

WEBINAR



TECHNOLOGIES for **NOx REDUCTION** in **INDIA**

Tuesday, June 2nd 10:00 AM (IST)

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Speaker
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Managing Director at INERCO USA

Main figures

Offices in **9** countries
19 companies
+35 year's experience
+650 employees
\$65 MUSD revenue

R&D

\$2.5 MUSD in R&D
+20 R&D projects
every year

References

+ 70 countries
+ 15,000 references
worldwide



Engineering



Technologies



Consultancy

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1. Introduction – Environmental Framework in India
2. Combustion & Low NO_x Technologies
3. Case Studies

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1. Introduction – Environmental Framework in India
2. Combustion & Low NO_x Technologies
3. Case Studies

- New emission standards: PM, SO₂, NO_x and Hg based on year of commissioning

Pollutant	TPP before Dec 31, 2003	TPP after Jan 1, 2004 before Dec 31, 2016	TPP after Jan 1, 2017
Particulate matter (PM)	100 mg/Nm ³	50 mg/Nm ³	30 mg/Nm ³
SO ₂	600 mg/Nm ³ units < 500 MW 200 mg/Nm ³ units ≥ 500 MW		100 mg/Nm ³
NO _x	600 mg/Nm ³	300 mg/Nm ³	100 mg/Nm ³
Mercury	0.03 mg/Nm ³ units ≥ 500 MW	0.03 mg/Nm ³	0.03 mg/Nm ³

MoEF: Indian Environment Protection Amendment (2015)

Pollutant	TPP before Dec 31, 2003	TPP after Jan 1, 2004 before Dec 31, 2016	TPP after Jan 1, 2017
NO _x	600 mg/Nm ³	300 mg/Nm³	100 mg/Nm³



??


Relaxation NO _x	600 mg/Nm ³	450 mg/Nm ³	450 mg/Nm ³ ??
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Technologies available

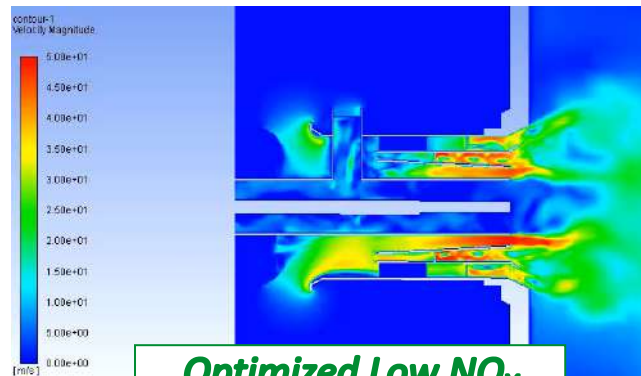
- **Primary Measures:** Low NO_x burners, OFAs, combustion optimization systems
- **Secondary Measures:** Selective Non-Catalytic Reduction (SNCR), Selective Catalytic Reduction (SCR)

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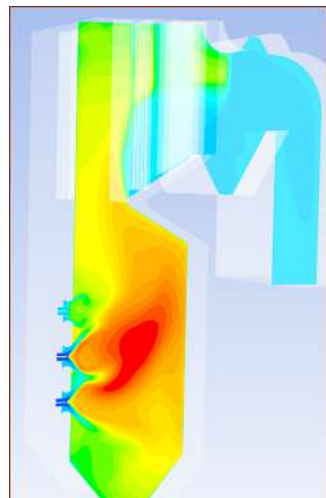


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 3. Case Studies

Combustion Modifications: LNB & SOFA



**Optimized Low NO_x
Burner Design**



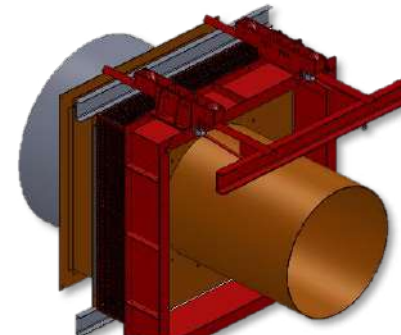
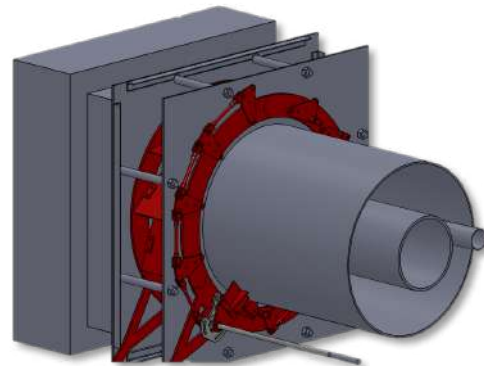
**Overall boiler impact
& assessment**

- Substoichiometric combustion, O₂ stratification, “low temperature” combustion
- Key aspects:
 - Velocities
 - Turbulence & **mixing**
 - Pressure drop combustion air / windbox
 - OFA/SOFA for combustion completion
- Evaluation of parameters:
 - **NO_x generation**
 - Temperature profile
 - Heat flux
 - Spray attemperators
 - Unburnt coal & residence time
 - CO generation
 - Corrosion, slagging
 - Heat rate affection

