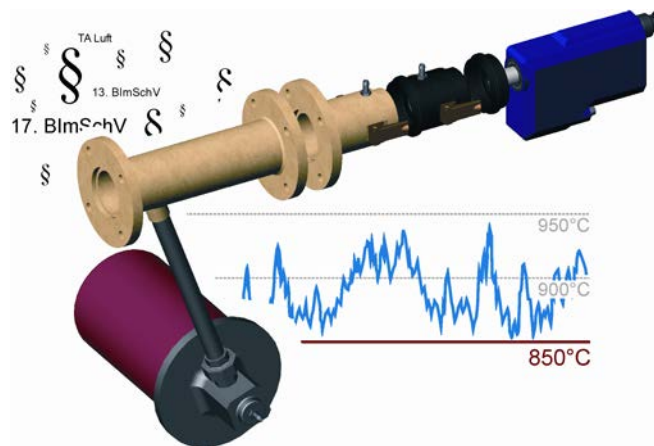


# Temperature Measurement of Combustion Processes using Infrared Radiation Thermometers



## The Subject

The subject of thermal waste disposal is determined, to an increasing extent, by environmental issues. Impositions of tight restrictions by legal authorities, especially the provisions of waste incineration, entail strict procedures for supervision and limitation of emissions into the atmosphere. This has become manifested, for instance, in regulations like the 13<sup>th</sup> and 17<sup>th</sup> BImSchV and TA Luft in Germany.

Apart from the responsibility for environment protection, there is a cross-industry economical interest by the users of incineration plants for suitable measurement and regulation techniques for process optimization, especially for a precise and reliable sensing of the measurement reading temperature.

## The Solution

By the non-contact temperature measurement using **HEITRONICS** Infrared Radiation Thermometers, a novel measuring technique is applied that offers some significant advantages to conventional temperature probes.

A comparison with conventional temperature measurement techniques clearly demonstrates the economical benefits of Infrared Radiation Thermometers in practice. Thermocouples are exposed to high static, dynamic and corrosive loads and thus have to be replaced after a relatively short period of time.

However, Infrared Radiation Thermometers measure temperatures by being introduced into the furnace and incineration chamber from outside without making contact to any surfaces. They virtually exhibit no wear at all and thus require a minimum of maintenance. Deviations from measured values, as are common for thermocouples are virtually unknown for contact-less temperature measurement. The Infrared Radiation Thermometers are not subject to any thermodynamic aging.

The performance features of **HEITRONICS** Infrared Radiation Thermometers are convincing:

- High measuring accuracy
- high long-time stability
- nearly unlimited service life
- low operating costs
- suitable for equipment meeting 13<sup>th</sup> and 17<sup>th</sup> BImSchV and TA Luft
- for temporary averaging, adjustment periods up to 600 seconds are possible.

## Approval for 13<sup>th</sup> and 17<sup>th</sup> BImSchV and TA Luft

Comparative measurements with thermocouples and the suitability tests of TÜV Southern Germany have revealed that combustion gas temperatures from 500 °C upward can be measured reliably and with good reproducibility using the **HEITRONICS** Infrared Radiation Thermometers KT19.69 and KT15.69.

The suitability test was carried out between July 1999 and July 2000.

