2021 AFPM
SUMMIT
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American Fuel & Petrochemical Manufacturers
Wednesday October 6th, 2021
2:45 to 3:30 PM CST
Acoustic Pyrometer Boilerwatch®
Furnace Gas Temperature Measurement

BOILERWATCH® MMP-II-SSX-LD

Acoustic Pyrometer - Refinery Applications

Master Distributor
Greenbank Energy Solutions Inc
185 Plumpton ave
Washington Pa 15301
724-413-4021

ACOUSTIC PYROMETER

The BOILERWATCH® MMP-II-SSX-LD acoustic pyrometer is an advanced industrial instrument that provides fully automatic measurement of high combustion-gas temperatures, permitting fuel trimming control within heaters and boilers. The system is completely non-intrusive, and operates on the principal that the speed of sound in a gas is proportional to the temperature of that gas. Acoustic transceivers are mounted on the outside of walls of the heater/boiler, and a high intensity acoustic signal is launched through the gas stream. Since the distance between the sound source and receiver is known and fixed, the average temperature of the gas along the acoustic path is computed from an accurate measurement of the sound signal's transit time.

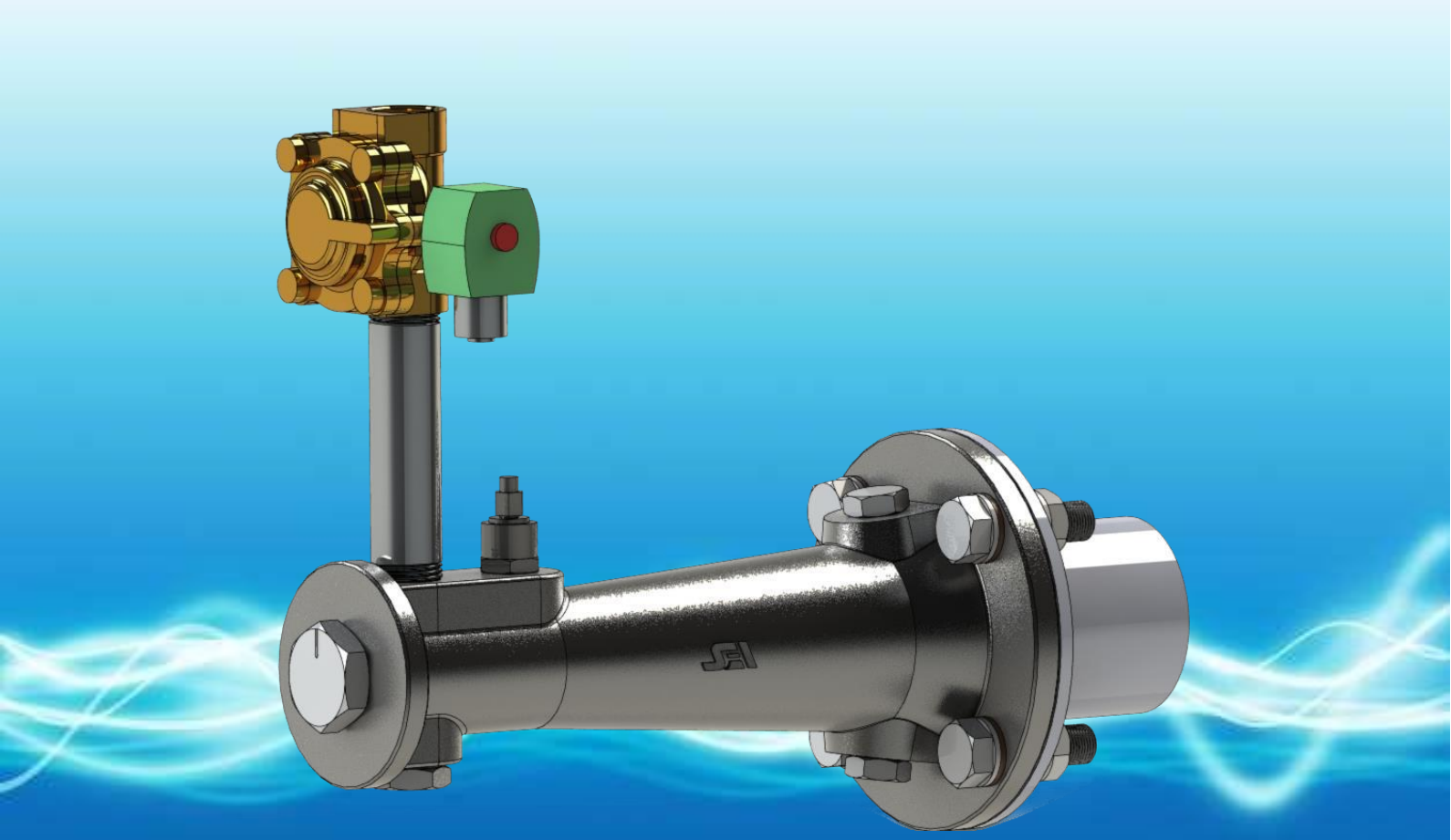
BOILERWATCH® MMP-II-SSX-LD systems are available in a variety of configurations. With up to 24 individual path temperatures available, systems may be configured for spatial 2 dimensional temperature mapping, independent temperature measurements, or a combination of both. BOILERWATCH® MMP-II-SSX-LD systems are easy to install, commission, and operate.

