 ft. when making 2200°F readings from a coal fired burner. In general, higher temperatures and greater concentrations of combustion by-products or particulates in the gas stream, will reduce the penetration of measurement into the gas.

One of the key features offered by KT19.69's proprietary spectral response is that it sees through the cooler gases which skirt the boiler perimeter, thus placing the measurement within the gas stream where temperatures are more representative of the whole and in a region which is less prone to inherent temperature fluctuations.

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*Hardware Summary*

KT19.69 includes a water and dust proof housing capable of being exposed to ambient temperatures from 32 to 300°F. (Air or water cooling is required for ambients above 140°F.)

To facilitate mounting and to shed the ambient temperature load, a unique hardware assembly has been created. A pipe flange, sized from 3" or greater, is required to fix the pyrometer assembly to the outside of the boiler. A non-porous thermal insulation spacer and spacer tube reduces conductive heat. A shield helps reduce radiant heat. The coolable housing of KT19.69 is available to shed the balance of conductive and radiant heat, as well as ambient convective heat or sun loading. Requests for custom modification to the hardware assembly are welcome.

A blast gate valve will serve to shut off near to 100% of potential escaping gases while checking the pyrometer's optics for cleanliness. A cover-cap held by a stainless steel chain, is available for covering the open assembly when the pyrometer is removed, as an added level of safety.

An air purge fitting shall accept a suggested 5 to 10 psi instrument air to keep the built-in sapphire window clean. The sapphire window serves to protect the pyrometer's calcium fluoride lens from dirt and thermal shock should hot gases back-up into the hardware assembly. A planned maintenance schedule should include a check of the two optical components at least on a monthly basis initially, and then longer if normal operating conditions allow. During critical boiler start-up conditions, it is suggested to check these optical components before firing because a dirty window or lens will produce a lower than actual reading.

*KT19 Performance Features*

KT19.69 is a highly stable and well featured pyrometer. General specifications are given on the KT19 Series Brochure.

Its' long-term stability is better than 0.0001 of the reading in Kelvins/month (e.g. better than 3°F per year when making 2000°F readings).

The standard signal processing of incoming radiation effectively averages the turbulant gas temperature radiation when setting response time to 10 seconds. Thus the need for external rolling average signal processing is not a requirement.

Actual field results when comparing KT19.69 readings with thermocouples have shown ± 18°F agreement when making 1800°F measurements.

The reading that KT19.69 makes is available simultaneously in three formats; 1) local display on its housing, 2) via 1 of the 4 selectable and span programmable analog outputs like linear 4 to 20mA, 3) via RS232 or with an optional external RS422 converter.

*Benefits of using KT19.69*

During boiler start-up, it is often desired to confirm that there is steam flow through the boiler tubes before exceeding a lower critical limit near 1000°F. This ability may help prevent boiler tube fracture of temporarily non-flowing tubes, provided a required operating procedure is followed.

When a utility boiler is on-line, the temperature reading can be used to trim burners to help balance boiler temperature and be used to reduce excessive fuel consumption when electric demand reduces.

For incinerator applications, a minimum acceptable operating temperature can be monitored for environmental requirements, in addition to trimming burners.

When burning coal, an upper temperature limit can be monitored to help reduce fusion related maintenance and down time.

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