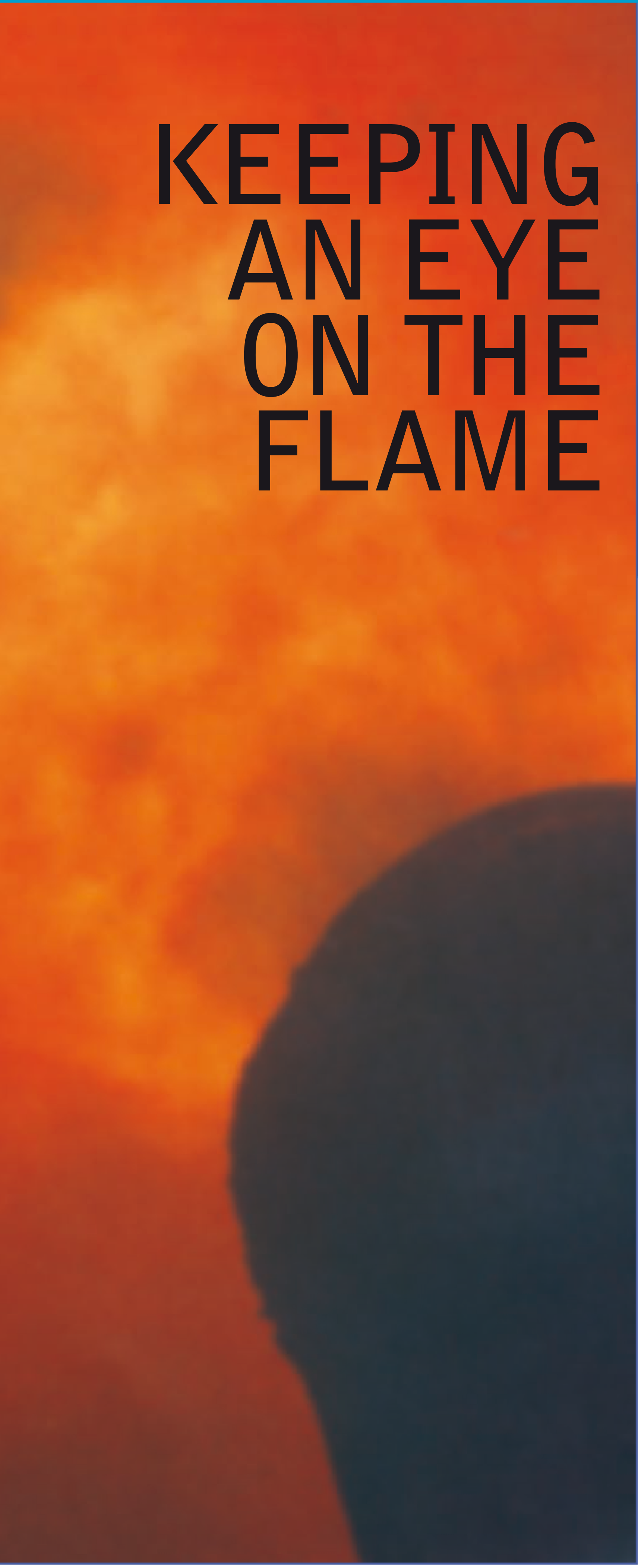
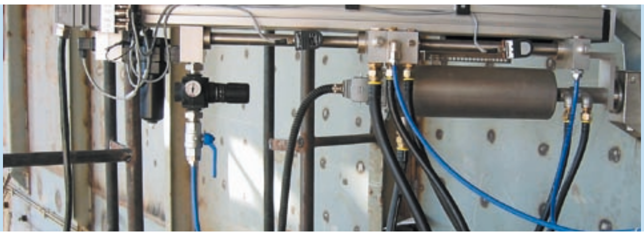


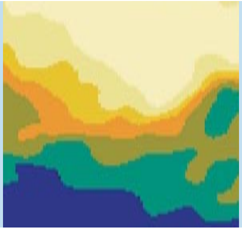
KEEPING AN EYE ON THE FLAME

THE DIFFERENCE BETWEEN GOOD AND BAD COMBUSTION MEANS A GREAT DEAL FOR THERMAL POWER PLANT OPERATORS. ROLAND ZEPECK OF DURAG LOOKS AT HOW MONITORING TECHNOLOGY CAN BE USED TO ACHIEVE BETTER BURNING.