BOILERWATCH® MMP-II-SSX-LD Provides temperature measurement in groups of 5 paths. Increases speed of processing 80%. Also reduces air consumption 80% compared to previous versions.

It has been shown that excess O2 can be reduced by at least 0.5%, which results in a vastly significant increase in fuel efficiency and heat rate. The cost savings from this benefit alone pays for a BOILERWATCH MMP-II-SSX-LD system in very short time.

Reducing temperature imbalances and eliminating hot spots, coke formation inside the tubes and the NOx production is reduced drastically. A uniform temperature distribution also reduces heat stress, increases the furnace life and process tubes, also extends the production.

With our Acoustic Pyrometer you can measure the gas temperature in any kind of furnace or boiler and get a distribution map temperature, all in real time. The waveguide can be located in 2, 3 or 4 wall of the furnace or boiler.



Software

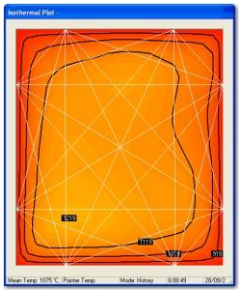
TMS-2000 displays gas temperature measurement data in a number of highly effective and useful presentations that provide critical and timely temperature related information on the furnace, boiler or thermal process being monitored. TMS-2000 presents operations and performance personnel with straightforward, yet powerful, visual information on current and historical gas temperatures. Spatial temperature distribution profiles (i.e. temperature as a function of position within a planar area), individual path average temperatures, path and area statistics, path temperature/time trends, and average gas temperatures within user-defined zones are available from TMS-2000. Both rectangular and circular planar geometry's are supported.

The PCU sends real-time temperature information to TMS-2000, which processes, stores, and displays the measurement data in a variety of user-selected formats.

The multiple sets of path temperatures, from which the various displays and presentations are derived, may be stored (archived) on hard disk or on a network drive for later offline display and analysis.

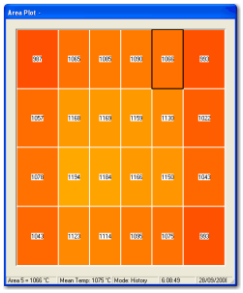
TMS-2000, like all of our software is menu driven for ease of use. In addition, it has soft key buttons to quickly move between screens, or to open and close screens.

Isothermal Map

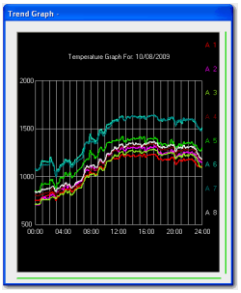


The Isothermal Plot screen displays spatial temperature distribution profiles in the form of color isothermal contours for a given furnace application. TMS-2000 supports two geometries, circular and rectangular. One presentation provides isothermal contour lines at a user defined temperature contour interval, with the temperature of the contours displayed. Smaller intervals provide a greater number of lines, and hence, more detail, while large intervals result in fewer lines within the planar area. By moving the cursor to any given point within the plane, the numerical value of the temperature at that point is displayed in the status bar at the bottom of the window. This status bar also displays the mean temperature, the mode (real time or history), as well as the time and date of the last data acquisition. In "history mode", data between specified starting and ending times may be played back in a slide-show style to visualize dynamic temperature changes over a period of time.

AreaMap



TMS-2000 can compute and display the average gas temperature within user-defined areas (or zones) of the mapping plane. Up to twenty-four (24) zones within the plane may be defined by the user. The system will then calculate and graphically display the average temperature within each of these zones. Area plots are especially useful for plant control systems such as a DCS.



