

EXPERIENCE OF LARGE RECOVERY BOILERS

Afonso Pereira, Brazilian Recovery Boiler Safety Committee ABTCP-CSCRB

BIG RECOVERY BOILERS OF BRAZIL AND URUGUAY, A PERFORMANCE COMPARISON AFTER MORE THAN 10 YEARS OF OPERATIONAL EXPERIENCE

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1. INTRODUCTION

This document intends to present the big recovery boilers of Brazil and Uruguay. The primary objective is to show the main challenges, problems, and solutions related to the situations and conditions that those users encountered over more than ten years of experience with these types of equipment. In this work, by definition, big boilers are those with more than 200 m² of furnace cross-sectional area. Using this concept, we have a total of 10 extra large recovery boilers in Brazil and Uruguay, the first one started in 2005 and the last one in 2017. There is one scheduled for 2021. Issues related to high availability during long campaigns (15 to 18 months), chloride and potassium removal and special construction material were also addressed.

2. PARTICIPANTS

Those 10 boilers are from 7 different companies and represent around 60% of total black liquor burned on Brazil and Uruguay. Typical values can be seen on the presentation attached.

3. RESULTS

After data collection, the presentation summarized our findings and main concerns.



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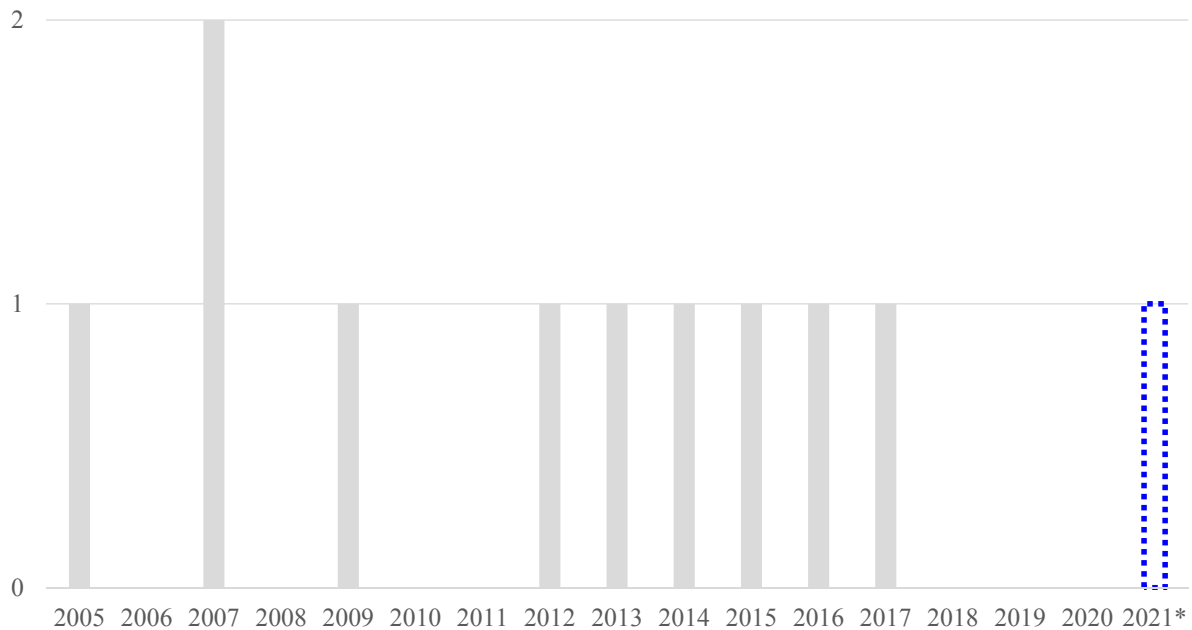
55th Anniversary International Recovery Boiler Conference



THE BIG BOILERS

- By definition, for this work, big recovery boilers are those with more than 200 m² of cross-sectional furnace area
 - There are 10 recovery boilers with these characteristics, 8 in Brazil and 2 in Uruguay
 - They are responsible for the burning of almost 60% of all the black liquor generated in these countries
 - 14 years of operational experience with these boilers
-

TIMELINE



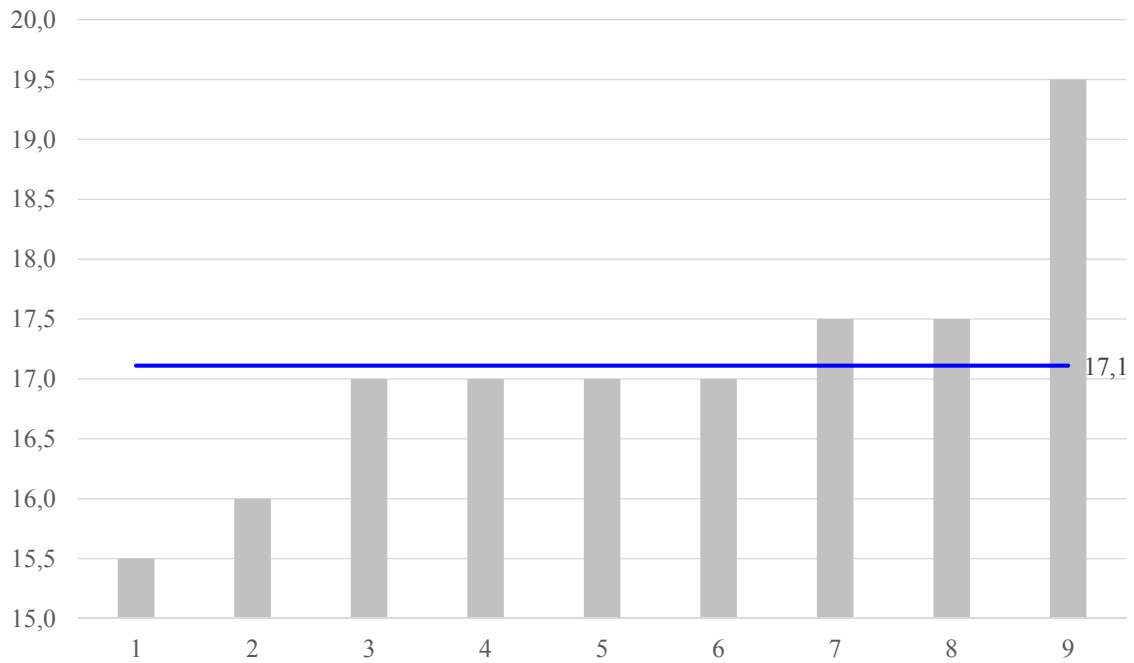
PARTICIPANTS

- 7 different companies in Brazil and Uruguay
- 9 mills exclusively eucalyptus pulp and 1 with eucalyptus and pine
- Kappa number: 17.1
- Alkali charge: 18.3%
- Ratio tss / ADTB: 1,5



