

Thermography

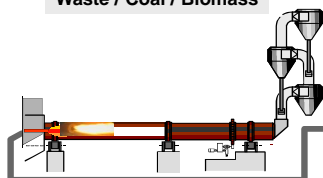
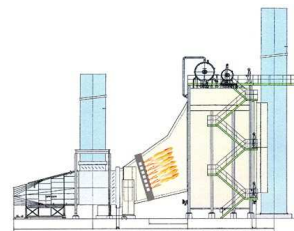
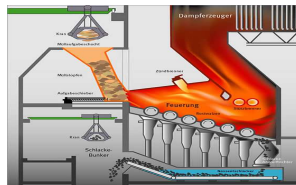
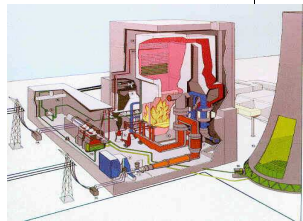
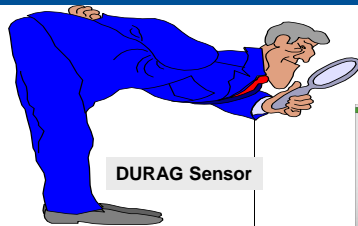
(Video-based Furnace Cameras)

Information Tool for Combustion Control & Efficiency in Fossil-Fuel fired Boilers

Reduced Maintenance Lower Primary NO_x

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Co-Authors: Eagarat Chaiyarith, Processplus Company Limited, Bangkok, Thailand
Maurizio Dal Cin, Power Generation Systems, Milano, Italy

DURAG Sensor System - Online Information from Thermal Processes in:



1 Basics of Combustion

2 Applications for Furnace Cameras

3 Combustion Chamber Lance with Camera

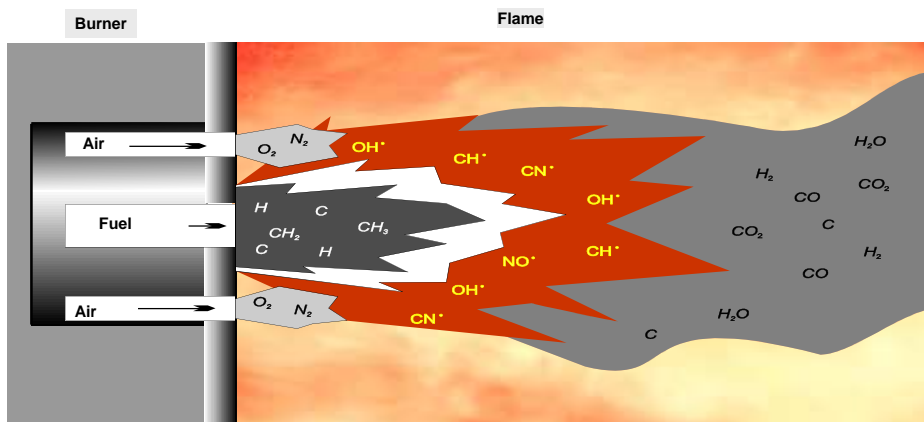
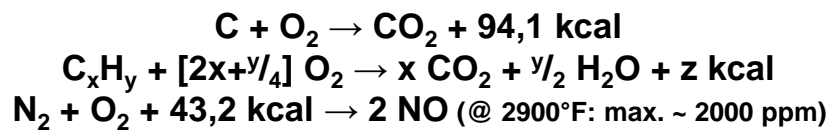
4 Theory of Thermography


