Petrobras using Topsøe SNOX™ sulphuric acid technology for flue and sour gas treatment in the new RNEST oil refinery in Pernambuco, Brazil

RESEARCH | TECHNOLOGY | CATALYSTS

COBRAS 2013, Brazil. Rodrigo Lavich, Petrobras and Torben Christensen, Haldor Topsøe

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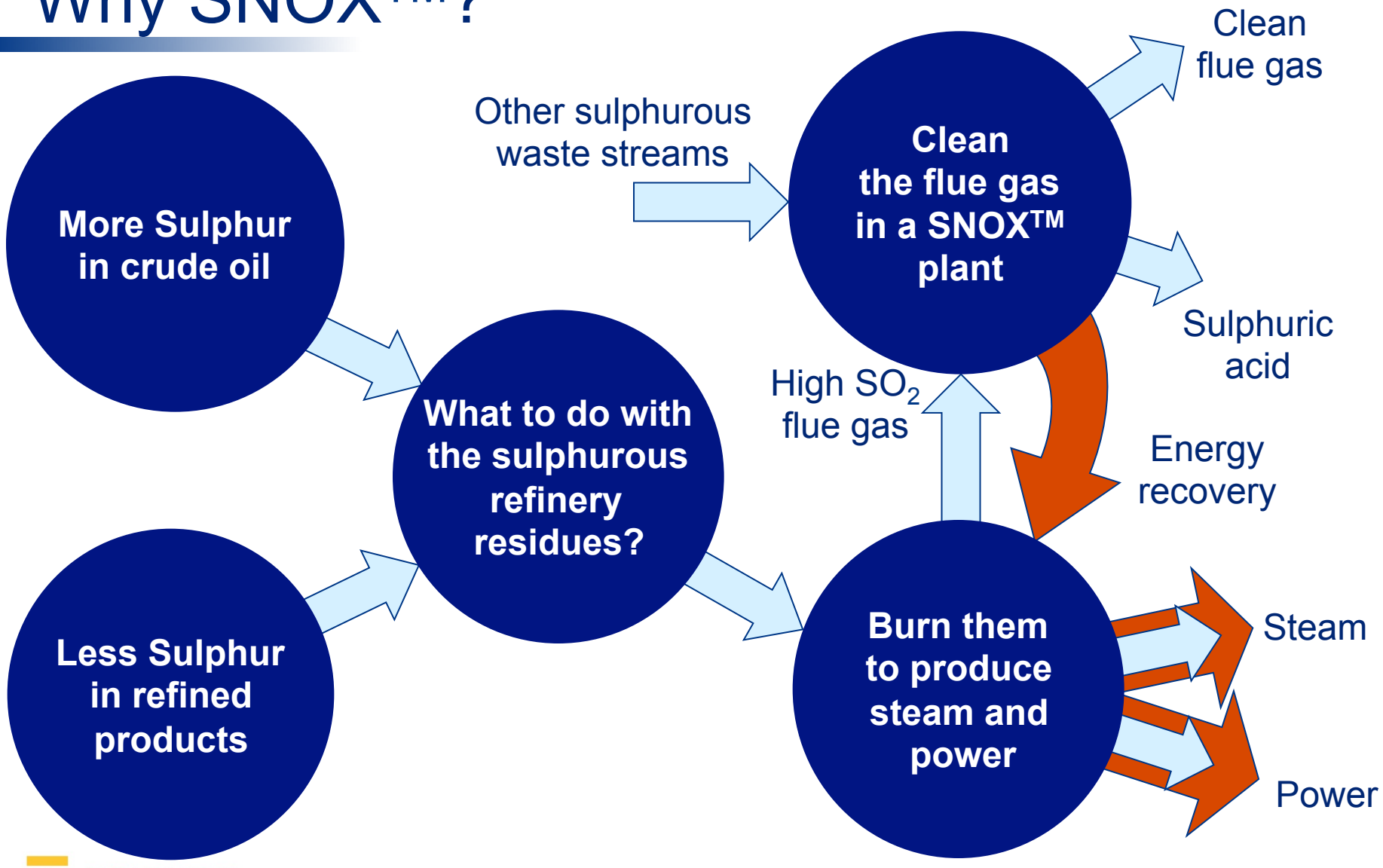
Presentation - main contents

- Introduction to the SNOX™ technology / similar WSA
- The SNOX™ process for treating SO_2 gases
- The Petrobras integrated solution
- Why PETROBRAS chose a technology like SNOX™
- SNOX™ environmemtal performance and the Brazilian regulation
- Sulphuric acid in Petrobras
- SNOX™ contribution to the energy balance in the refinery
- Pictures from installation at site

SNOX™ technology - “the concept”

- Converts SO_2 in flue gases into commercial-grade sulphuric acid
- Reduces NOx in flue gases into harmless N_2
- No consumption of chemicals or other additives
- No production of waste products
- Simple, efficient and reliable SO_2 and NOx treatment process
- Increases power plant thermal efficiency by additional energy recovery

Why SNOX™?