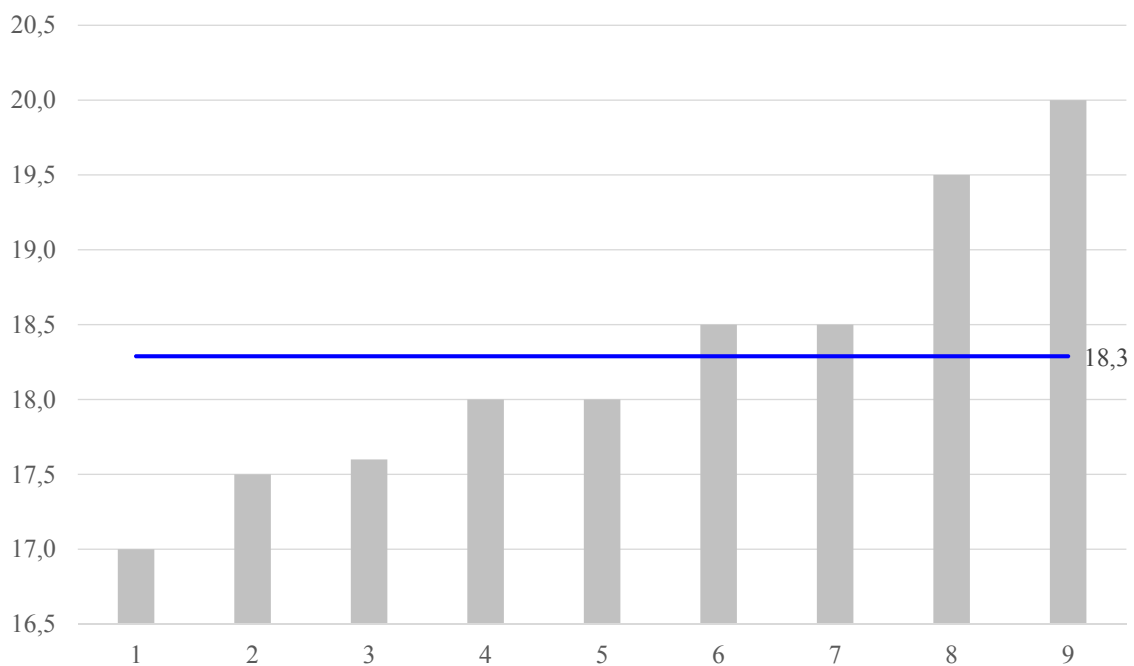
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KAPPA NUMBER



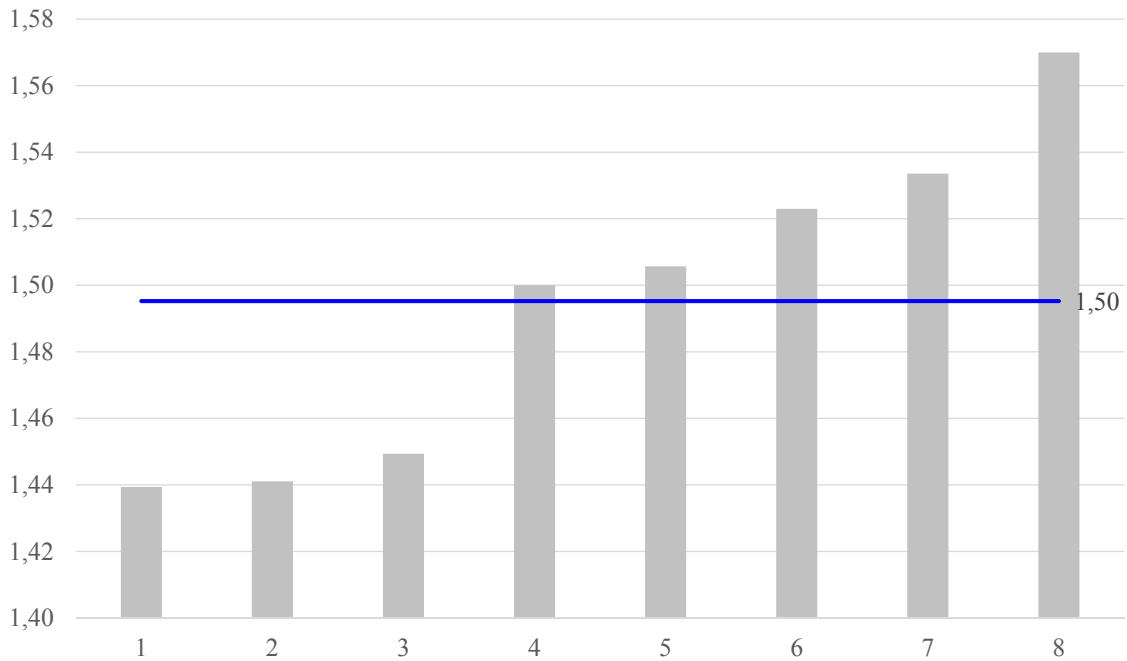
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ALKALI CHARGE





RATIO TSS/ADTB



VECTORS

- Analyzed variables:
 - Project Data
 - Operational values
 - Operation, inspection and maintenance
 - Events
 - Challenges