Combustion Modifications: LNB & SOFA



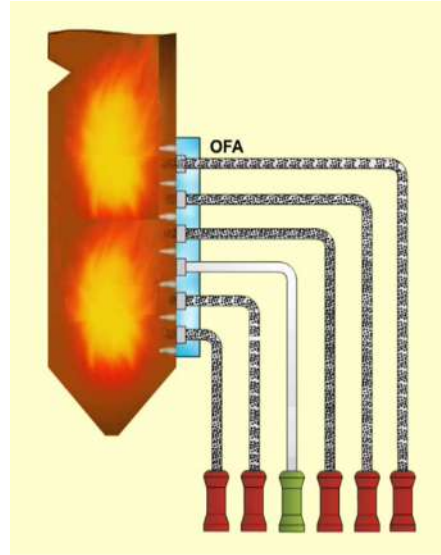
*LNB + OFA / SOFA
nozzles & ducts*



Burner upgrade

Combustion Modifications

Conventional burner system



- When one mill is out of service a **gap** is produced in the combustion area

↑↑ NOx

↓ Efficiency

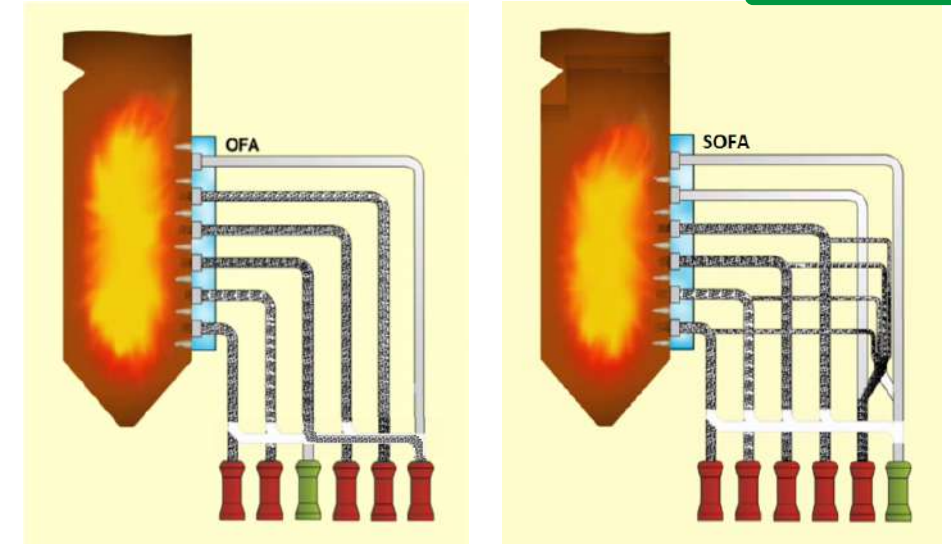
↑ FEGT

↑ Corrosion,
slagging

↑ LOI

FLEXICOM - LNB

PATENTED



- FLEXICOM-LNB** is a retrofit of the coal distribution to create a Low NOx System by connecting mills & burner elevations