Trend Graph

Path temperature graphs show up to 8 Areas and/or path temperature values. Both minimum and maximum temperature scale values may be selected for optimum resolution of the trace display. Time periods may be selected from the previous 24 hour periods up to 365 days. Each pen is color coded, any pen may be assigned to 8 paths and/or areas. The Time and Temperature are displayed by moving the mouse over the graph.

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Leak Detection / Noise

The TMS-2000 presents a system for the detection of noise in the combustion zone of the furnace or boiler.

The microphone that is located in the waveguide can hear the normal noise of the boiler / furnace continuously and displays a graphical trend for 24 hours a day, 365 days a year.

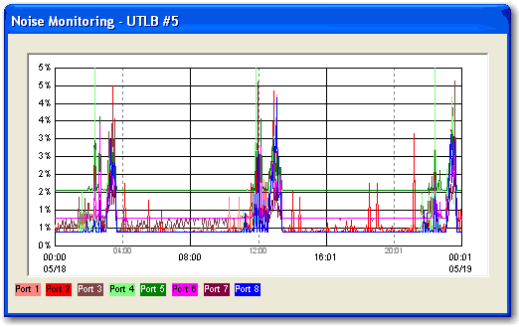
Before our transmit signal is generated noise for the measurement of temperature, the microphone in the waveguide noise heard inside the boiler / furnace, allowing it to generate a graph of noise.

When a pressurized fluid such as steam or water escapes through a leak in piping, valves, or feed water tubes, it generates acoustic emissions which travel through the component's structure. Small holes generate high frequency acoustic emissions (above the audio frequency range) as the hole increases in size the low frequency complement of the acoustic emission increase and the airborne noise can be heard.

BOILERWATCH® MMP-II-SSX-LD with Leak Detection may be used to detect early boiler tube leak to avoid secondary damage to pressure parts. Boiler acoustic tube leak detection system must be used as it prevents damage to costly boiler parts and it is very much cost effective.

Traditional leak detection system such hearing hissing sound by ear or monitoring feed water flow or furnace vacuum is not much reliable because it cannot detect small leak so damage to vital costly equipment of boiler may not be avoided. Operators noticed many instances where thermal power plants boiler allowed to run for long time due to confusion which caused permanent damage to many boiler tubes, refractory and boiler structures. Hence importance of acoustic monitoring leak detection systems sincerely felt.

Sootblower



Early detection by BOILERWATCH® MMP-II-SSX with Leak Detection results in substantial reduction of repair times and costs with a consequent increase in plant availability and profits. The early detection of a boiler tube leak will give financial savings which will easily exceed the initial capital cost of the detection system even at the very first event.