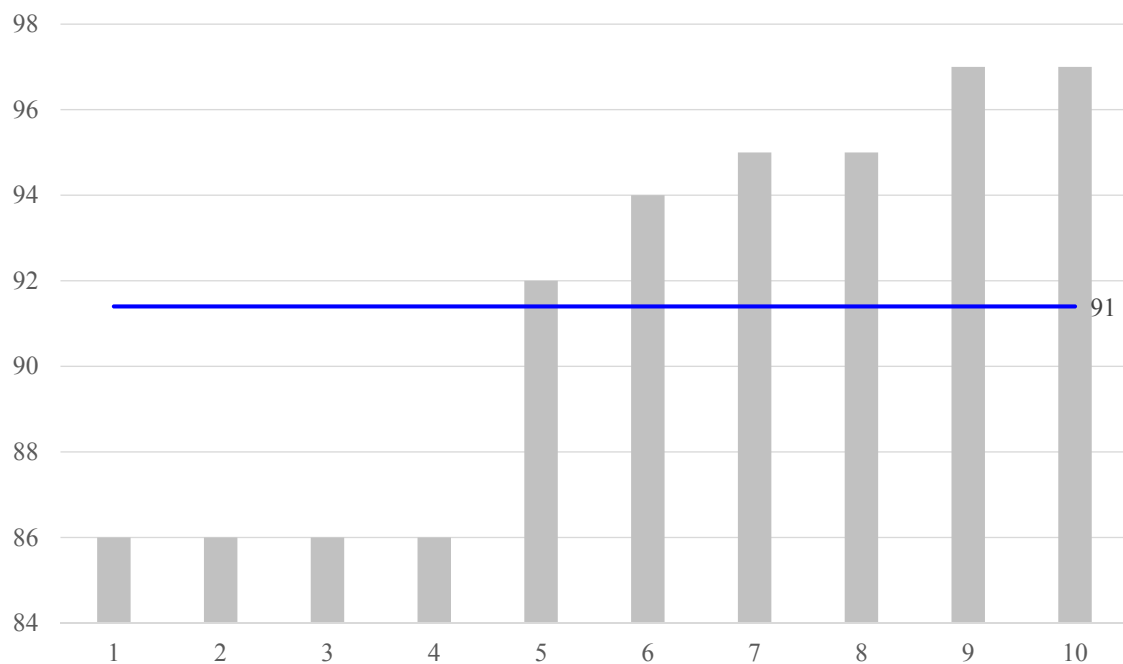


PROJECT DATA

- Pressure
 - Temperature
 - Net steam flow
 - Original capacity
 - Furnace Area
-



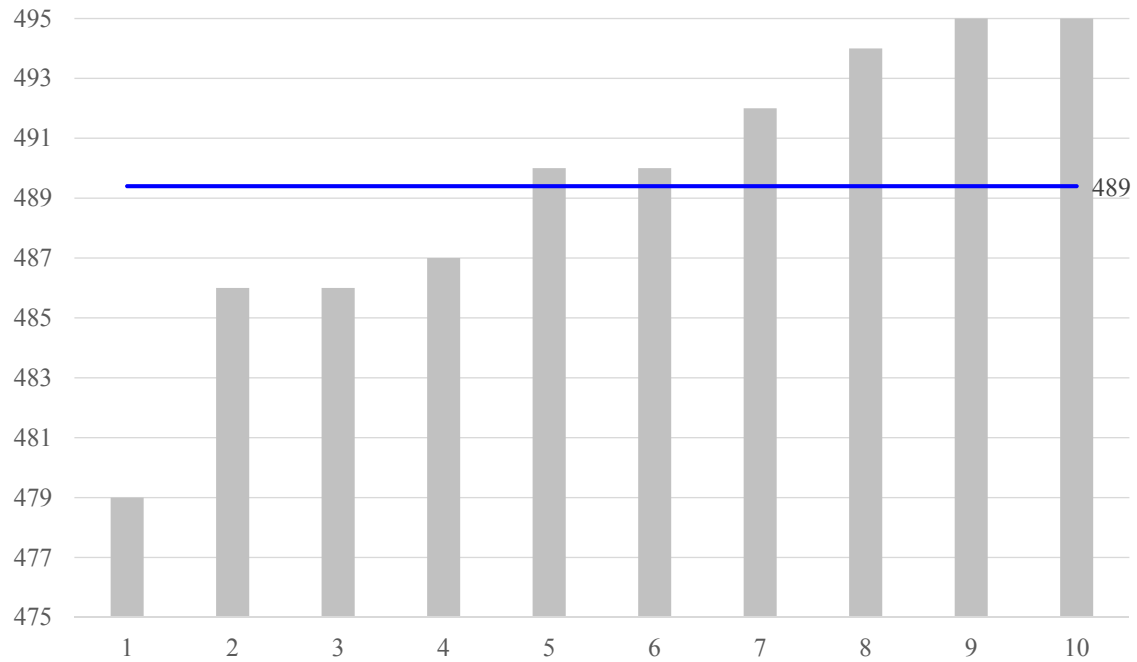
PRESSURE (Barg)





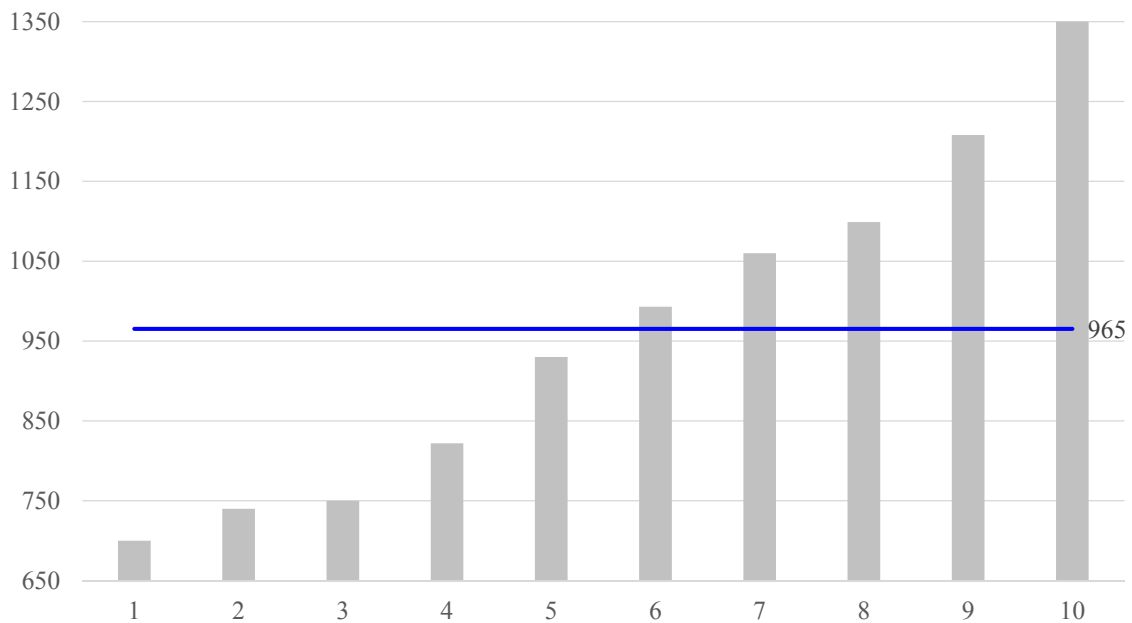
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TEMPERATURE (°C)