↓↓ NOx

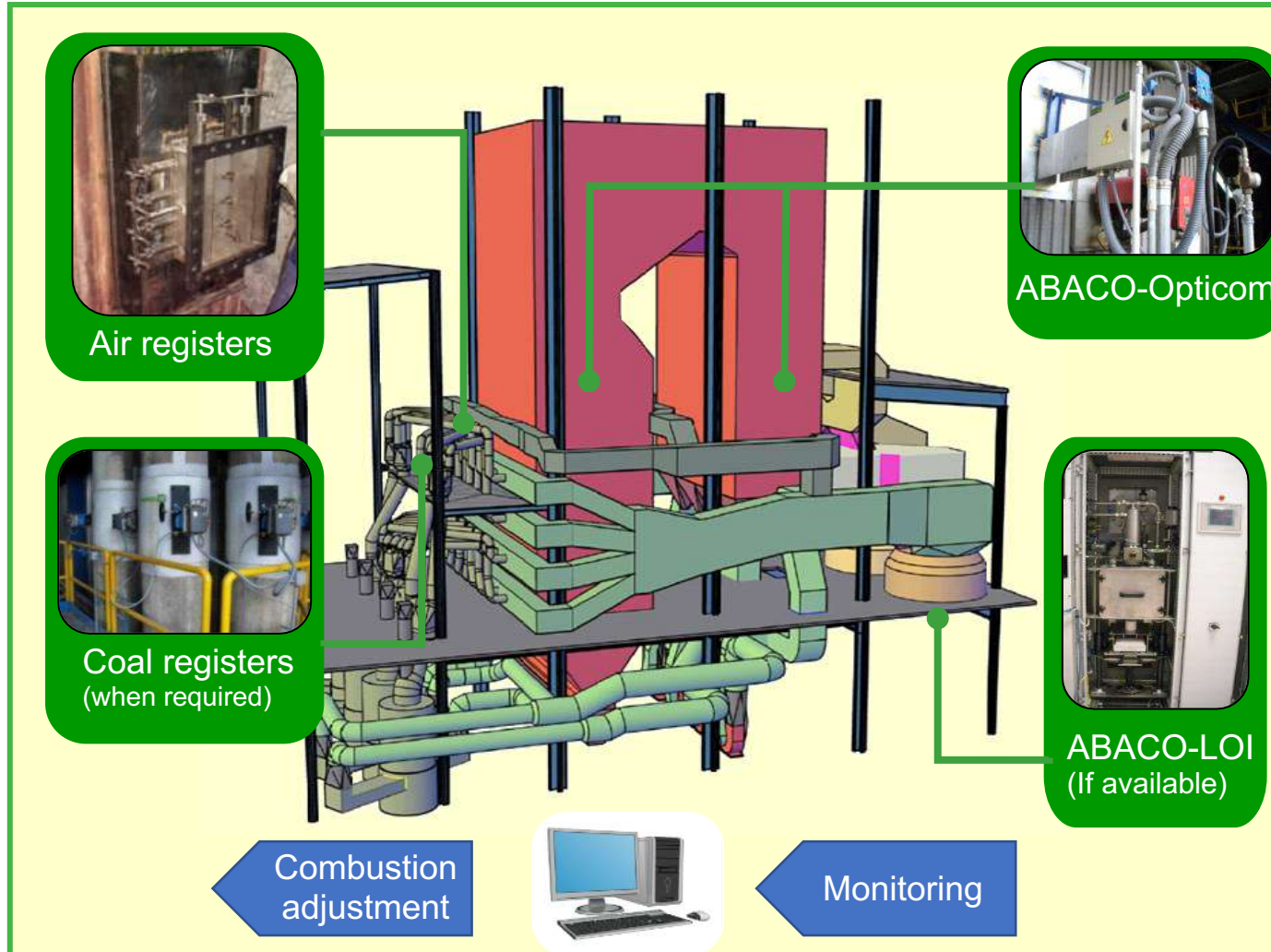
↑ Efficiency

FEGT control

No Corrosion
or slagging

↓ LOI

Combustion Optimizer & Analyzers



- **Advanced monitoring**
- **Closed-loop control**
- **Continuous tuning**

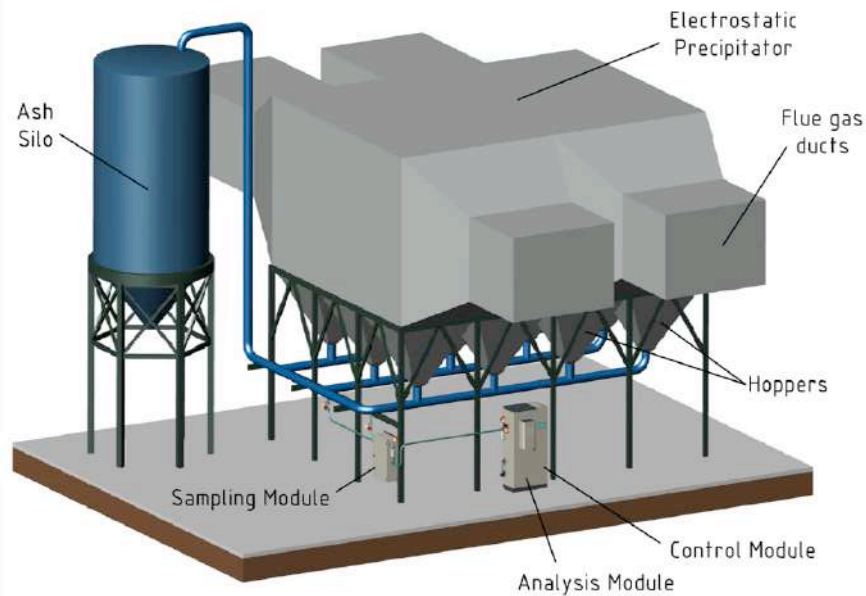
ABACO

PATENTED



BAT for NO_x reduction
and efficiency
improvement

Combustion Optimizer & Analyzers



ABACO

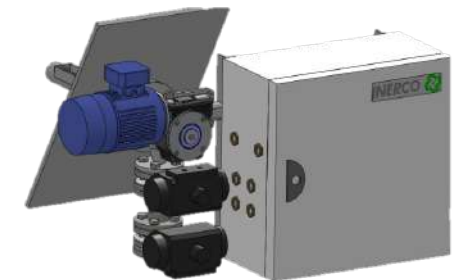
LOI

PATENTED

- Continuous measurement of **unburnt matter** (LOI) in fly-ash. Also applicable to the measurement of **coal properties**
 - Potential **fuel savings**
 - Guaranteeing **fly-ash saleability**
- Based on **reference techniques** (thermogravimetric analysis) similar to those used for **laboratory analysis**
 - No drift, **no calibration** required
 - **Unaffected by changes** in coal/fly-ash properties
 - Unaffected by interferences (NH₃, SO₃, etc.)