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Components

1 3020TR Transceiver Unit · Wave Guide and Preamplifier

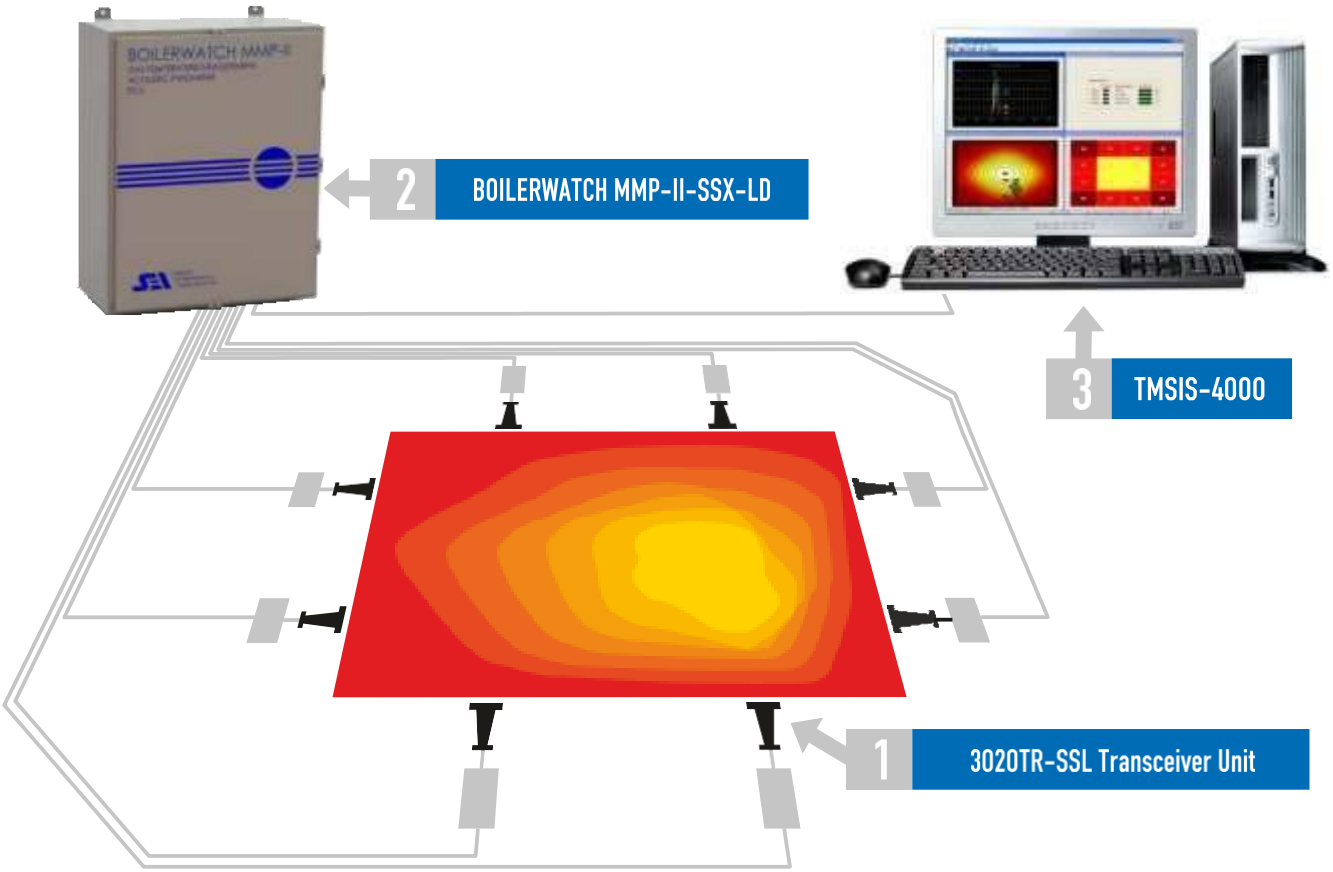
Pneumatically driven acoustic sound source and receiver. Mounts on exterior boiler/furnace heater wall/observation door. The maintenance of these sensors is practically none because the same air that use to generate the sound, also serves for cleaning and cooling. It consists of a microphone and solenoid valve.

2 BOILERWATCH MMP-II-SSX-LD · Processor Control Unit (PCU)

Sound spectrum used for reliable detection is from 500 Hz to 3,500 Hz. Simultaneous detection is available to sample all paths in less than 15 seconds. Provides temperature measurement capacity for up to eight (8) independent paths (requires 2 model 3020TR Transceiver units per path), or up to a twenty-four (24) path array for spatial temperature distribution mapping (using up to 16 model 3020TR Transceivers).

3 TMSIS-4000

The TMSIS-4000 utilizes the TMS-2000 software to convert path temperature data provided by the BOILERWATCH PCU into area data for planar temperature distribution mapping applications. The spatial temperature gradients are displayed in the form of an isothermal map and accurately represent a planar temperature gradients. Additionally, the complete two-dimensional (2-D) (planar) isothermal map is sectioned into 24 areas forming an array of area temperatures, which constitute a single spatial temperature plane. The area temperature data is then fed directly into the plant Distributed Control System (DCS), Data Acquisition System (DAS), for data presentation and archiving.



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Components

1 3020TR Transceiver Unit · Wave Guide and Preamplifier

Wave Guide

Material: Stainless Steel 316L
Dimensions: 200mm flange diameter, 325mm length
Flange: ASTM standard 3-inch 150 lb. pipe flange
Weight: 26 lb. (11,8 Kg.)
Temperature Environment: Flange: +450ºF (+232ºC) max.; Ambient Air: +130ºF (+54ºC) max.
Noise generated: Inside: 126bB. Outside: 0dB
Air Pressure to Sound Source: Air Service. 80 - 120 psig (5.0 - 8.3 Bar)
Air consumption: 5 bar = 2.26 ft3/min (No Constant)