**Both measurement systems were classified as suitable** by the

***Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)***

and published under the heading

*Uniform practice for the supervision of emissions and immissions*

in the

*BMU Bulletin dated 10-11-2000 \* IG I 3-51134/2*

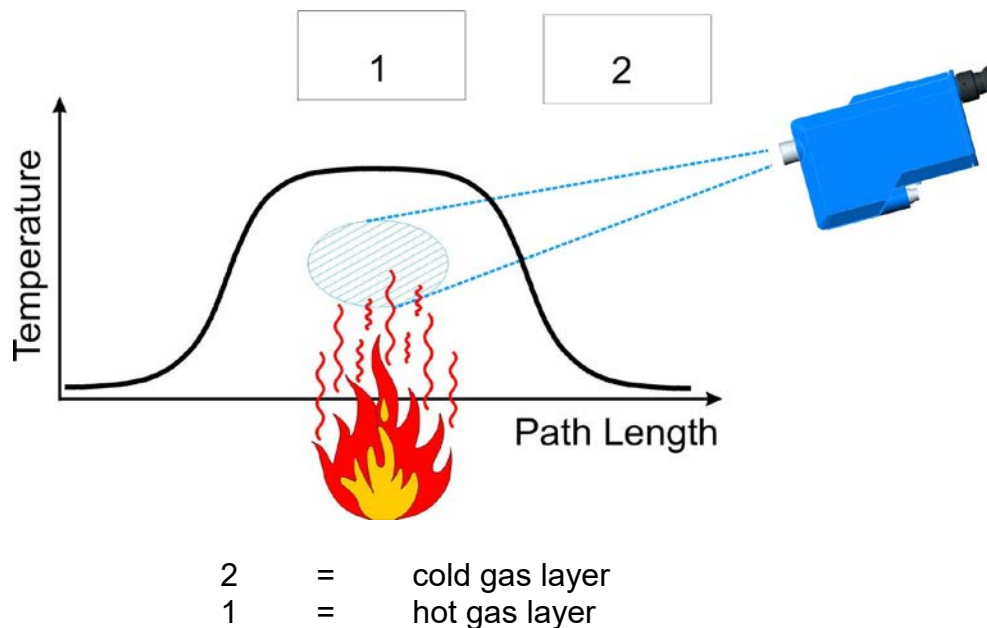
Section II: *Suitability for measuring equipment for continuous measurement of reference values / operational values*

Chapter 3: *Minimum temperature*

## Measurement Principle

The principle of pyrometric temperature measurement is based on optical radiation density measurement of a thermal radiation emitted from a measured object. If the object-specific features are known, the temperature may be determined directly by such measurement. In those cases, the radiation density is mostly not determined throughout the total electro-magnetic spectrum, but within a rather small spectral range adapted to the measuring task concerned.

The **HEITRONICS** Infrared Radiation Thermometers KT19.69 and KT15.69 have been conceived specifically for temperature measurement in hot combustion gases, like e.g. incineration plants, garbage pyrolysis plants or rotary kilns furnace. They operate in a spectral range where hot carbon dioxide ( $\text{CO}_2$ ) shows a high degree of emission, but cold  $\text{CO}_2$  is largely transparent. This measurement principle provides a correct valuation of the detected heat radiation of the hot gas body without any reading displacement by absorptions in colder gas layers between the real target measuring volume and the Infrared Radiation Thermometer (see Fig. 1).



*Fig. 1: Measurement of the temperature of a hot gas body through a cold gas body*

$\text{CO}_2$  is particularly suitable for pyrometric detection. This molecule is represented in the mentioned applications in sufficient concentrations. Strong IR emission bands in wave length regions for which there are sufficiently high radiation density values are expected at the process temperatures, according to the Planck's distribution.

## Applications

**HEITRONICS** Infrared Radiation Thermometers KT19.69 and KT15.69 are used in fuel engineering and large-size fuel engineering plants, more and more replacing the thermocouples used before.

Typical applications are, for instance, in household waste or special waste incineration plants, but also for various purposes in the steel and cement industries. The different measuring tasks are versatile and numerous:

- Fire chamber final temperature measurement
- SNCR control
- heating output regulation
- trimming of burners
- minimum temperature supervision according to 17<sup>th</sup> BImSchV
- grating control.

The versatility of applications can be demonstrated by the example of a waste incineration plant:

### a) Measurement of gas temperature in the combustion chamber

The temperature of the combustion gas is determined in the combustion chamber. For this purpose the **HEITRONICS** KT19.69 is mostly used.