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SNOX™ for combustion of petcoke and heavy residue oil in boilers

Combustion of petcoke
or residual oil

O_2
N_2
CO_2
H_2O
SO_2
SO_3*
NOx
VOC
C
V_2O_5*
NiO*

SNOX™

Cleaned gas

Dry dust

Sulphuric acid

*) Troublesome compounds in conventional FGD

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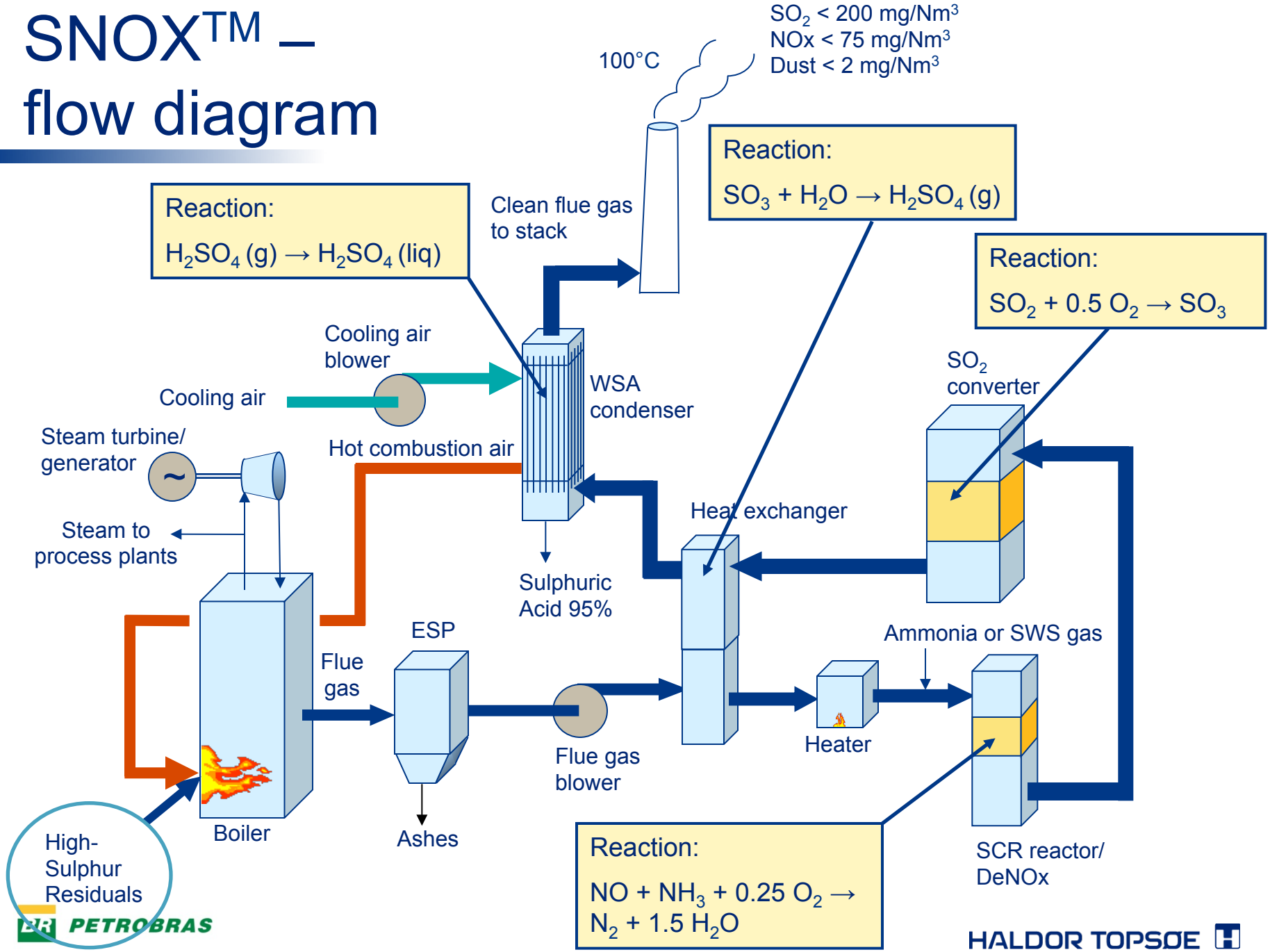
SNOX™ – flow diagram