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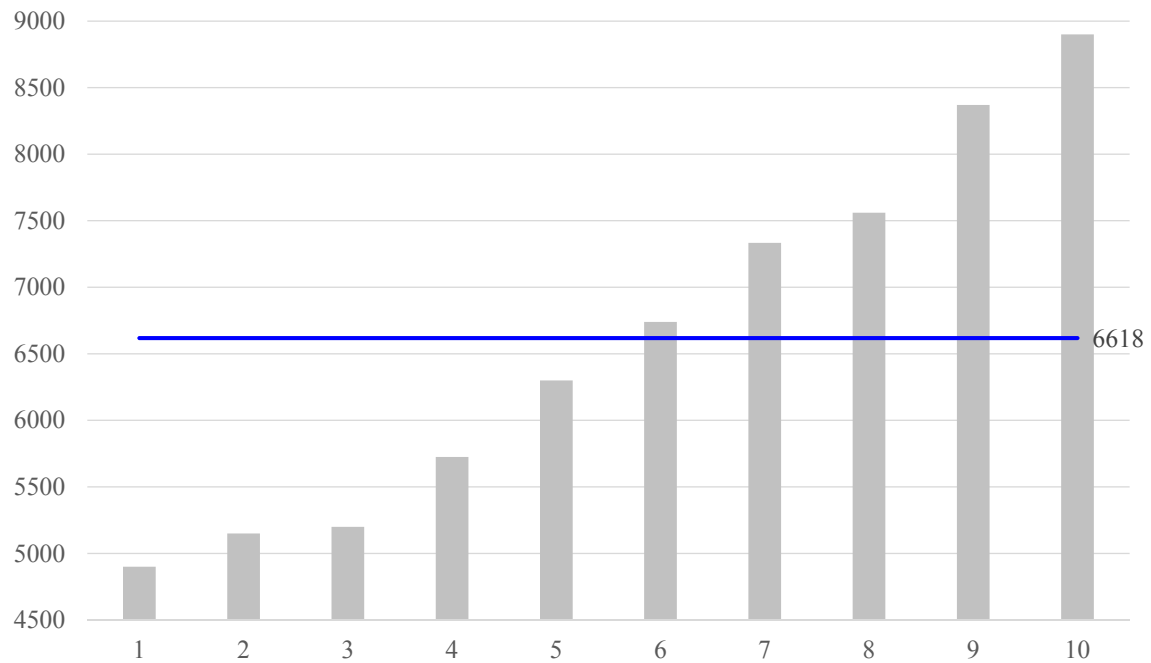
NET STEAM FLOW (t/h)





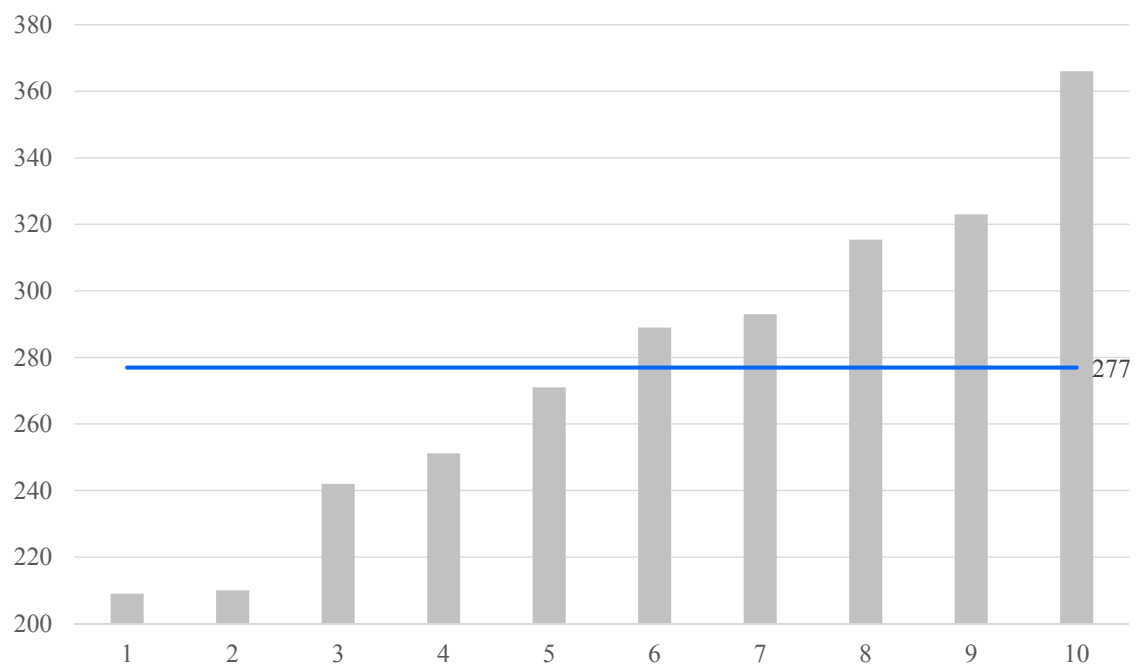
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ORIGINAL CAPACITY(tss as fired/d)