Instruments of the KT19.69 and KT15.69 types are available as special versions with adjusting periods up to 600 seconds. The long adjusting periods are needed to realize comparability to the very slow thermocouples.

In view of the redundancy, only two instruments are required in contrast to measurements with thermocouples.

### b) Measurement of minimum temperatures

According to the 17<sup>th</sup> BImSchV, a minimum temperature of 850°C and 1,100°C, respectively, is prescribed for the incineration of halogenized organic compounds with chlorine content higher than 1%. By this requirement, it is ensured that all organic ingredients of the waste gas, particularly the highly toxic, partly cancerogenic and mutagenic pollutants such as dioxines, furanes, polychlorinated bi-phenyles (PCB) or polycyclic aromatic hydrocarbons (PAH) are transferred to more harmless compounds.

The HEITRONICS Infrared Radiation Thermometers KT19.69 and KT15.69 are the only type-tested measuring equipment approved for the supervision of minimum temperatures according to the 17<sup>th</sup> BImSchV, apart from thermocouples.

The thermocouples currently used are not tested for suitability because they are classified as capable of being calibrated anyway.

## c) Measurement of waste gas temperature for control of NO<sub>x</sub> reduction

For the reduction of nitric oxides (NO<sub>x</sub>), ammonia is introduced to the flue gas through nozzles. Here again temperature is a major criterion of process control. The temperature should be measured relatively quickly and online. For this reason, Infrared Radiation Thermometers KT19.69 and KT15.69 are preferred with adjusting periods of 1 and 3 seconds, respectively.

The benefits of suitability-tested **HEITRONICS** Infrared Radiation Thermometers KT19.69 and KT15.69 are convincing from a measuring viewpoint:

- No influence on the readings by “radiation errors”  
These are radiation proportions caused by the system that might lead to severe measuring errors when measuring using thermocouples.
- No-wear measurement by non-contact methods  
The **HEITRONICS** Infrared Radiation Thermometers are installed outside of the combustion chamber and thus will neither corrode nor be distorted. No baking effect will occur as is usual for thermocouples.
- Drift-free measurement  
**HEITRONICS** Infrared Radiation Thermometers operate in a wide ambient temperature range free from any drift, for many months and years.
- Integral and rapid measurement with variable response times  
The measurements can be realized very quickly from 30 ms. Depending on the type of application, the response time can be extended up to 10 minutes. For measuring the minimum temperature we recommend an adjustment period of 240 seconds.
- Virtually maintenance-free  
**HEITRONICS** Infrared Radiation Thermometers are maintenance-free when applied properly. For this purpose, especially the gage opening into the combustion chamber must be kept free. HEITRONICS offers adequate air-operated auxiliary equipment.
- Price worthiness  
Due to the low maintenance effort and the freedom from wear, the purchase cost will amortize within 1 – 3 years.
- Flexibility of configuration possibilities
- 4-20 mA and RS-232/422 Ausgänge
- Operational software for start-up, reading display and system monitoring based on Windows™.
- Approved technology highly available
- Safe automatic operation

## Measuring Systems and Sets

For installation of **HEITRONICS** Infrared Radiation Thermometers, an adequate gage opening shall exist in the furnace wall, for example a steel pipe of 50 mm minimum inner diameter and a flange DIN 2573 NW65. Using the adapter B4 or B5 and the quick release holder B2, the **HEITRONICS** Infrared Radiation Thermometer can be coupled directly to the flange.

As a preventive protection measure the use of the window adapter B7 is recommended. This adapter is provided with a sapphire window, which is particularly scratch-proof, temperature-resistant and easy to clean.

To guarantee smooth functioning of the measuring systems, any potential clogging of the gage opening shall be avoided. This is particularly true for installation in zones where the temperatures are above the slag or dust softening point. Therefore, it is recommended to use a pulsed-air flushing system by which any deposits can be blown out of the steel pipe once or twice a day.