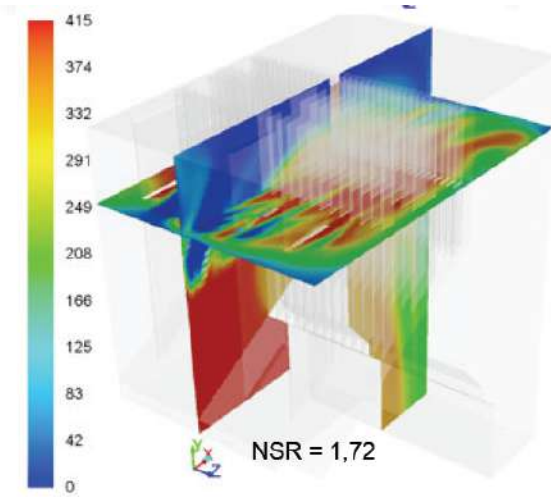


Analysis & Control Module

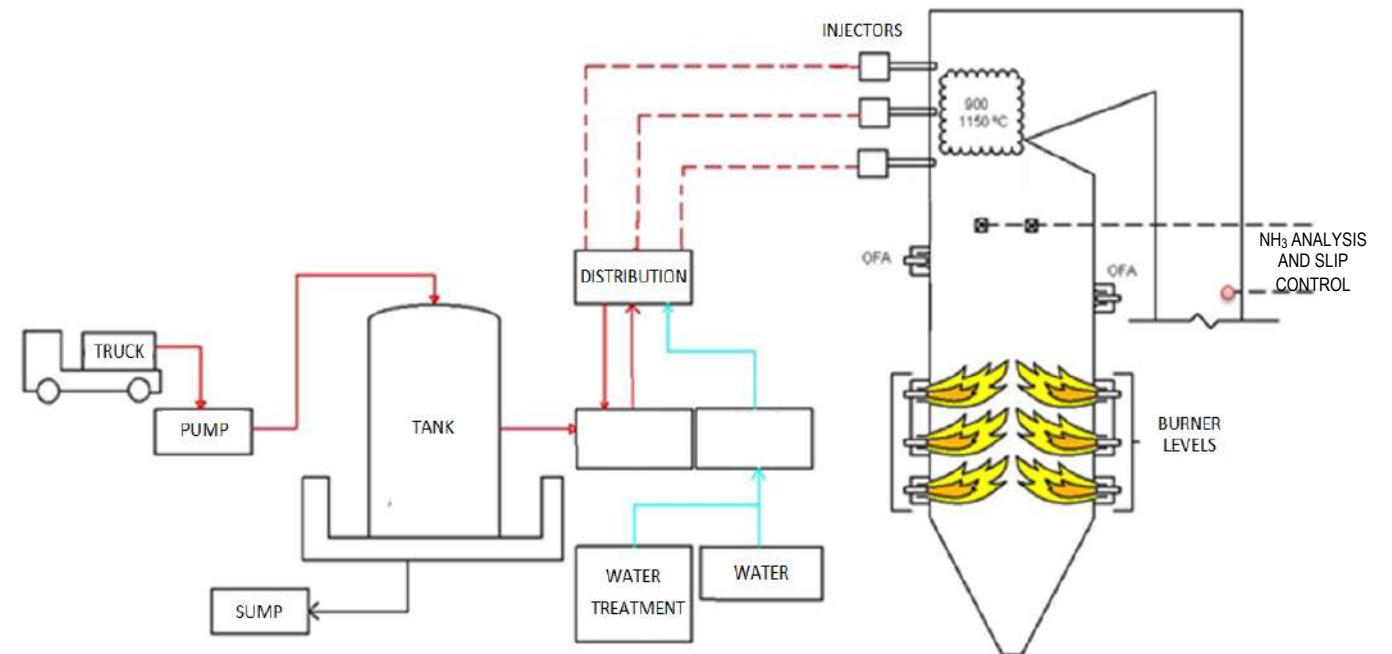


Sampling Module

SNCR: Selective Non-Catalytic Reduction



- Reagent injection at specific temperature window (900 – 1150 °C)
 - Ammonia or urea
 - Mixing & residence time
 - Ammonia slip control
 - Changing operating conditions (boiler load, excess O₂, BOOS) – Closed-loop control



SNCR Components

Combustion & Low NO_x Technologies

Scenario	Technologies	Relative Capital Cost (LNB =1)	NO _x reduction
600 mg/Nm ³	Combustion optimizer and/or minor furnace modifications	.25	< 25%
	Low NO _x burners (LNB)	1	< 40%
450 mg/Nm ³		1-1.25	< 50%
300 mg/Nm ³	LNB + Combustion optimizer and furnace modifications	1-1.5	< 60%
	LNB + SNCR	2-3	< 70%
100 mg/Nm ³	LNB + SCR	7-10	< 85%

Baseline Indian plants 700-900 mg/Nm³

Combustion & Low NO_x Technologies

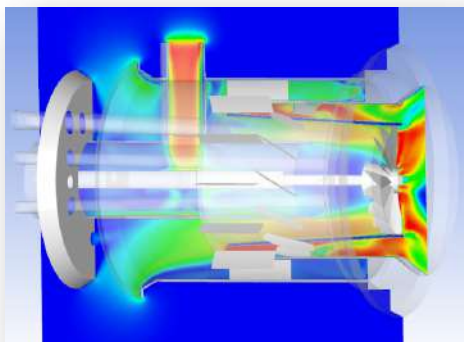


SERVICES

Combustion diagnosis &
Guarantee tests



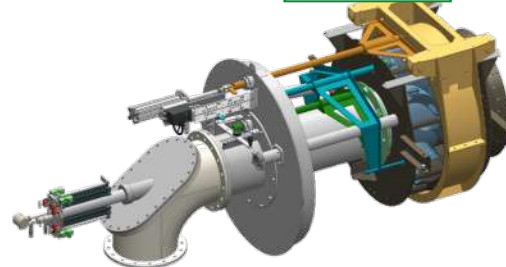
Consultancy



TECHNOLOGY

Boiler & Burners

LNB - OFA



Monitoring & Optimization




DeNO_x Abatement

SCR



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Relevant case study: Bocamina

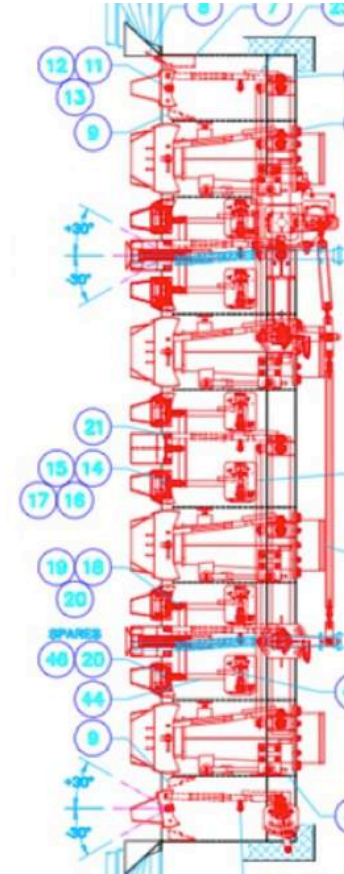
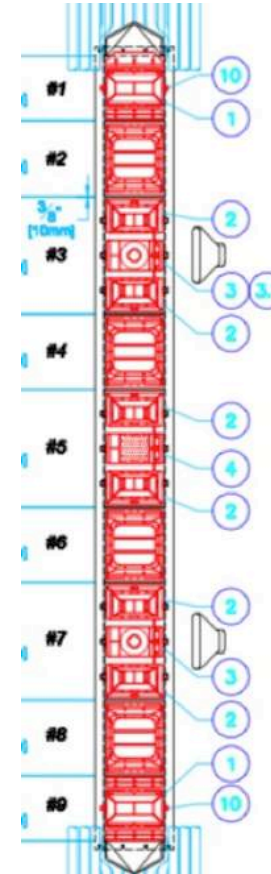
Bocamina Power Plant



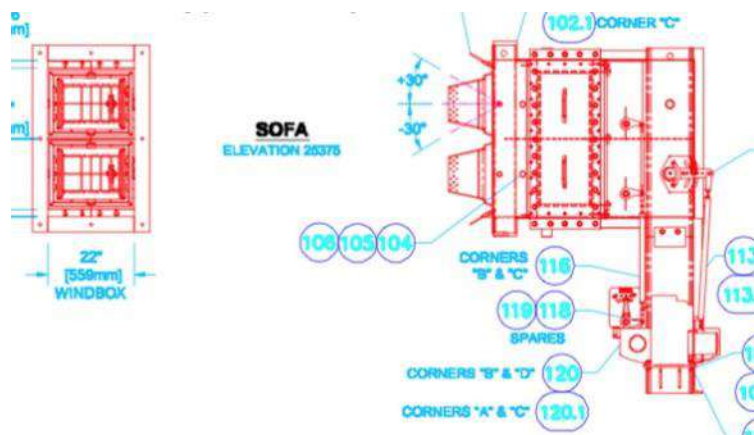
- Chile
- Utility: ENDESA Chile
- 127 MWnet
- Tangential-fired boiler
- 4 mills / 4 burner elevations
- NO_x baseline = 550 mg/Nm³
(d.b., 6%O₂)
- NO_x objective < 400 mg/Nm³