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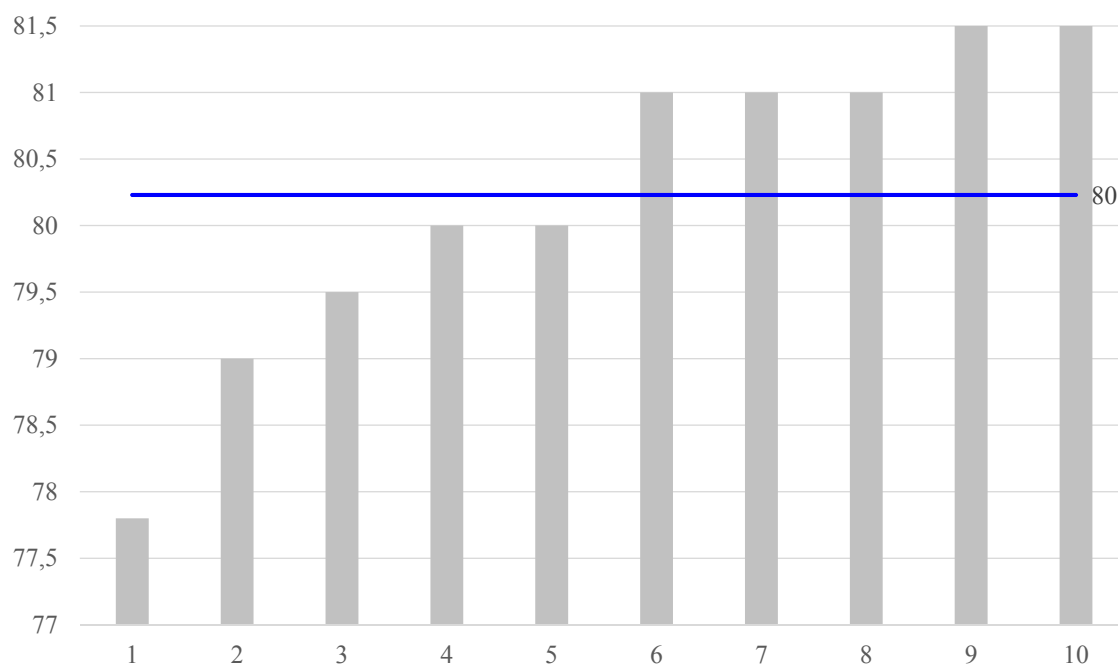
FURNACE AREA(m²)



OPERATIONAL VALUES

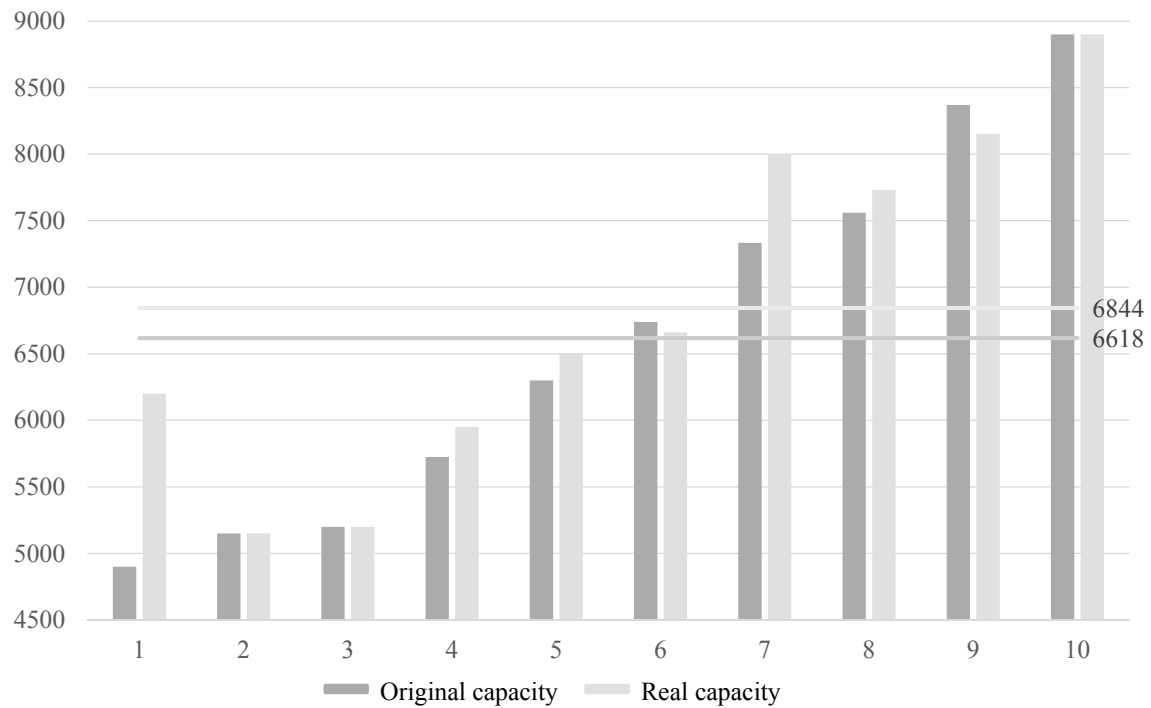
- Dry solids
 - Original x Real capacity
 - Specific furnace load
 - Steam to fuel ratio
-

DRY SOLIDS (%)

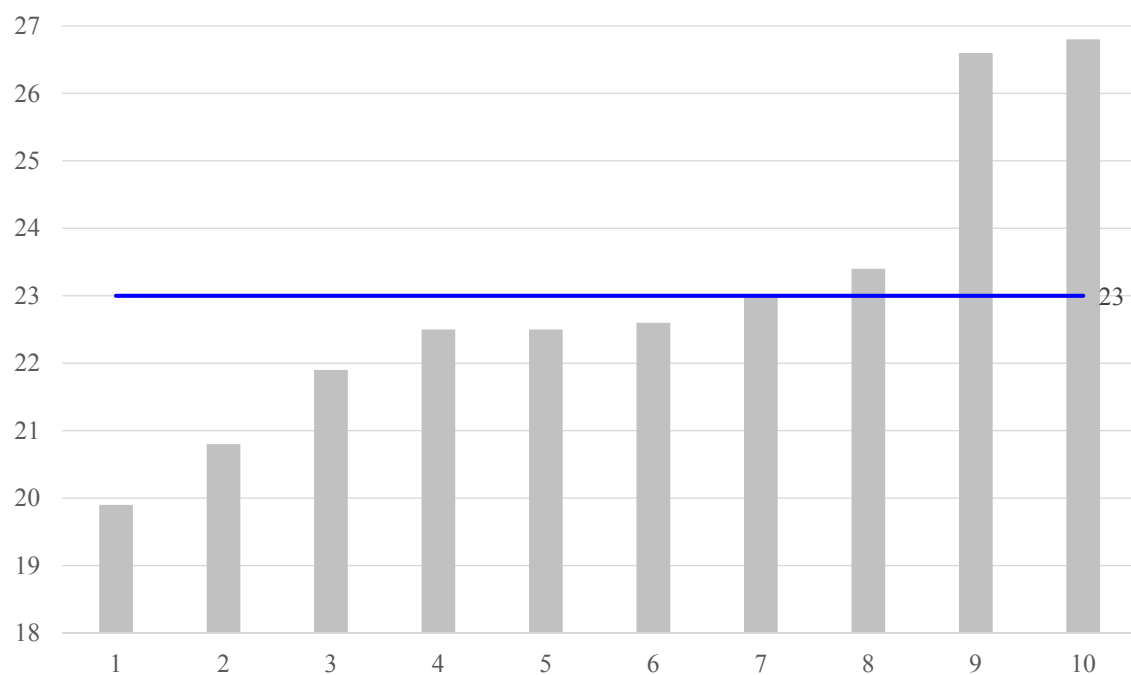




ORIGINAL X REAL CAPACITY (tss as fired/d)