## Components

### KT19.69

1. Infrared Radiation Thermometer KT19.69
2. Adapter set
  - 2.1. Adapter B4
  - 2.2. Adapter B7
  - 2.3. Adapter B2
3. Transformer T24 DC

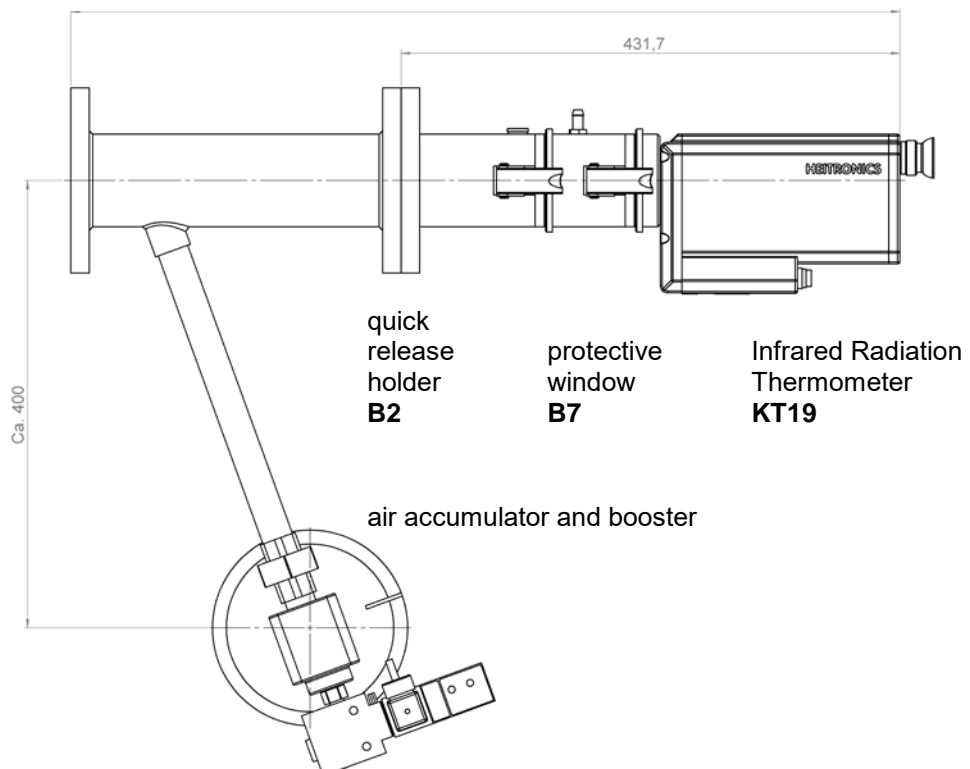
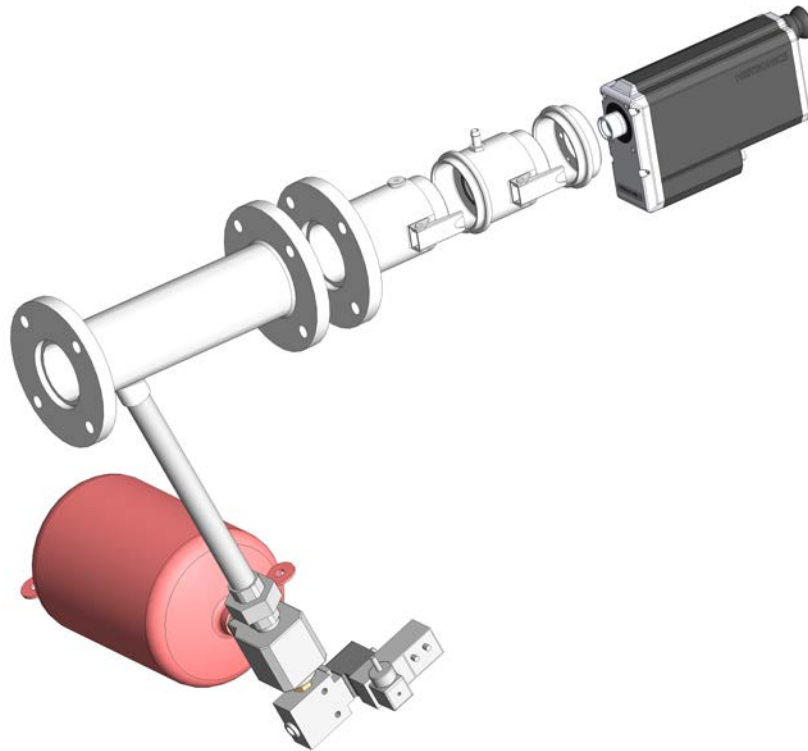
### KT15.69