Relevant case study: Bocamina

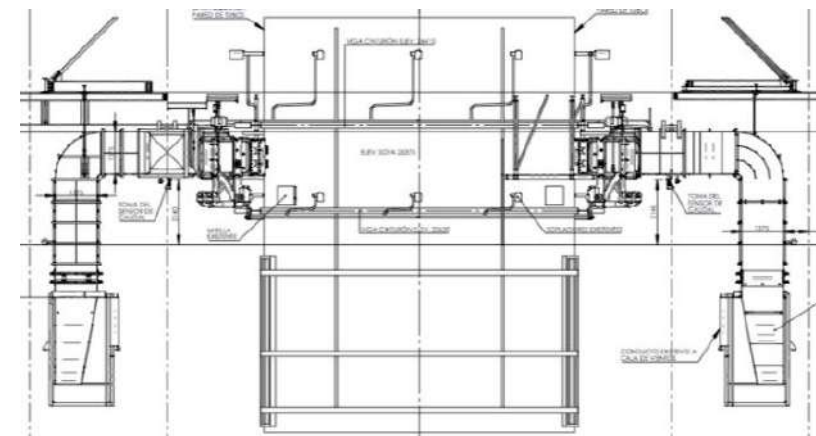
New LNB



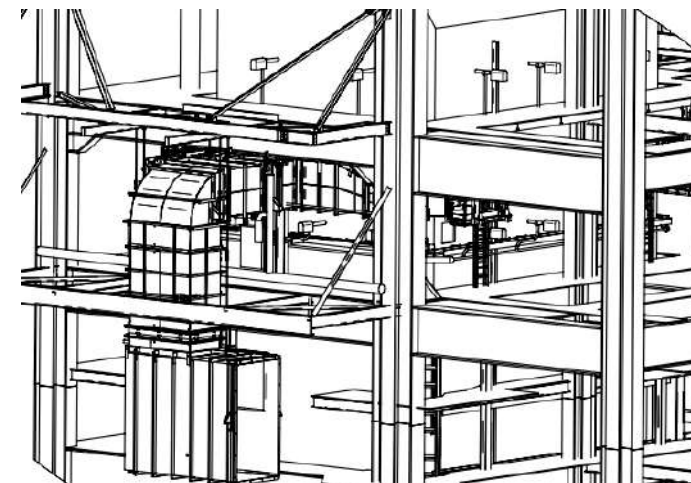
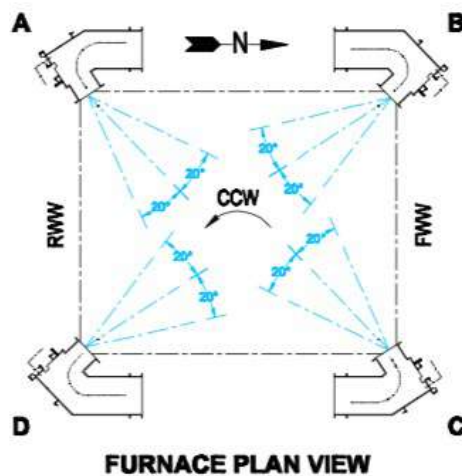
Relevant case study: Bocamina



Installation SOFA

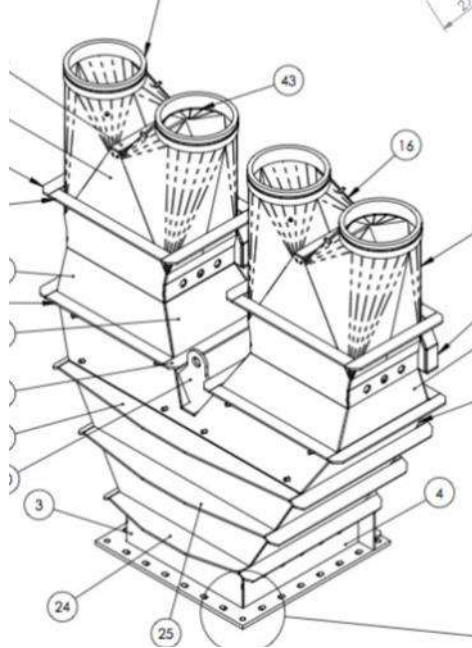


SOFA ducts

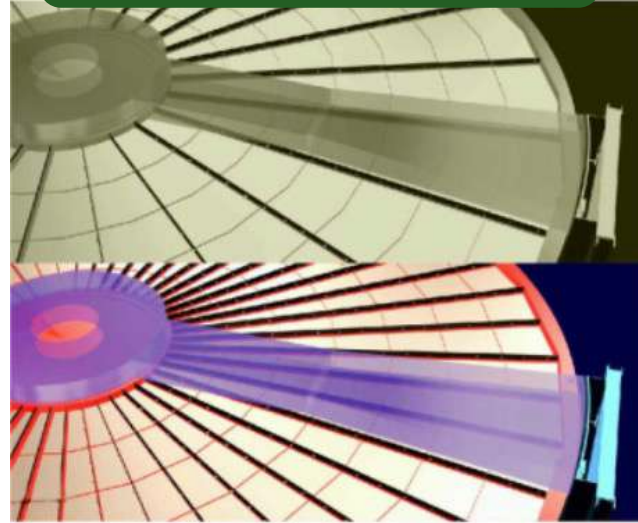


Relevant case study: Bocamina

Improving coal
distribution



Double sealing system
for APH



Installation cleaning
system for APH



Windbox modifications to improve
operation at minimum load

Relevant case study: Bocamina



Results

- NO_x emission achieved = **390 mg/Nm³**
only with 13% of OFA (but designed up to 25% capacity)
- CO < 100 ppm
- LOI not worsened
- Heat rate not worsened

