

IR-Camera for Control of Combustion Processes

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1 Explanation of problem and condition of insert

For optimal control of special combustion processes for instance in refuse incineration plants it's necessary to have information about the temperature distribution in the combustion chamber. Infrared cameras are suitable for this task because at a wavelength of 3.9 μm it's possible to make visible the burning object through the flames. High grade requirements such as rough conditions of operating, high ambient temperature and maintenance free operations over many years are set on for such infrared cameras. Usually such requirements are not fulfilled by infrared cameras customary in trade or the operation is only possible with costly and expensive protectors.

Tests of insert are showing that a high two-dimensional resolution can give pictures of good visibility. Usually these pictures are not necessary because of a limited number of regulation units to control the feeding of the air for the combustion process for instance. In such a case usually a high resolution carries to a process of integration over segments of the picture to get average values to control the regulation unit.

To take into account all of these requirements a new infrared camera was developed to control combustion processes specially in refuse incineration plants. This in comparison non expensive camera with an adjusted number of pixels can fill all requirements of a high sophisticated process control device in industrial processes even under rough conditions.

2 Non cooled Infrared camera with small pyroelectric array

The infrared camera to control the combustion process has a small pyroelectric array with 128 elements. With this array it's possible to obtain a thermo picture with 8×16 pixels (see figure 1). This number of pixels is sufficient to control combustion processes in refuse incineration plants as well as to force down the price for a high stable infrared sensor array. A high benefit is that the sensor works at ambient temperature and has not to be cooled. For the modulation of the infrared radiation only a simple chopper is necessary. The quality of the measurement of the temperature is comparable to 128 high grade chopper mode pyrometers. The housing of the camera is designed to operate the camera under rough industrial conditions without any additional protections. An optional operation with water cooling can extend the ambient temperature of the camera up to 100 $^{\circ}\text{C}$.

For the real time pattern correction a digital signal processor is used. The maximum picture repetition is 32 picture per second. Suitable software is designed to control the measurement process. The camera can be controlled and monitored via a PC. To operate the camera over long distance fiber optics for reliable connections are in use.

3 Combustion chamber objective with air brush and water cooling system

Previously used cameras to control the combustion process has been designed with big protection and cooling devices. For such cameras big breakthrough through the wall of the combustion chamber has been necessary. To avoid this high expenditure and to minimise the price for installation a long objective for the range of the infrared wavelength was developed which will feed the infrared radiation to the sensor array. The camera can therefore operate outside the wall of the combustion chamber. The

new developed objective is equipped with a water cooling facility. The entry point for the infrared radiation is only about 5 mm in diameter and equipped with an air brush unit. With this properties the objective can resist a temperature stress of about 1500 °C. With an installation length of 800 mm and a diameter of about 100 mm the effect to the wall of the combustion camber for the installation of the camera is negligible.

4 Technical dates and experiences of insert

The developed infrared camera has the following parameter:

Measurement range	650 °C to 1500 °C
Temperature resolution	better than 0.5 K
Spectral range	3.9 μm \pm 0.1 μm
Accuracy	\pm 1 K \pm 1 % of measured value
Angle of aperture	> 70°
Frame frequency	32 Hz, selectable to 1/128 Hz

During the insert of the infrared camera at refuse incineration plants a high dynamic of the combustion process is to notice. The new developed infrared camera is reliable in use and makes a continuously operation possible to enhance the control of the processes in combustion chambers. Finally an improvement of the control of the combustion due to the insert of the new infrared camera can take part to the environmental protection.

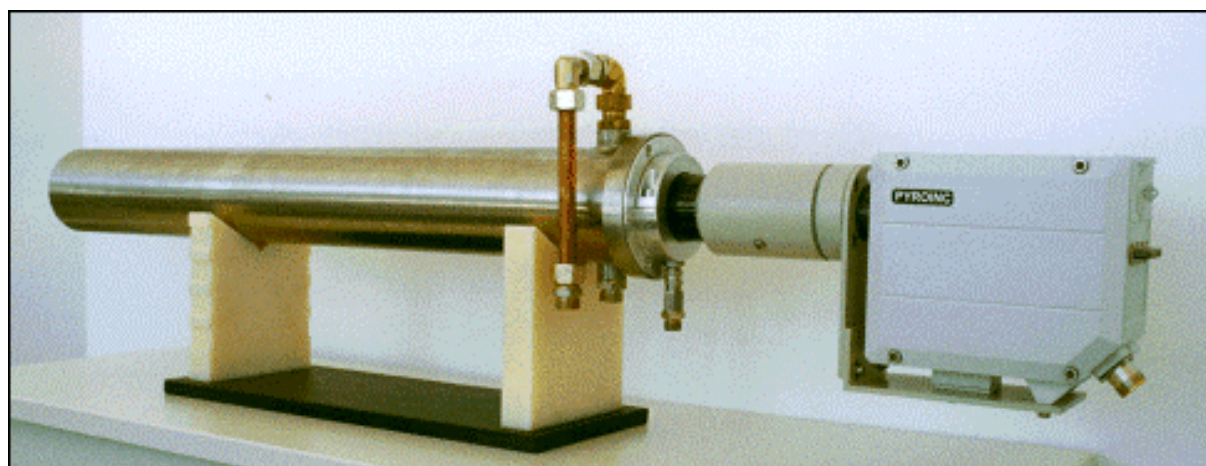
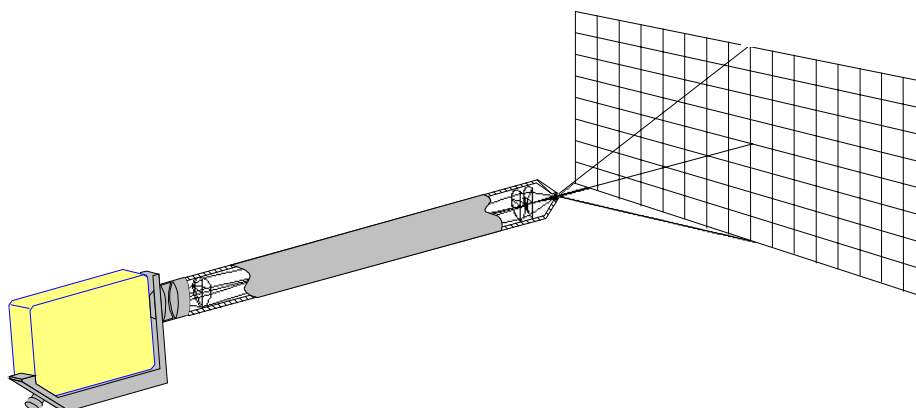


Figure 1: Developed IR-camera with special objective for control of combustion processes