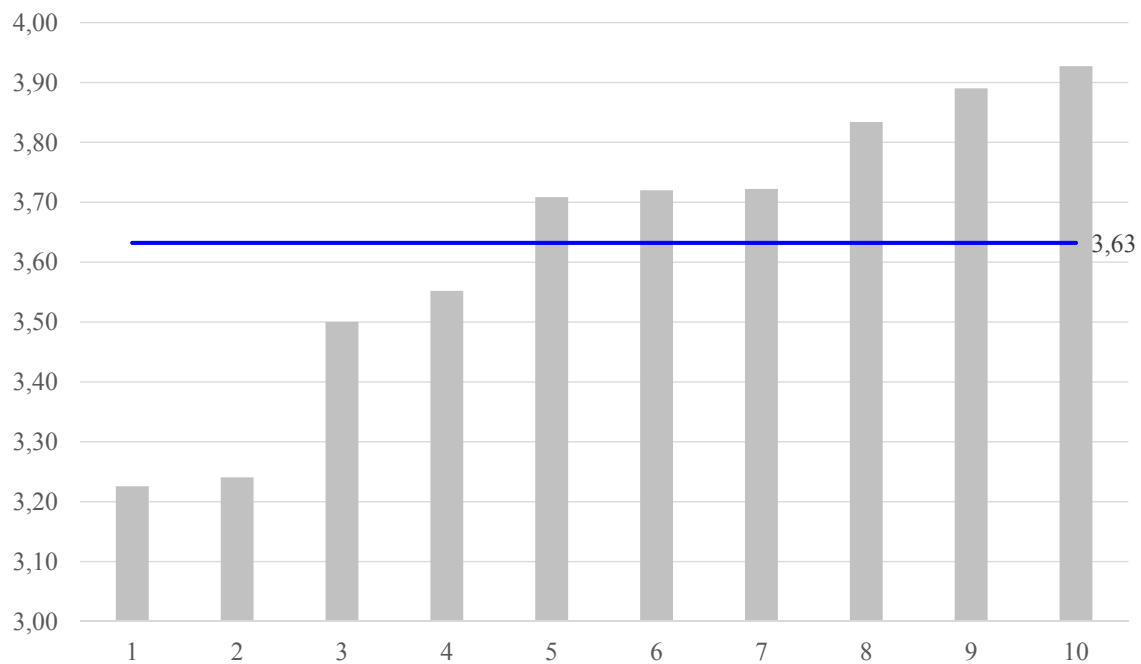


SPECIFIC FURNACE LOAD (tss virgin/m².d)





STEAM TO FUEL RATIO (t of steam/tss virgin)



OPERATION, INSPECTION AND MAINTENANCE

Air distribution

- Primary air: 23% of the total flow, with pressure of 1,5 kPa, 100% with automatic cleaners
- Secondary air: 43% of the total flow, with pressure of 3,25 kPa, 100% with automatic cleaners
- Tertiary air: 34% of the total flow, with a pressure of 4,55 kPa, 30% with automatic cleaners
- Only two boilers with online carryover detectors

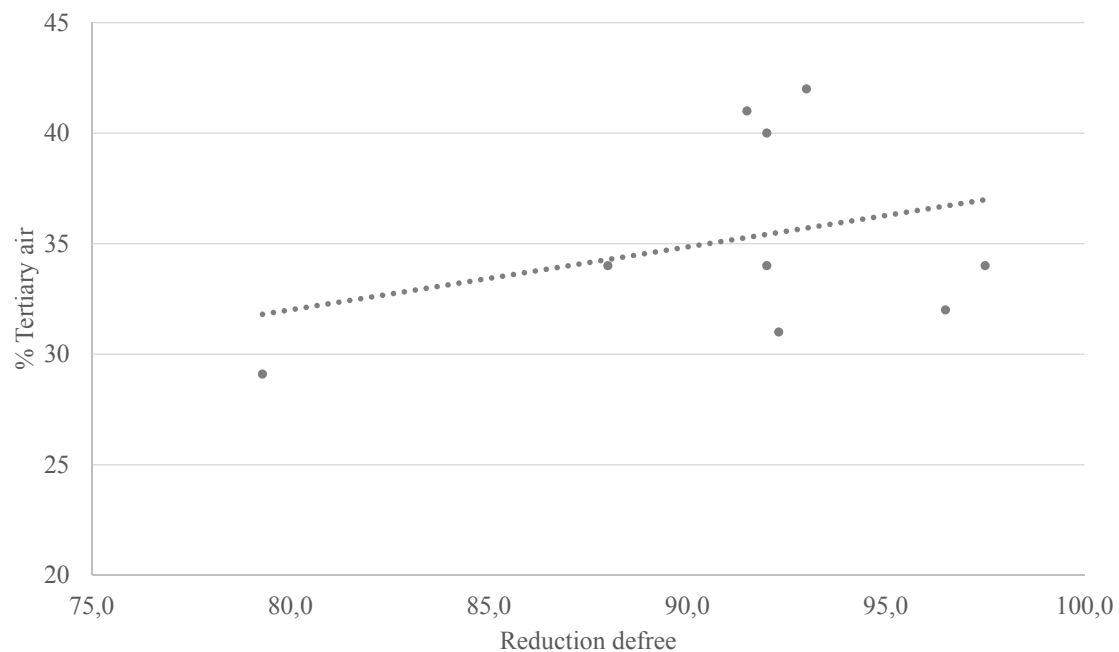


OPERATION, INSPECTION AND MAINTENANCE

- Reduction degree: High dispersion - the best correlation was found with the percentage of tertiary air