1. Infrared Radiation Thermometer KT15.69
2. Adapter set
  - 2.1. Adapter B5
  - 2.2. Adapter B7
  - 2.3. Adapter B2
3. Transformer T24 DC
4. Air purge  
Erpulsor 5 set with adapter pipe *Erpulsor 5*

The following illustrations show the typical gage sets with the **HEITRONICS** radiation auxiliaries described above.

## Gage Set with Infrared Radiation Thermometer KT19.69

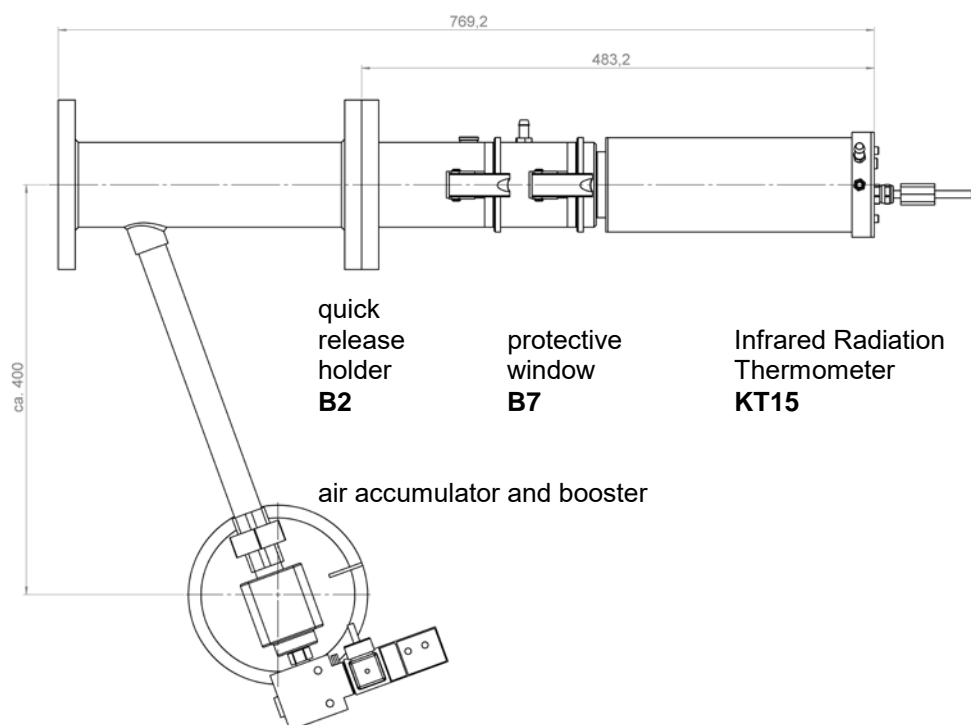
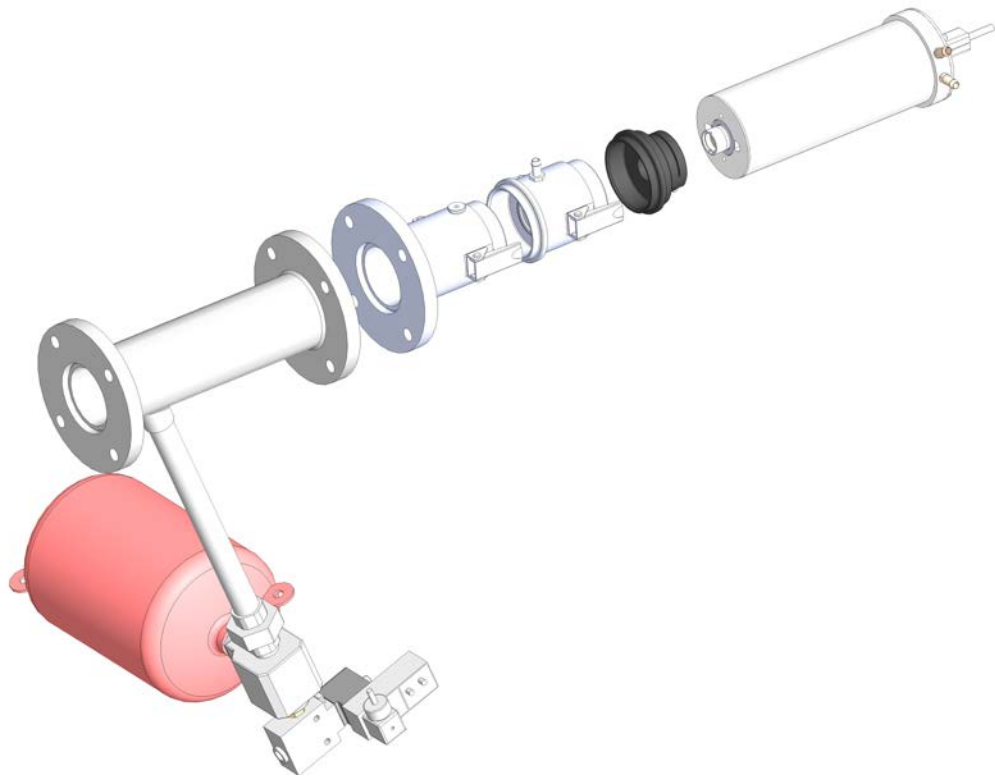
- with viewing aperture
- integrated temperature display
- operating keyboard