5 Modular System

6 Benefits & References

7 Applications & Installations

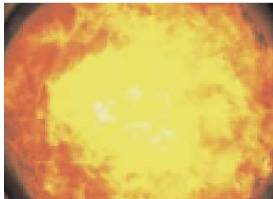
Chemical Processes in the Combustion





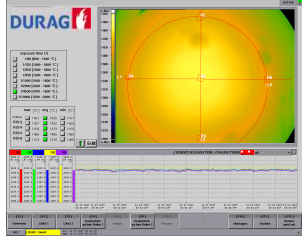
DURAG System

DURAG Furnace Cameras




VISUALIZATION
Video Technology

➔




TEMPERATURE ANALYSIS
Thermography



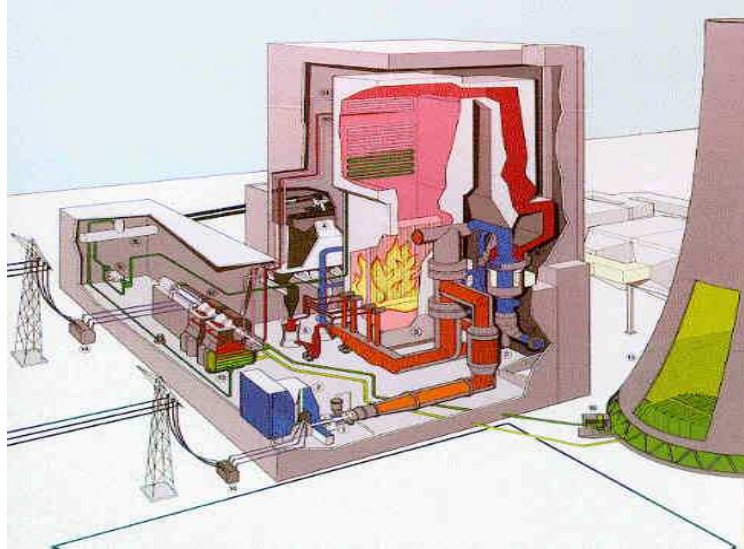
Smart Solutions for Combustion and Environment **DURAG GROUP**

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3	Combustion Chamber Lance with Camera
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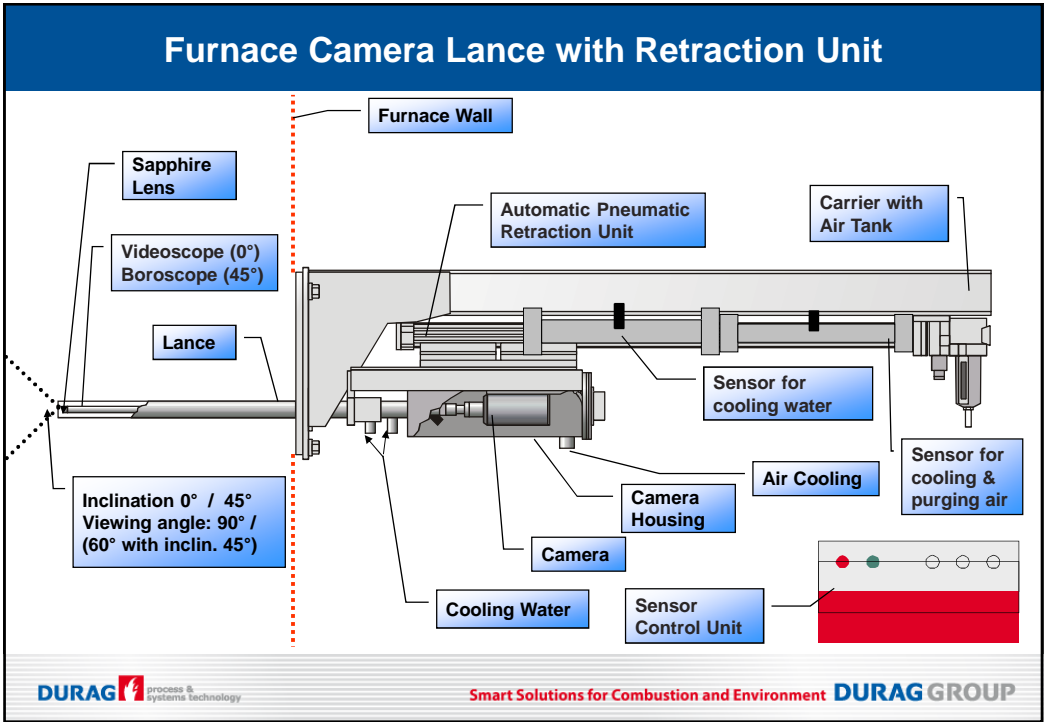


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COAL / OIL / GAS FIRED POWER PLANTS



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Logos: DURAG process & systems technology, Smart Solutions for Combustion and Environment DURAG GROUP

Basics of Thermography 1

- The Thermography System operates as a spatial spectral pyrometer based on picture processing
- Basic concept of the False Color Calculation and Temperature-identification is the Law of Radiation discovered experimentally by Jožef Štefan 1879 and derived from the thermodynamic by Ludwig Boltzmann in 1884
- According to that every body emits, based on its temperature (for $T > 0 \text{ K}$), electromagnetic rays