Preamplifier

Ambient Air Temperature: + 140 ºF (60ºC) maximum, No solar loading on cabinet
Enclosure: 343H x 288W x 130D mm
Weight: 14 lb (6,4 Kg)
Industrial Standards: NEMA/EEMAC Type 4. IEC 60529, IP66

2 BOILERWATCH MMP-II-SSX · Processor Control Unit (PCU)

Ambient Air Temperature: + 130 ºF (54ºC) maximum, No solar loading on cabinet
Enclosure: 762H x 610W x 356Dmm
Weight: 110 lb (50Kg)
Industrial Standards: NEMA/EEMAC Type 4. IEC 60529, IP66

3 TMSIS-4000

Number of Ports: Two minimum and up to sixteen maximum
Number of Paths: Up to twenty-four (24) paths
Warranty: Two (2) years.

TMS-2000 Software

Measurement Range: 32ºF to 3500 ºF (0ºC to 1927 ºC)
Temperature Units: English or Metric (ºF or ºC)
Accuracy: Better than 0.5%
Measurement Acquisition Time: 5 seconds per path typical
Data Output: OPC/Ethernet
Saved Data: Unlimited (Isothermal map, trend Temperature and Noise)
Remote access: VPN or IP Remote
AC Power: 120/240 VAC, 50/60 Hz.

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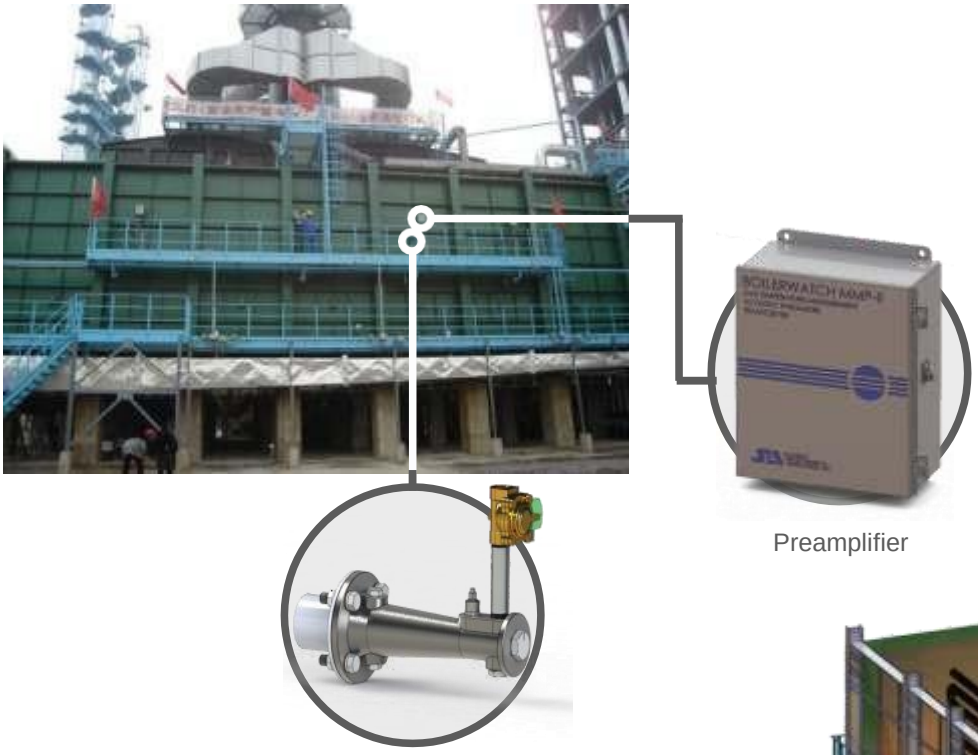
SINOPEC SHANGHAI DELAY COKER