The quality and efficiency of firing systems and the associated operational availability of boiler plants and steam generators is essentially dependant on the optimal mixture and dosing of fuel and combustion air in the entire combustion zone.

Disturbances of the local fuel/air ratio can result in localised combustion areas with high combustion temperatures and high formation of thermal NO_x. Other problems include the creation of localised combustion areas with incomplete combustion, associated with the production of high levels of CO. High flue gas losses can also result, along with high amounts of unburned carbon (UBC) or lost of ignition (LOI).





Furthermore, variations in the fuel/air mix ratio can cause local displacement of the main combustion zone compared to the design position, local overheating of boiler construction material and finally, high temperature corrosion and thermal stress combined with boiler tube ruptures.

Challenges

To achieve an optimal control of the combustion process, it must be possible to adjust two firing parameters individually. These are the uniform distribution of fuel according to the design data and secondly, control of the combustion air distribution over the entire combustion zone.

Receiving good basic information from the actual situation inside the firing zone is essential in order to be able to achieve these targets. Therefore an online/real-time analysis of the actual firing situation is mandatory and has to deliver information regarding the local position of the main combustion zone, flame temperature distribution, local flame propagation, the ignition point of flame and the presence of any local fouling.

Solution

The furnace camera sensor of the DURAG Video & Thermography System (also known under the trade name, FlamesightVideo/Therm) supplies online information directly from the combustion chamber to assist the operator in adjusting the complete combustion process optimally. The system provides a real-time video image as well as a real-time online thermographic analysis of the temperature distribution inside the combustion chamber.

The DURAG Thermographic System is an optical pyrometer based on advanced video data processing technology. A high quality picture with a wide angle of view and a small sensor diameter is obtained with a boroskope lens. The CCD camera is mounted in the cold part of the lance, thus allowing sensitive equipment to be mounted outside of the combustion chamber, allowing continuous use at high temperatures. An additional sapphire lens and air flushing are used to protect the boroskope tip from slag and ash particles.

In addition to the video image the system provides methods for the thermal analysis of the spatial temperature distribution inside the combustion chamber. It can determine the temperature within freely definable areas and lines (Region Of Interest - ROI, and Line Of Interest - LOI). The system is also capable of continuous parallel temperature analysis in all ROI's with continuous display of the absolute temperatures on screen. Other capabilities include the ability to perform continuous temperature analysis along all LOI's with continuous display of the absolute temperature profile through the combustion chamber and the detection of the actual thermal position of the combustion zone.

For automatic closed loop control measures, all the data generated by the thermographic systems can be transferred to the main process control system (DCS) at the customer site through a standardised data interface.

To guarantee the largest and unobstructed observation range the sensors

Technical data

Video system: **PAL, pixel: 752(H) x 582(V), fixed focus.**

Thermography overall radiation:
Temperature range: 1000-1800°C

Optics field of view: **0° sensor: horizontal 72°, vertical 54°, diagonal 90°**
45° sensor: horizontal 48°, vertical 36°, diagonal 60°

Gas temperature in combustion chamber:
With water cooled sensor: <1800°C
With air cooled sensor: <1100°C

Environment temperature:
Sensor/retracting unit: 0°C - 60°C
Field cabinet: 0°C - 45°C

Required working space for sensor/ retracting unit: **1450 x 500 x 800mm (LxWxH)**

Working length in combustion chamber: **max 450mm measured from welding plate.**

Power supply: **230V/50Hz, 500VA**

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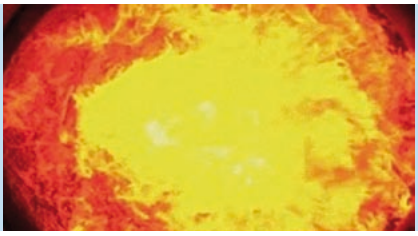

along with their optical systems are directly moved into the combustion chamber. To withstand high temperatures between 700°C and 1600°C (typical for these furnaces) the sensors are air or water cooled. All parts which are affected by the flue gas are made of special stainless steel to cope with the chemical reactions and high temperatures of the flue gas.