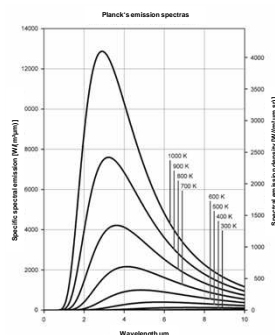
Jožef Štefan



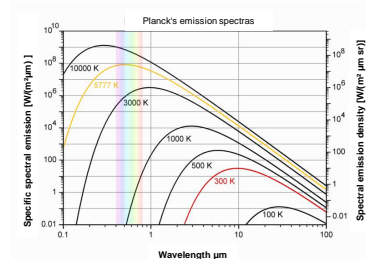
Ludwig Boltzmann

Basics of Thermography 3

In 1900 Max Planck derived the Planck's Law which describes the amount of electromagnetic energy in relation to the wavelength radiated by a black body.

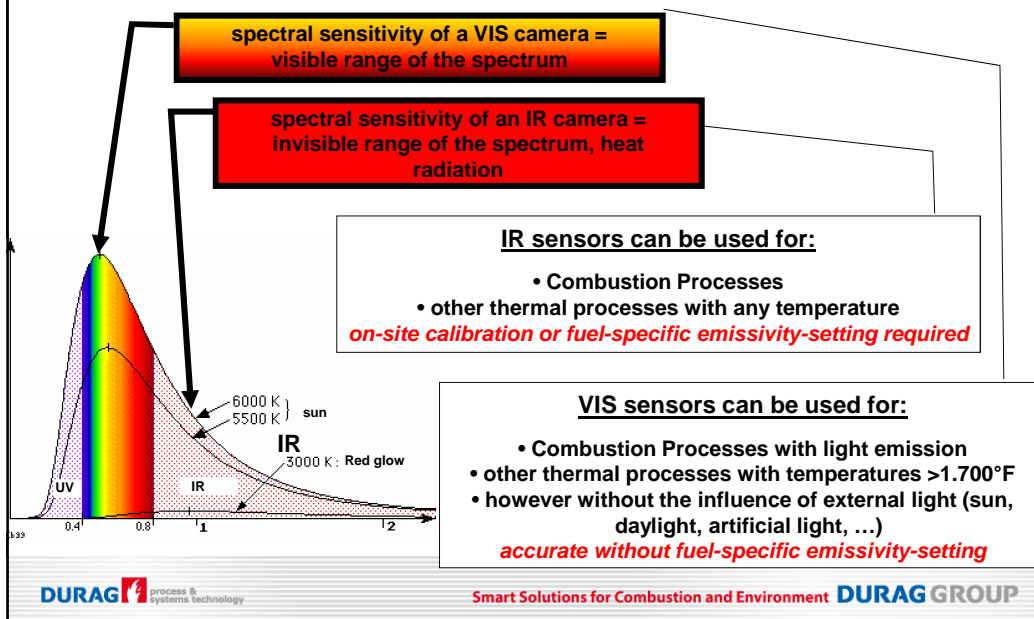


Planck's Emission Spectras for various temperatures



Planck's Emission Spectras for various temperatures in double-logarithmic diagram