Relevant case study: Lada

Lada Power Plant

- Spain
- Utility: IBERDROLA
- Gross power: **350 MWe**
- Opposed wall-fired boiler
- 5 mills / 5+5 burner elevations
- NO_x baseline = 700 mg/Nm^3 (d.b., 6% O_2)
- NO_x objective < 200 mg/Nm^3

Operating problems:

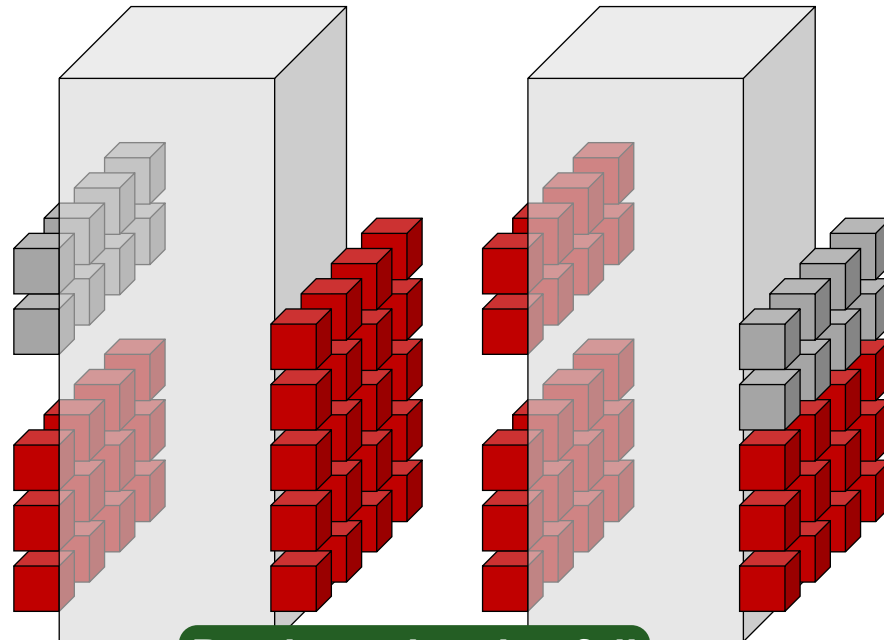
- Slagging close to the burners
- Top burners damaged
- Corrosion



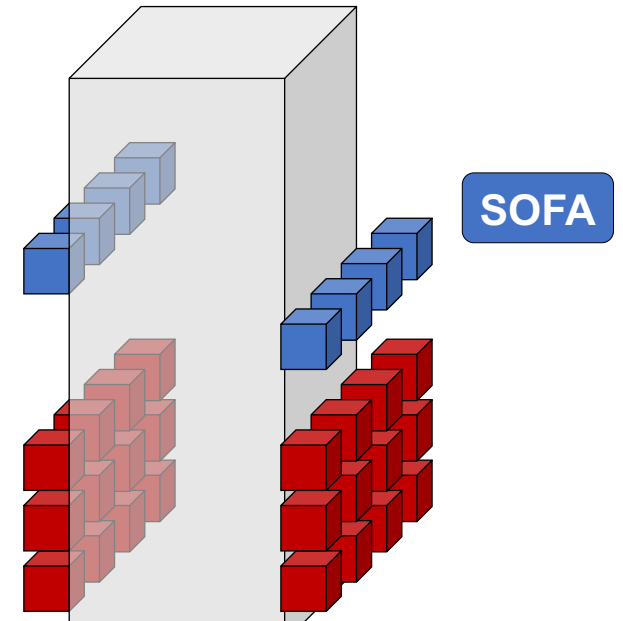
Relevant case study: Lada

FLEXICOM - LNB

Existing burner registers used as
SOFA – no need for new boiler
ports and SOFA ducting