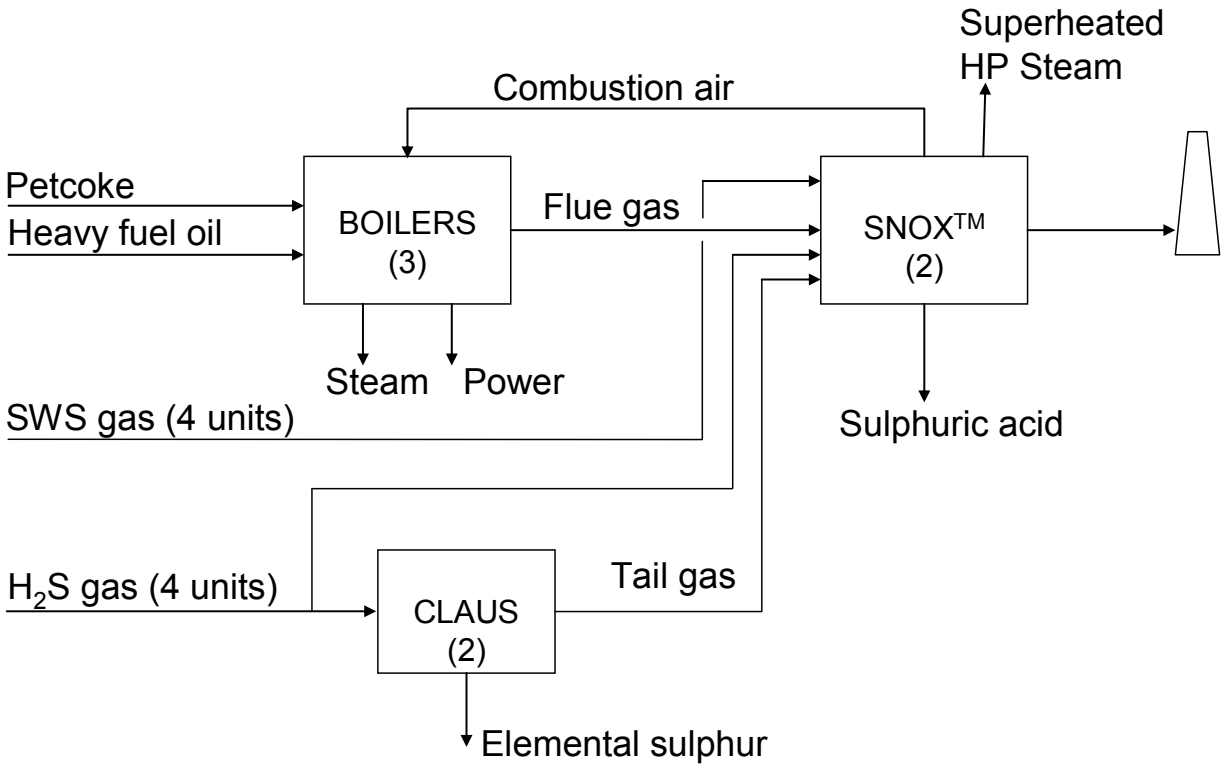
The advantages of taking refinery waste gases (H_2S and SWS) to SNOX™ plant

- Reduced requirement for fuel gas
- Smaller or no Claus plant required
- Direct production of more valuable product
- No problems with high content of NH_3 in SWS gas
- No problems with fluctuating hydrocarbons content in SWS gas
- Direct utilization of heat from H_2S gas and SWS gas for HP steam generation
- Limited CO_2 emission as there is no gypsum formation
- Better fuel economy in boiler