On-site Application for Video and Thermography Sensors



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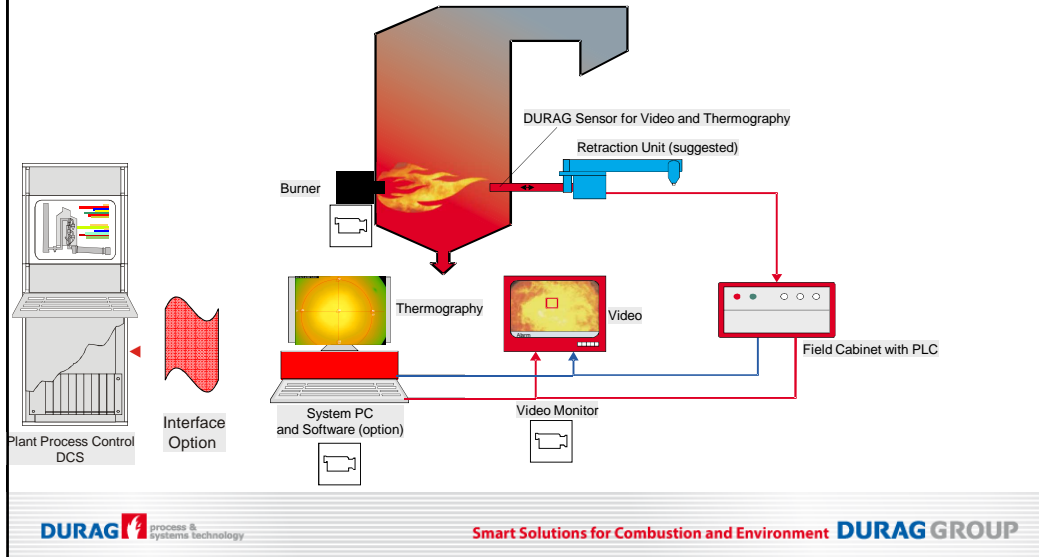
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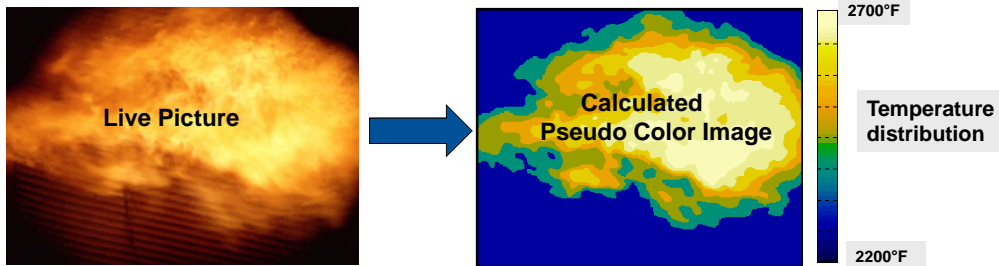
7 Applications & Installations

Video and Thermography in coal / oil / gas fired Power Plants

One video shows the start-up of the main burners, the second one the fireball, both in a tangential fired coal boiler (650 MW)
The Screenshots show the power plant and the thermography images with Lol's and Rol's in the in the same boiler



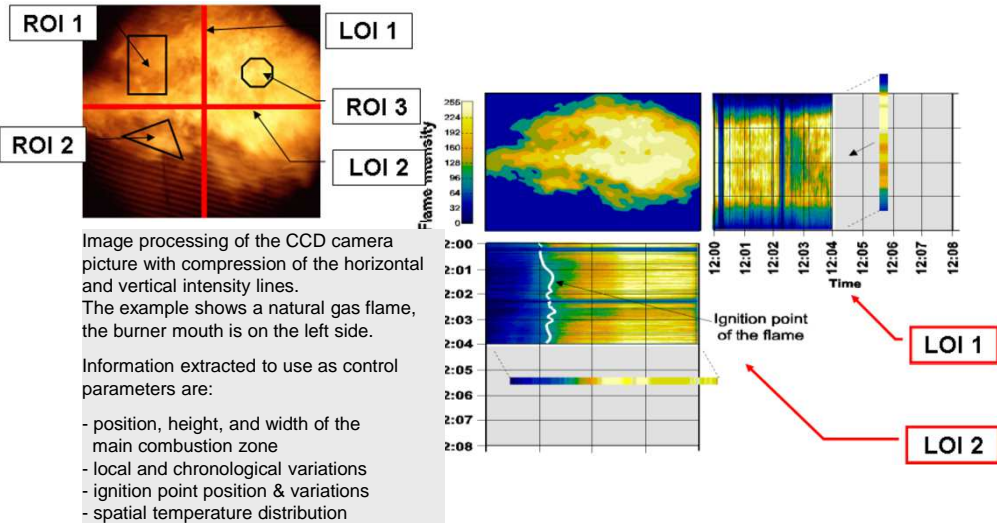
Video System → Image Processing = Thermography



Calculations:

- f** Temperature (in absolute terms, accuracy app. $\pm 1.5\%$)
- f** Temperature Distribution
- f** Flame Position
- f** Ignition Point
- f** Combustion Zone Detection