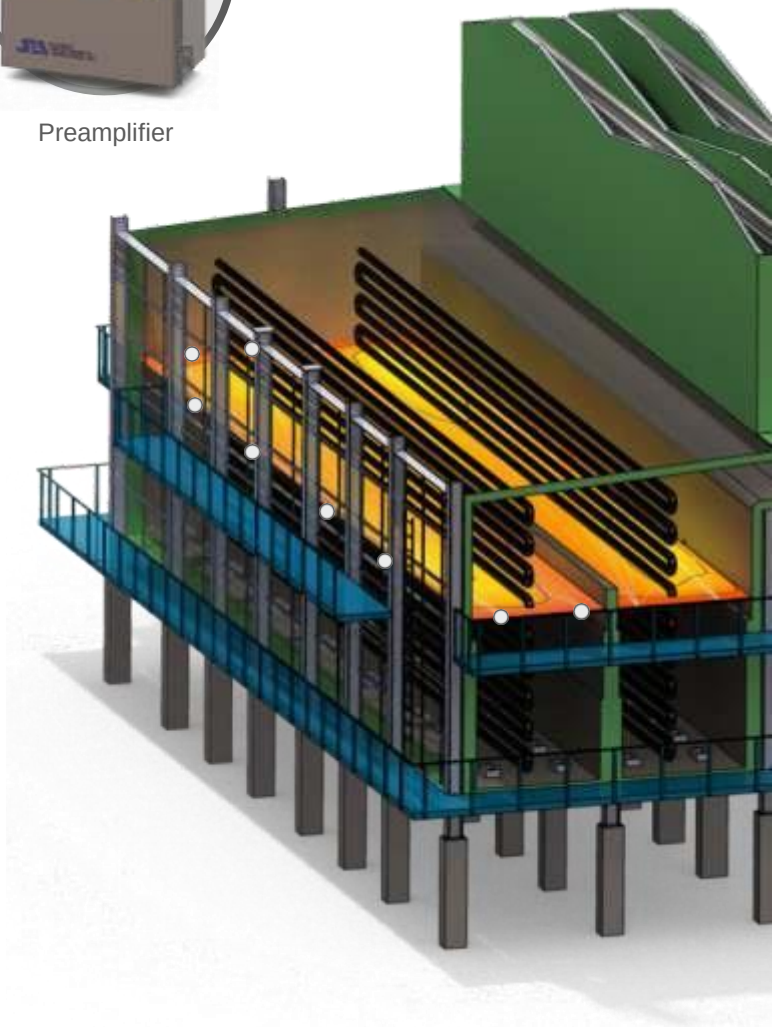
Installation



Preamplifier

Wave Guide

PCU



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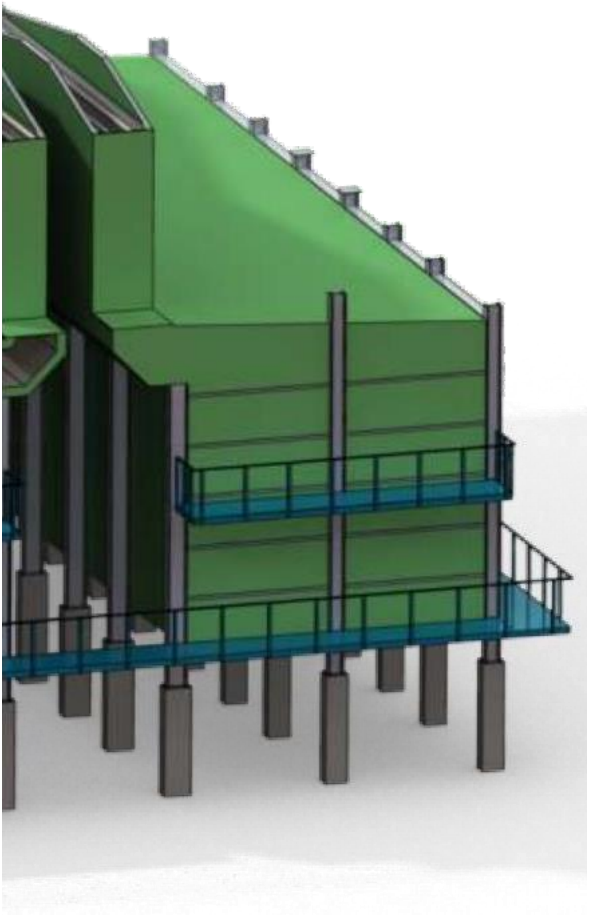
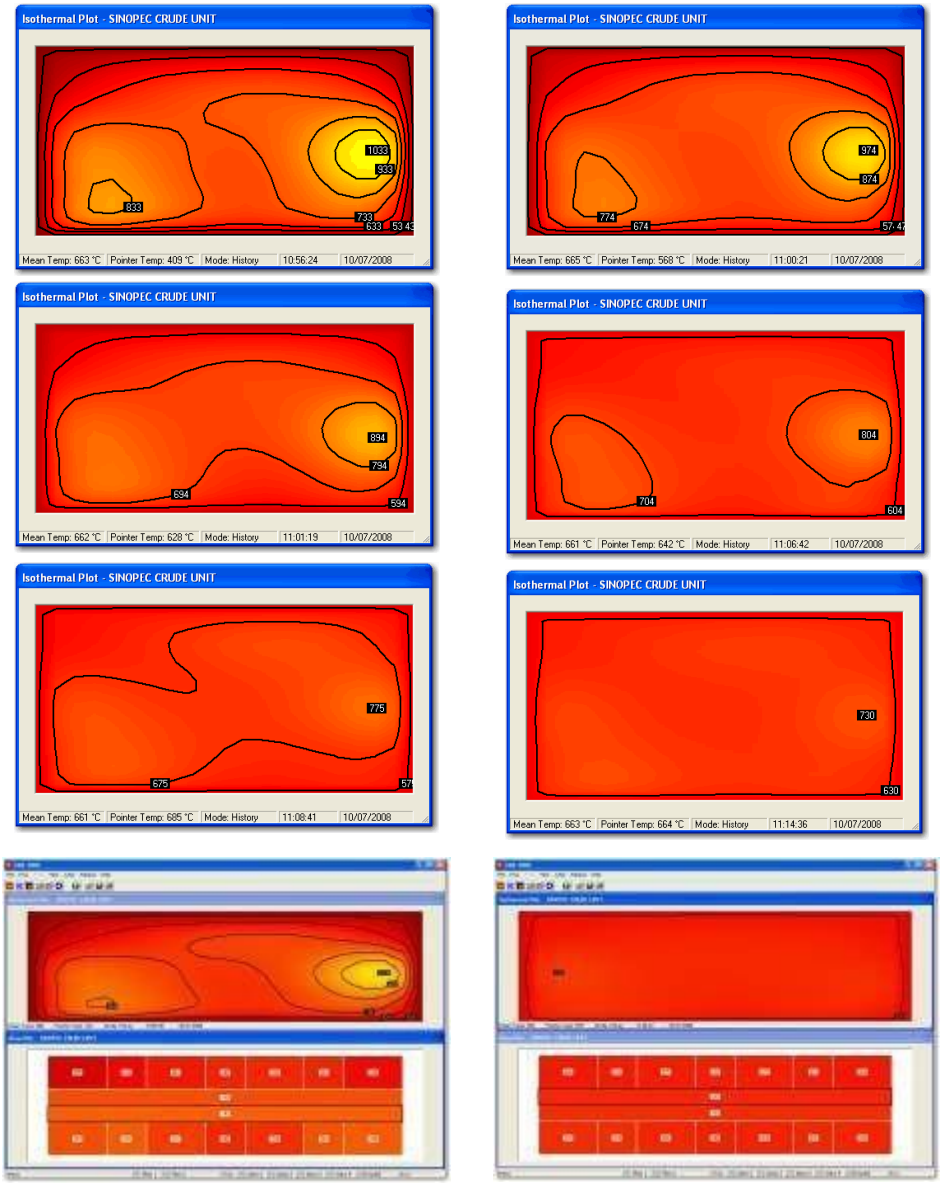
A uniform furnace temperature distribution is very important to avoid hot spots on the flame effect.

One of the problems encountered in refinery furnaces is the heat flow imbalance. This imbalance can cause high coker formation and high temperatures metal tubes that that reduce the unit ability and may cause premature failure.

As you can see in the Acoustic Pyrometer Isothermal map there is a hot spot at the process tubes, which making adjustments to the air and fuel register was achieved a balance heat distribution by reducing the hot spot and maintaining the same temperature average household. The ΔT (temperature differential) before and after adjustments was reduced significantly. Before adjustment the ΔT between the Minimum and Maximum temperatures Areas was reduced from 200 °C to 40 ° C.





Max. Temp: 792ºC
Min. Temp: 585ºC
ΔT: 207ºC
Mean Temp: 666ºC

Max. Temp: 701ºC
Min. Temp: 664ºC
ΔT: 37ºC
Mean Temp: 666ºC

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PETROBRAS REGAP DELAY COKER

Installation

Wave Guide

Preamplifier

PCU

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The problem with the image 1 is that most of the heat is concentrated in the center of the heater. The heat needs to be evenly distributed along the entire heater in order to reduce coke build up in the process tubes. Air register adjustments are needed to achieve a more even heat distribution.

The image 2 shows a broader heat distribution in the center of the heater. This maximizes the efficiency of the heater by reducing the concentrated heat as seen before and even distributing it along the heater.