REDUCTION DEGREE





OPERATION, INSPECTION AND MAINTENANCE

- Liquor distribution: Many issues related with droplet size, distance traveled and burner durability
 - Liquor pressure: 1.8 barg
 - Liquor temperature: 140.1 °C
 - Superheating degree: 23.3 °C
 - Nozzle life cycle: From 5 to 120 days
 - Key factors: Boiler load, liquor speed and external cooling
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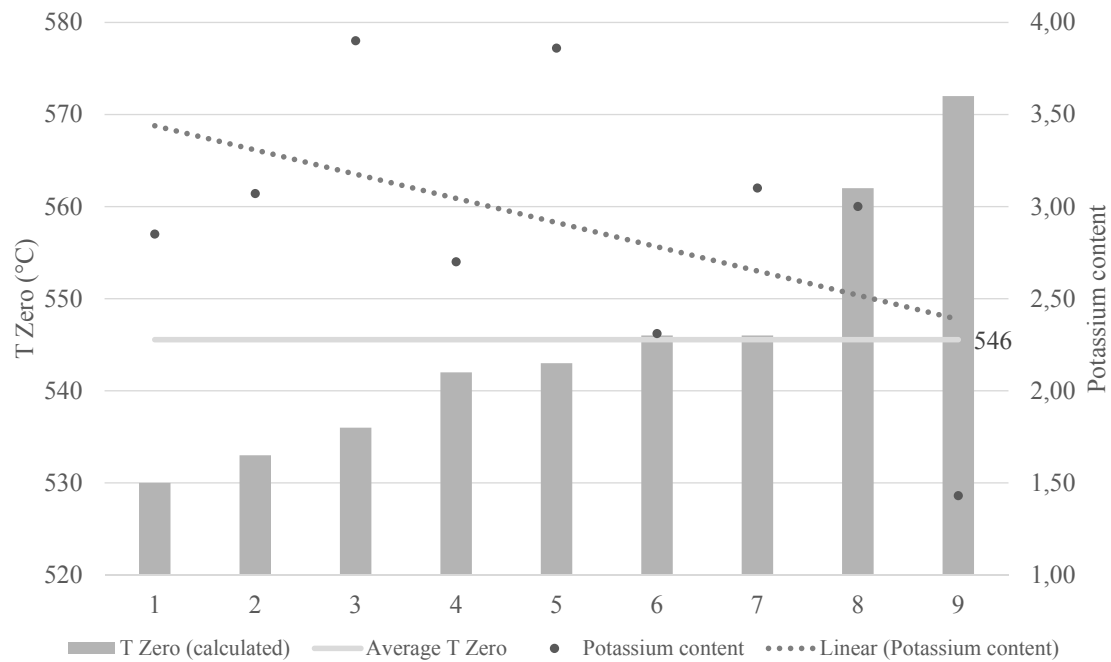


OPERATION, INSPECTION AND MAINTENANCE

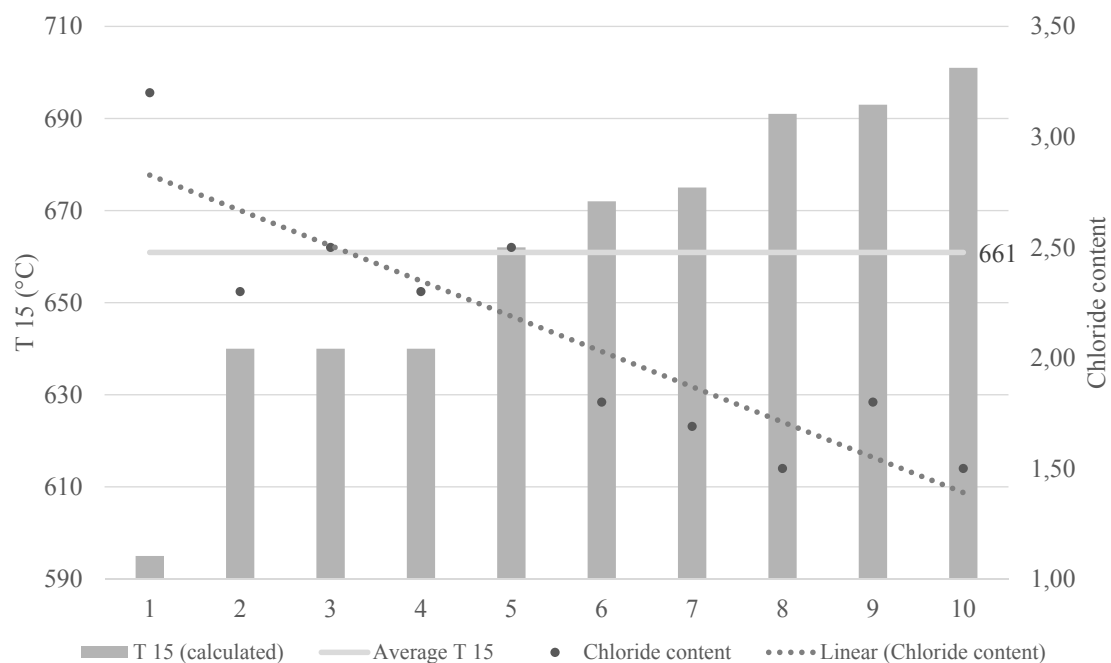
- Ash: 100% of the boilers treat the ash for chloride and potassium removal
 - Quantity treated: 289 t/d (around 50% of total ash)
 - Chloride content: 2.1%
 - Potassium content: 3.0%
 - Carbonate content: 21%
 - T zero: 546 °C
 - T 15: 661 °C
-