The number and location of the places where they are installed depends on the specific nature of the monitoring task (eg of single burner, elevations, combustion chambers), the measurements of the combustion chamber, the firing belt and plant specific options.

Typically one or two furnace cameras are fully enough to visualise and analyse the entire combustion chamber.

As far as the control room is concerned, the setup requires the installation of one video monitor for every sensor or for every sensor group for online visualisation of the combustion process and one PC with a graphic monitor (maximum processing of two sensors possible) for thermography and temperature analysis.

Applications and results

Online monitoring and thermal evaluation of the combustion situation in boiler plants is commonly used with the following firing systems: coal, fuel oil, gas (luminous flames), co-combustion of secondary fuels (eg waste water sludge), biomass boilers, tangential firing systems (corner or wall orientated), wall orientated firing systems and opposite burner orientated firing systems ('boxing' firing systems).

The online data from the DURAG Video and Thermographic System supports the analysis of the combustion process; it provides the tools and ability to improve combustion quality by taking the necessary measures. This can include the correction of undefined and incorrect positioning of the main combustion zone through adjustment of the fuel/air ratio for individual burners. The system can also be used to minimise the amount of unburned carbon in the ash (UBC/LOI). Furthermore, it can be used to minimise flue gas losses and can increase the efficiency level by adjusting the excess air at constant combustion.

Using optimal furnace control reduces the maintenance requirements and furnace out-of-service conditions due to local overheating and undefined situations in the water and steam systems (avoiding water tube ruptures). It also has the benefit of minimising the boiler's start-up time through a controlled temperature profile.

Because of all these benefits, using the thermographic temperature analysis data to aid operation of the boiler typically results in a Return-of-Investment period of less than one year.

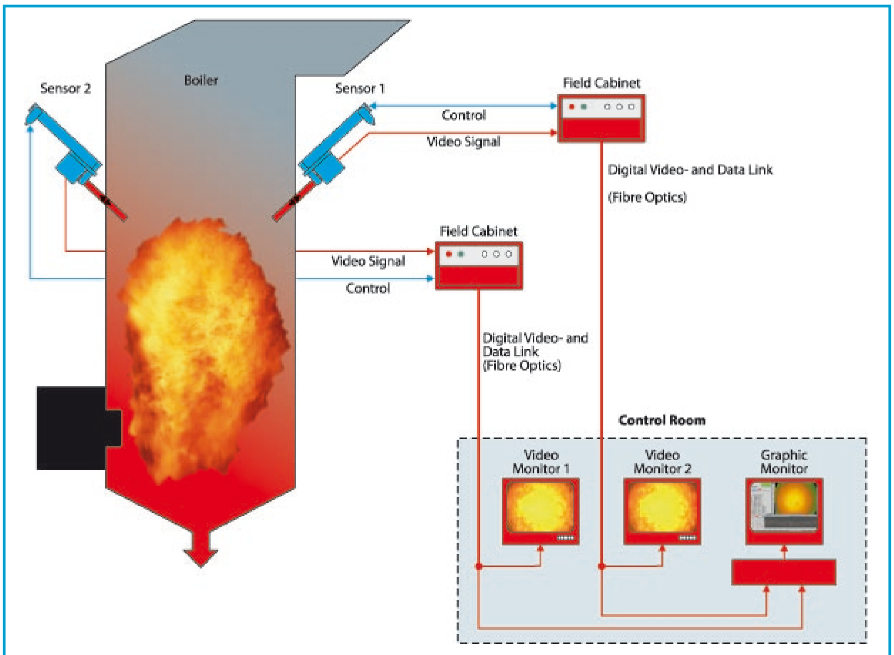

Figure 1: Diagram illustrating DURAG's Video and Thermography System monitoring combustion in the furnace.

Feature information

Roland Zepeck holds a diploma degree in chemical engineering and process chemistry. He has written multiple papers on various aspects of environmental monitoring and combustion technology.
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