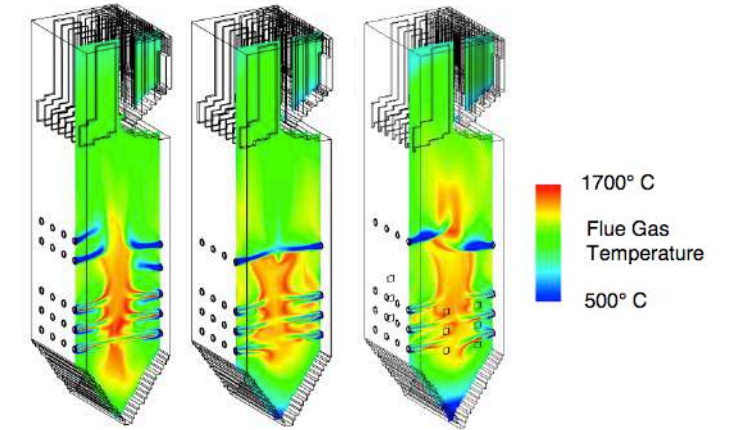
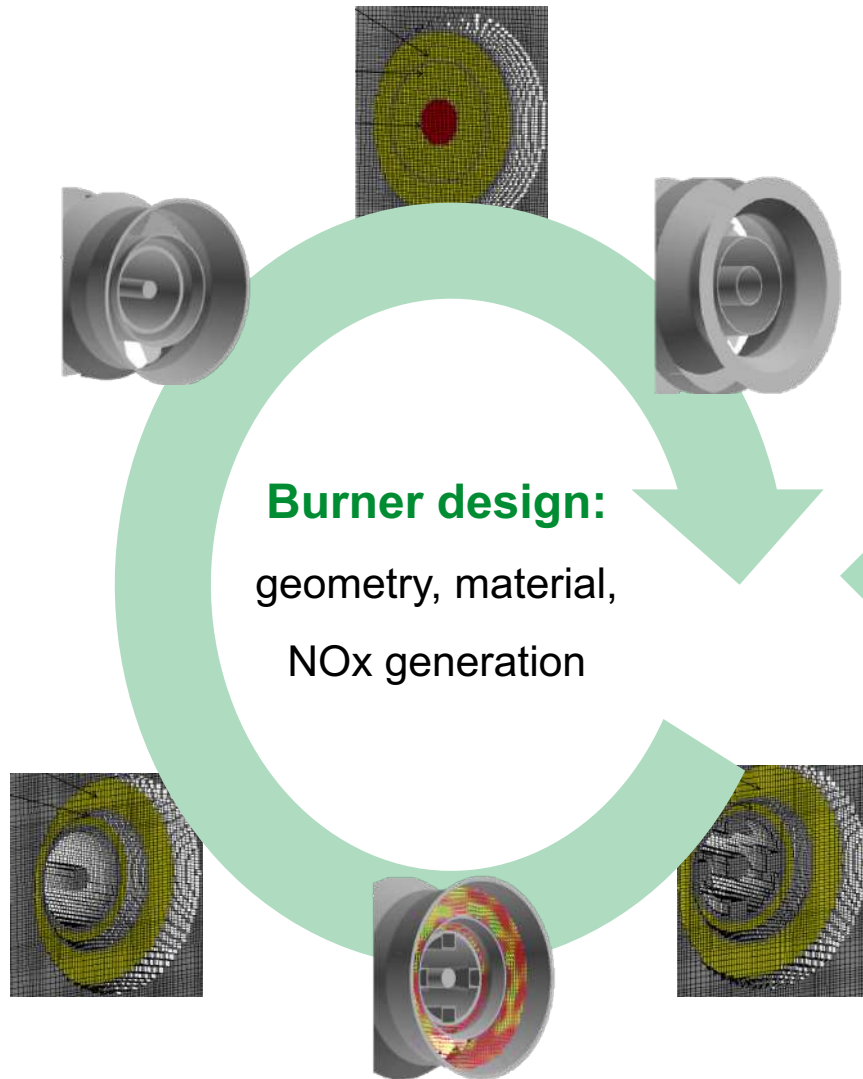
Previous situation full
load



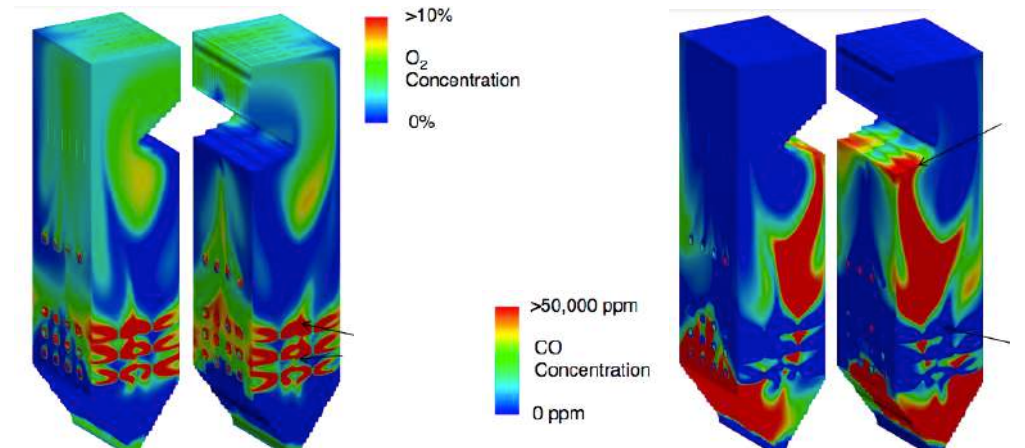
With FLEXICOM

Coal concentrated in lower levels,
independently of the mills in operation

Relevant case study: Lada

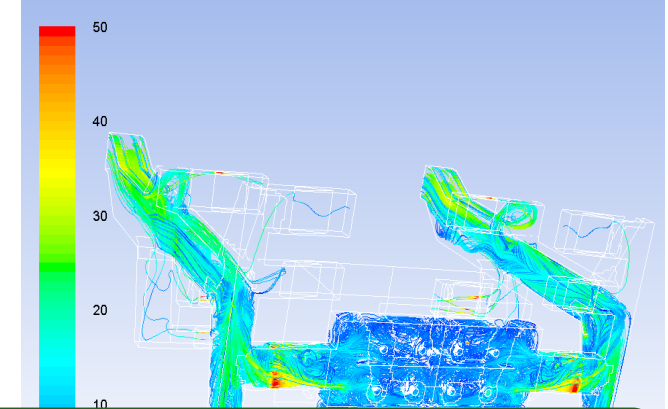
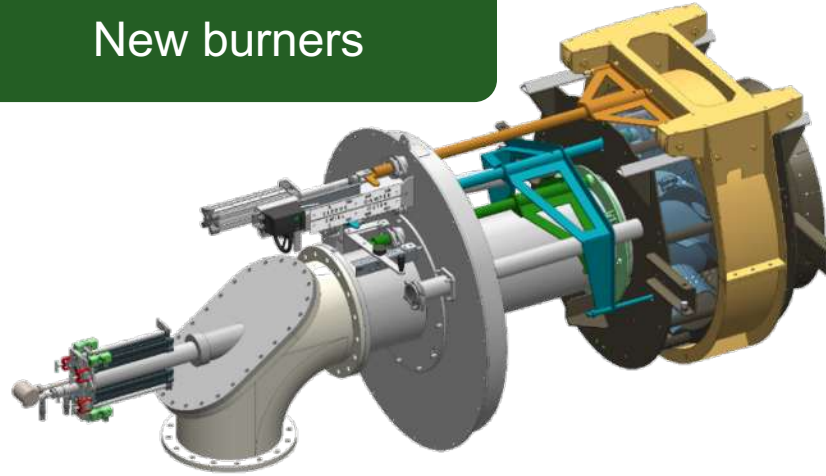