## Gage Set with Infrared Radiation Thermometer KT15.69

- with protective cooling jacket WK15



## Specifications

### Basic Data KT19.69

Output:	0 - 20 mA, 4 - 20 mA, 0 - 1 V, 0 - 10 V
Adjusting period:	5 ms bis 600 s
Operating voltages:	22 - 30 VDC or 24 VAC $\pm$ 10%, 48 - 400Hz
Power consumption:	$\leq$ 150 mA at 24 VDC
Permissible ambient temp.:	-20°C bis +70°C, in HD version +300°C
Type of protection:	IP 65
Connection:	1 or 2 PVC or PTFE cables, 7 and 12 pin via plugs
Weight:	2.5 kg, in HD version 4 kg
Options:	viewing aperture cooling jacket (HD version) for ambient temperature > +60°C serial interface RS232
Accessories:	air accumulator quick release holder B2 protective window adapter B7

### Basic data KT15.69

Output:	0 - 20 mA, 4 - 20 mA, 0 - 1 V, 0 - 10 V
Adjusting period:	30 ms to 600 s
Operating voltages:	22 - 30 VDC or 24 VAC $\pm$ 10%, 48 - 400Hz
Power consumption:	$\leq$ 150 mA at 24 VDC
Permissible ambient temp.:	-20°C to +70°C, in HD version +300°C
Type of protection:	IP 65
Connection:	1 PVC or PTFE cable, 12 pin via plugs
Weight:	0.55 kg, with cooling jacket 2.5 kg
Options:	cooling jacket WK15 for ambient temperature > +60°C serial interface RS232 or RS485
Accessories:	air accumulator quick release holder B2 protective window adapter B7