Video System → Image Processing = Thermography



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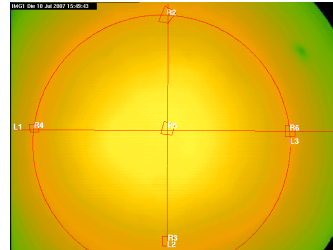
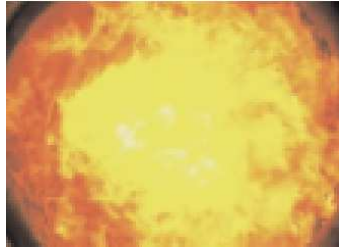
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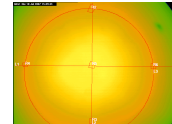
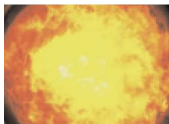
Video System + Image Processing = Thermography Example: Furnace Camera in fossil-fueled boilers



Benefits for the Operator in Boilers from the DURAG Video and Thermography System

- fi Video System:**
Online insight into the boiler with presentation of fire ball form and position.
Visualization of up-most level of burners during start-up.
Viewing of Clinker build-up.
- fi Thermography / Temperature Distribution Analysis:**
Presentation of the temperature distribution in the boiler / fireball with temperature determination in selected Regions of Interest and temperature profile along selected Lines of Interest (measurement areas).
With this temperature information the operator will be able to adjust online the set points for fuel quantity, primary and secondary and over-fire air.
The operator is able to detect online thermal unbalances in the firing area (fireball, firewall) and maintain the thermal fireball/wall position in the center of the boiler.
In Grate fired systems hot and cold spots on the grate plus the post-combustion zone are detected.
Reducing drastically the possibility of local overheating and water tube ruptures.

RESULTS



Example 1:

Tangential-fired Boiler, Coal, 2 x 650 MW:
Typically 2-3 watertube ruptures per year because of unbalanced fireball and local overheating
Total cost for repair and loss of production: app. \$ 1.900.000 / year / boiler
Since two DURAG Furnace Cameras with Video & Thermography are installed (total investment \$ 180.000):
NO tube ruptures since 7 years!
Savings per year estimated at \$ 1.900.000 per boiler!

Example 2:

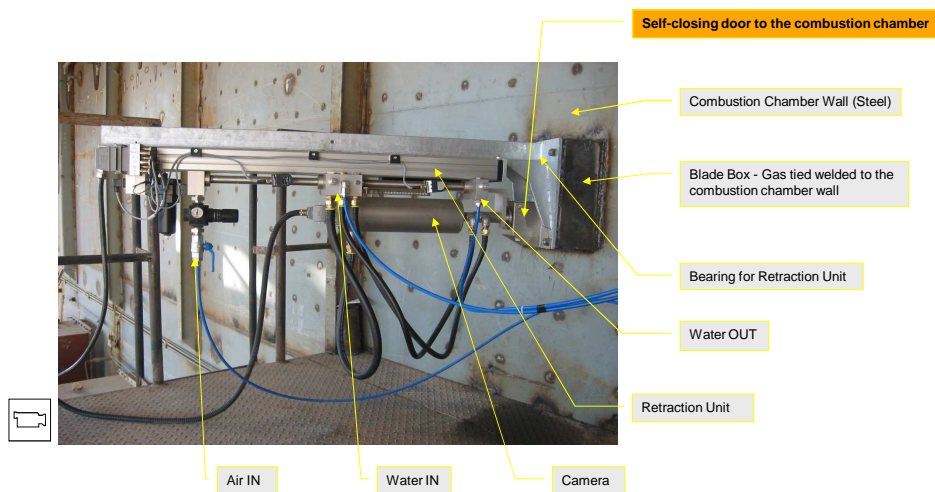
Tangential-fired Boiler, Oil & Gas, 305 MW:
Installation of one DURAG Furnace Camera with Video & Thermography and on-line temperature analysis during start-up resulted in 20% faster start-up (start-up time reduced from 5 to 4 hours!)
Total investment \$ 80.000. Total **savings per start-up estimated at >\$ 90.000 !**

Example 3:

Tangential-fired Boiler, Coal, 650 MW:
Installation of one DURAG Furnace Camera with Video & Thermography per burner, online real time temperature analysis of the flame root section, fuel/air trimming based on temperature profile.
Reduction of primary NO_x by >12%.

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Sensor with Air Purging, Water Cooling, and Pneumatic Retraction Unit



Furnace Cameras with Air Cooling and Pneumatic Retracting Unit

Burner Flame Analysis Camera



Down-Shot Furnace Cameras

Furnace Cameras with Air Purging, Water Cooling, Pneumatic Retraction Unit



Burner Flame Analysis Cameras: NTPC SIMHADRI, India



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