Furnace assessment: overall NOx generation, heat transfer, velocities, carbon-in-ash, CO generation, corrosion

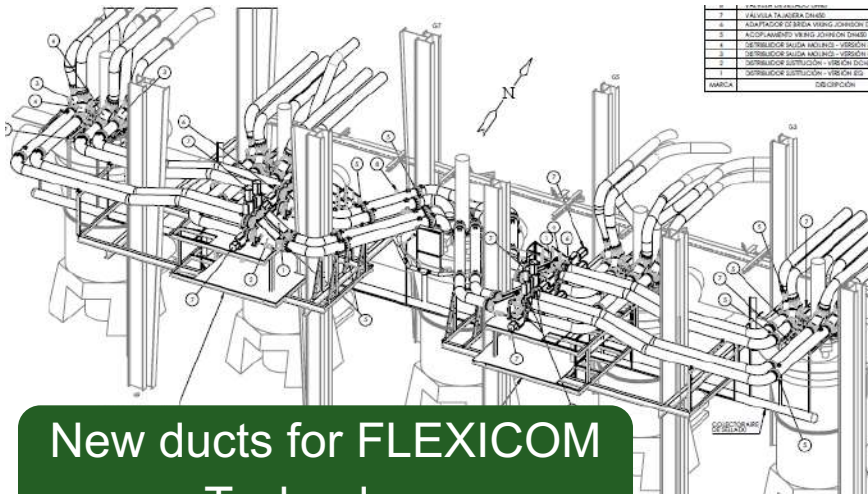


Relevant case study: Lada

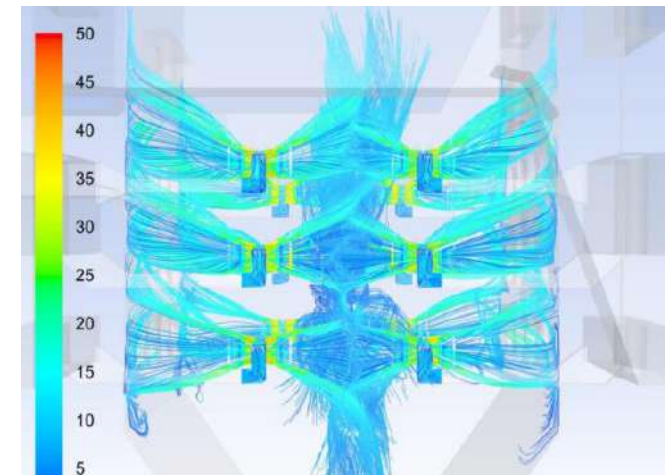
New burners



Retrofit of the windbox for the new burner configuration



New ducts for FLEXICOM Technology



Curtain air

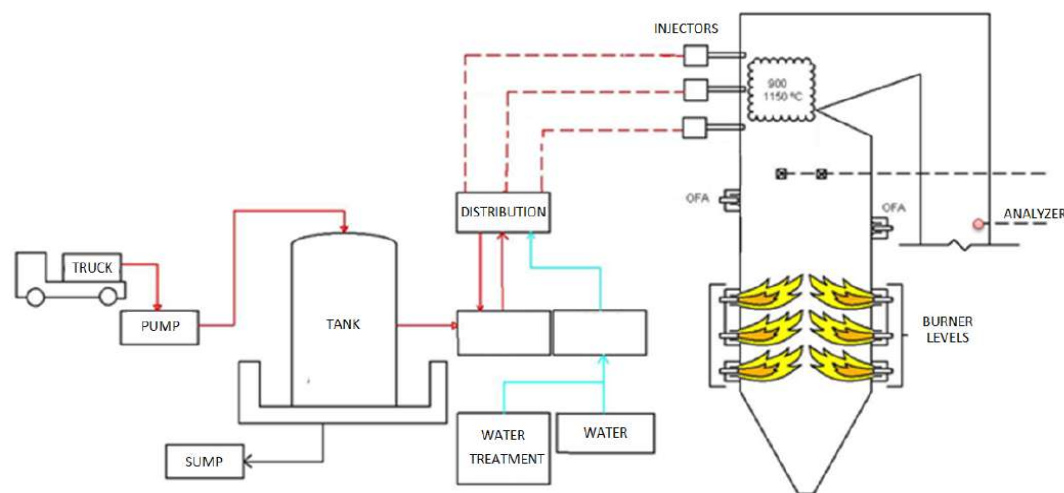
Relevant case study: Lada

SNCR

DISTRIBUTION SKID



WATER DILUTION SKID



ADDITIVE
SKID



STORAGE TANK

Relevant case study: Lada

Results

- NO_x baseline = 700 mg/Nm^3 (d.b., $6\% \text{O}_2$)
- NO_x emission only with Primary Measures = **240 mg/Nm^3**
- NO_x emission with PM and SNCR **$< 170 \text{ mg/Nm}^3$**



Other case studies



Los Barrios Power Plant

- **580 MWe**
- NO_x baseline = 800 mg/Nm^3 (d.b., 6% O_2)
- NO_x **result** < **450 mg/Nm^3**
- Technology: FLEXICOM-LNB



Battle River GS

- **405 MWe**
- NO_x baseline = $500 - 800 \text{ mg/Nm}^3$ (d.b., 6% O_2)
- **15 to 30%** NO_x reduction
- **0.5%** Heat rate improvement
- Technology: ABACO

Other case studies



Velilla Power Plant

- **360 MWe** (high ash coal)
- NO_x baseline = 2200 mg/Nm^3 (d.b., 6% O_2)
- NO_x **result < 490 mg/Nm³**
- Technologies: FLEXICOM-LNB, ABACO, Burner upgrade + OFA



Barranco & Granadilla

- **4 x 80 MWe**
- NO_x baseline = 420 mg/Nm^3 (d.b., 6% O_2)
- NO_x **result < 200 mg/Nm³** with PM
- NO_x **result < 150 mg/Nm³** with PM + SNCR
- Technologies: LNB + OFA, SNCR



Thanks for your attention

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