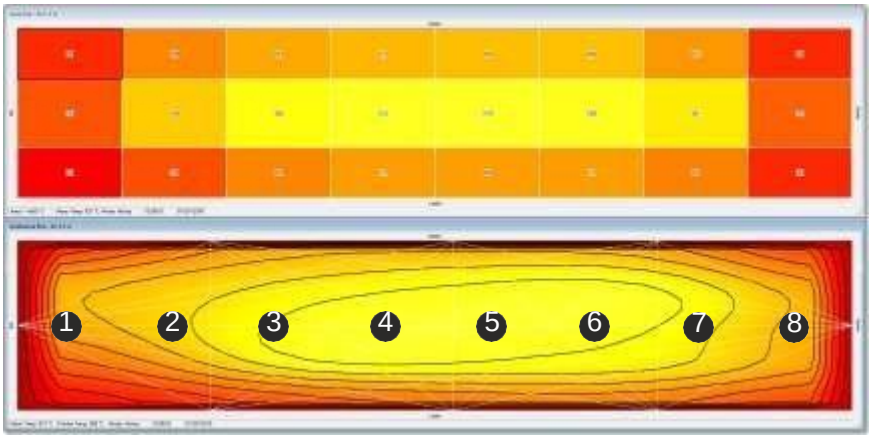


Image 1
Max Temp: 1015ºC
Min Temp: 634ºC
Mean Temp: 831ºC

BURNER#	PRESET	ADJ 1	ADJ 2	ADJ 3
1	45%	28%	20%	20%
2	35%	35%	25%	20%
3	30%	35%	30%	25%
4	30%	40%	35%	35%
5	30%	35%	35%	35%
6	40%	40%	40%	40%
7	25%	20%	20%	20%
8	40%	28%	20%	20%

The adjustments made to the air registers per burner

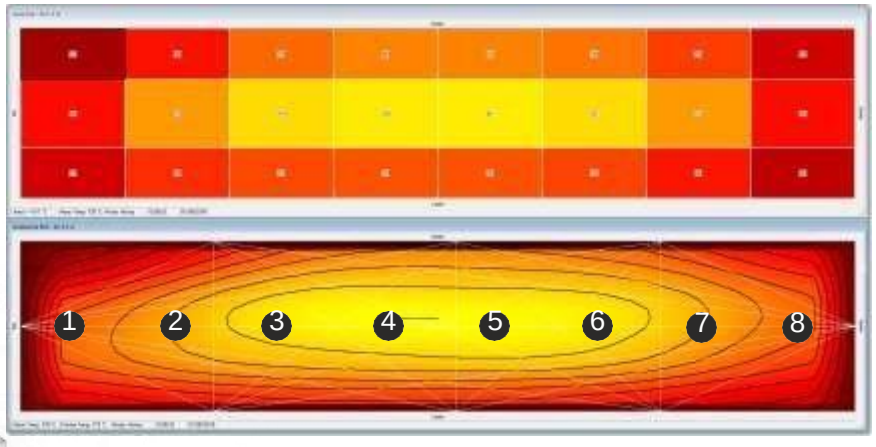
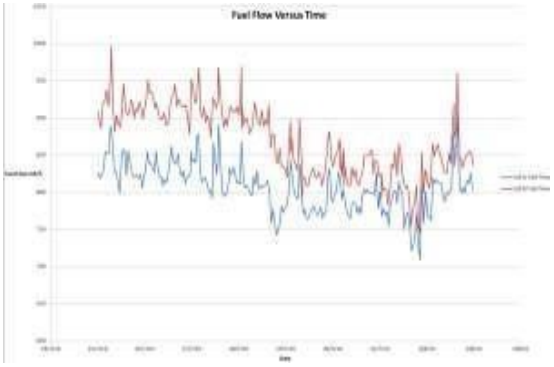


Image 2
Max Temp: 941ºC
Min Temp: 517ºC
Mean Temp: 735ºC

The graph below shows the fuel flow for both Cells A and B. Cell A had much lower fuel consumption since the previous adjustments. After the upset and change in the air registers, Cell A's consumption decreased to that of Cell B's levels. On average, before the upset the difference between Cell A's fuel consumption and Cell B's was 100 m3/h. This translates to a fuel savings of 2400 m3 of fuel saved by only adjusting one cell or a 12% decrease in fuel consumption.



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SOME OF OUR CLIENTS

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