T ZERO AND POTASSIUM CONTENT



T 15 AND CHLORIDE CONTENT



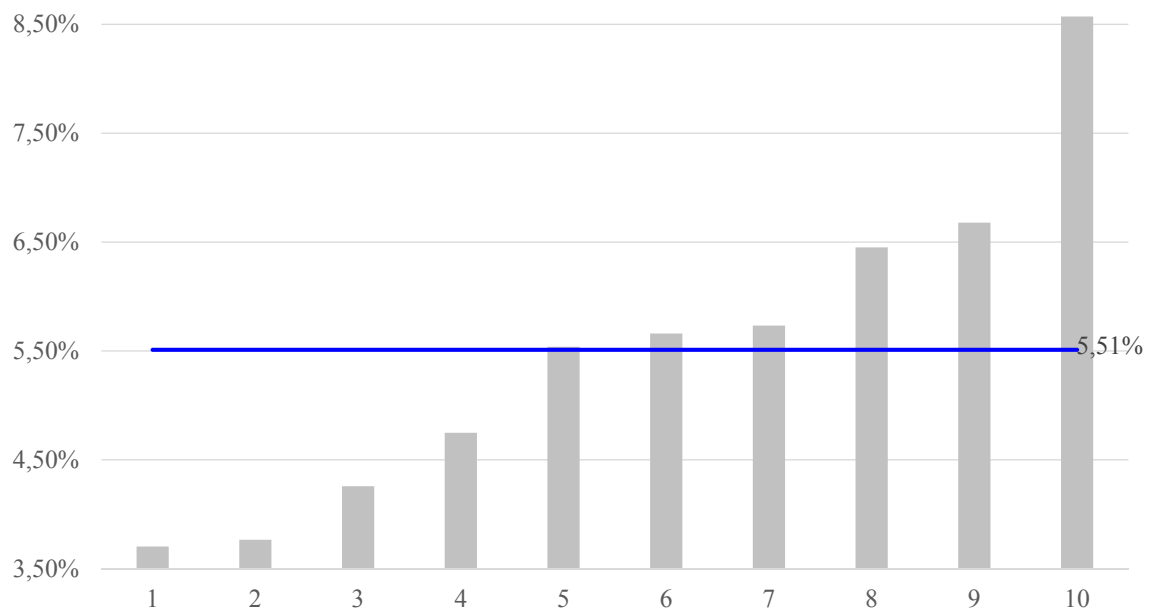


OPERATION, INSPECTION AND MAINTENANCE

- Sootblowers:
 - Pressure: 28 barg
 - Temperature: 321 °C
 - Flow: 51,7 t/h
 - Ratio: 5,5% of net steam flow
 - Number of sootblowers: 112
 - APC together with ash treatment are key issues to decrease such number
-



SOOTBLOWER SPECIFIC STEAM CONSUMPTION(%)





OPERATION, INSPECTION AND MAINTENANCE

Emissions:

- No problems with TRS and SOX emissions
 - No problem with particulate emissions - 44 ppm
 - NO_x value: 202 mg / Nm³, potential medium-term problem, technology using SNCR / SCR may be the future
-



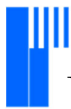
OPERATION, INSPECTION AND MAINTENANCE

- Special procedures after unexpected shutdowns are essential to decrease superheater failures (condensate issues)
 - Long cooling times due to the smelt inventory in case of ESP's- We had an ESP with 169 requested hours for cooling
-



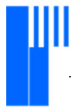
OPERATION, INSPECTION AND MAINTENANCE

- Boiler general shutdown (GSD) time is the same although boilers are bigger and bigger. A GSD usually lasts 8 days from liquor to liquor
 - Pressure parts without access for inspection, mainly economizer
 - Sootblower lances life cycle follow-up procedures need to be improved
 - The high number of companies involved in the GSD brings more complexity to such activity.
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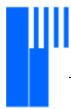
EVENTS

- 39 events:
 - 25 leakages
 - 4 accidents
 - 10 water contaminations
-



LEAKAGES

- 25 leakages
 - 10 on the economizer
 - 5 on the boiler bank(w/ 1 ESP)
 - 4 on the superheater
 - 6 on the lower furnace (w/ 3 ESP)
-



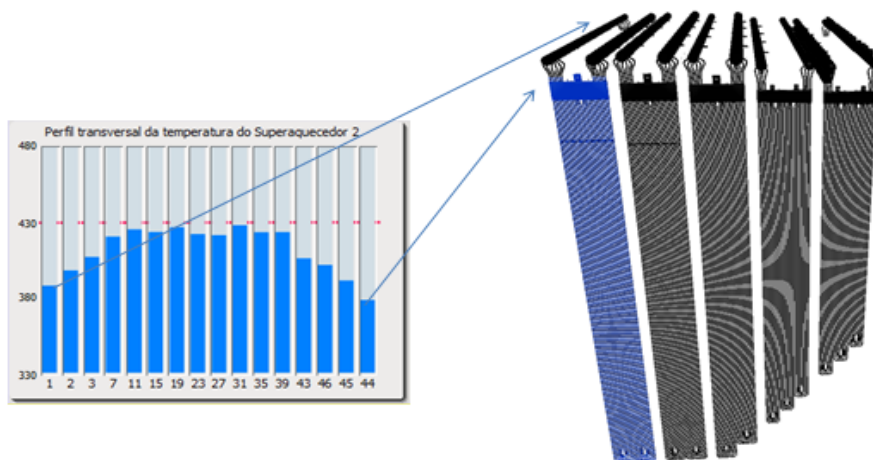
LEAKAGES

- Leakage detector: Installed in 50% of the recovery boilers - They were not protagonists in the reported events.
-

LEAKAGES

- Superheater materials - T zero and temperature profile
 - Economizer inspections and repairs - No access
 - Vibration – Sootblower pressure
 - Frozen smelt removal during GSD - Hidroblast x mechanical removal (manual tools)
-

SUPERHEATER TEMPERATURE PROFILE





VIBRATION- SOOTBLOWER ON THE SH



ACCIDENTS

- 4 accidents
 - Explosion related with GNCD
 - Explosion related with fuel oil
 - Ash hopper failure during waterwash on a GSD
 - Mechanical damage to screen tubes

ACCIDENTS

- Screen x lumps
 - Hoppers mechanical resistance – What is the design maximum load for an hopper?
-

HOPPER FAILURE





WATER CONTAMINATION

- 10 boiler feedwater contamination
 - Eliminate occurrences of contamination of boiler feedwater either by the correct analysis of potential risk situations, by HAZOPS and/or other tools, or by intrinsic safeguards of the boiler by the use of correct instruments and more restrictive controls for these situations at the boiler
-



CHALLENGES

- Increase the time between GSD's:
 - Uruguay: 18 meses
 - Brazil: Legal limitation of 15 months or up to 24 with in house dedicated team for inspections (SPIE)
 - What are the limits of other areas? Would they get bigger campaigns?
-



BIGGER CAMPAIGNS

- Smelt spouts on bigger boilers have a more comfortable situation due to the smaller load gradients
 - Inspections on smelt spouts with an 18-month campaign prove that such elements will not be a problem for longer campaigns
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CHALLENGES

- When will the maximum capacity limit for a recovery boiler be reached, such as lime kilns and drying machines?
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THANKS FOR YOUR TIME