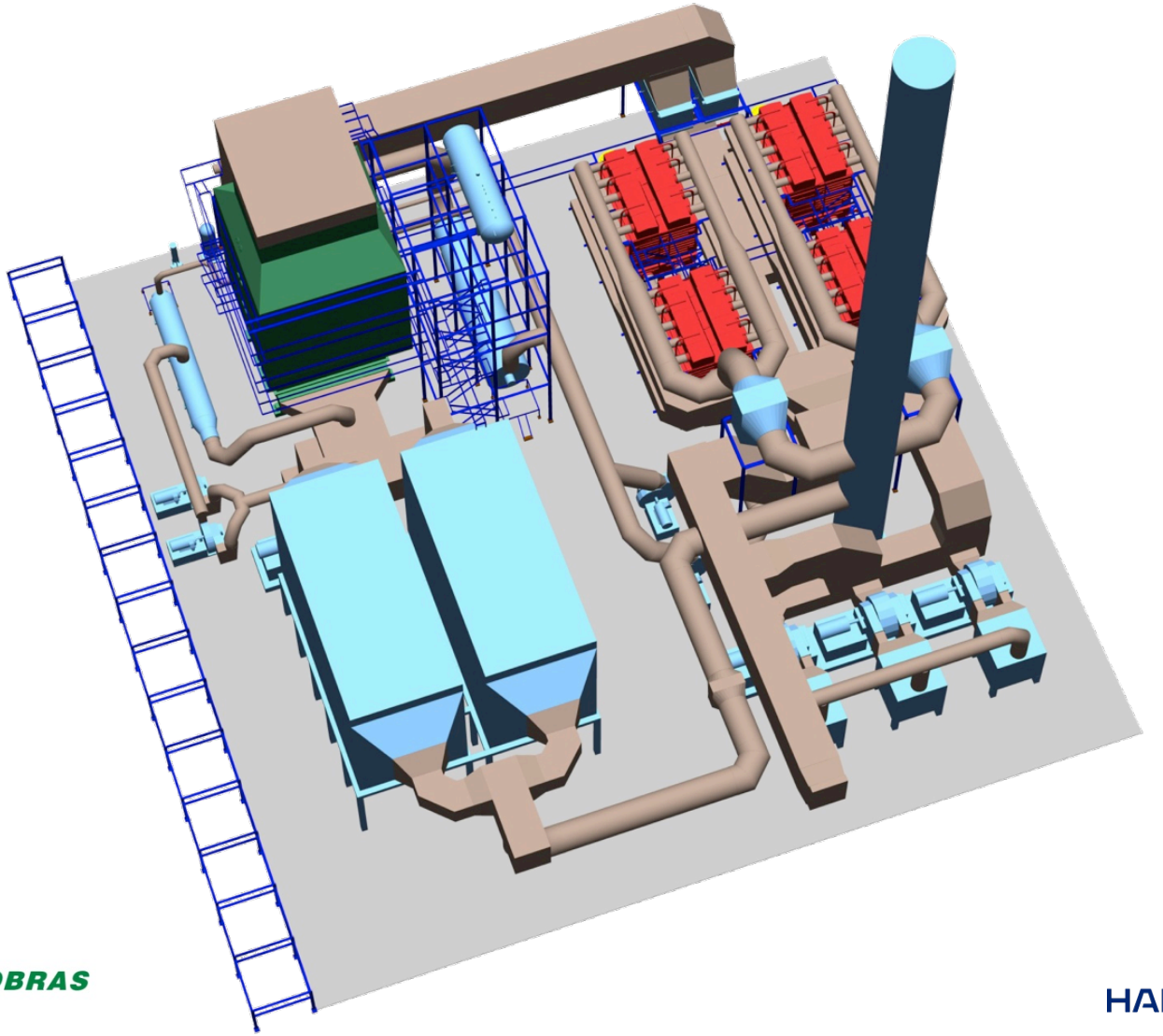
SNOX™ references

- **NEFO, Aalborg, Denmark** (1991)
  Coal-fired 300 MW power plant
- **Ohio Edison, Niles, Ohio, USA** (1991)
  Coal-fired 35 MW demonstration project
- **Raffineria di Gela, Sicily, Italy** (1999)
  Petcoke-fired 300 MW steam and power plant
- **OMV Refinery, Schwechat, Austria** (2007)
  Residual oil-fired steam and power plant
  SNOX™ also treats Claus tail gas
- **Petrobras RNEST Refinery, Brazil** (2014)
  Residual oil/petcoke fired steam and power plant.
  2 SNOX™ plants also treat Claus tail gas, H_2S gas, SWS gas and other sulphur-containing waste streams
- **125 WSA plants, same as SNOX, not for power prod.**

Petrobras RNEST SNOX™ configuration



Petrobras RNEST SNOX™ – birds view



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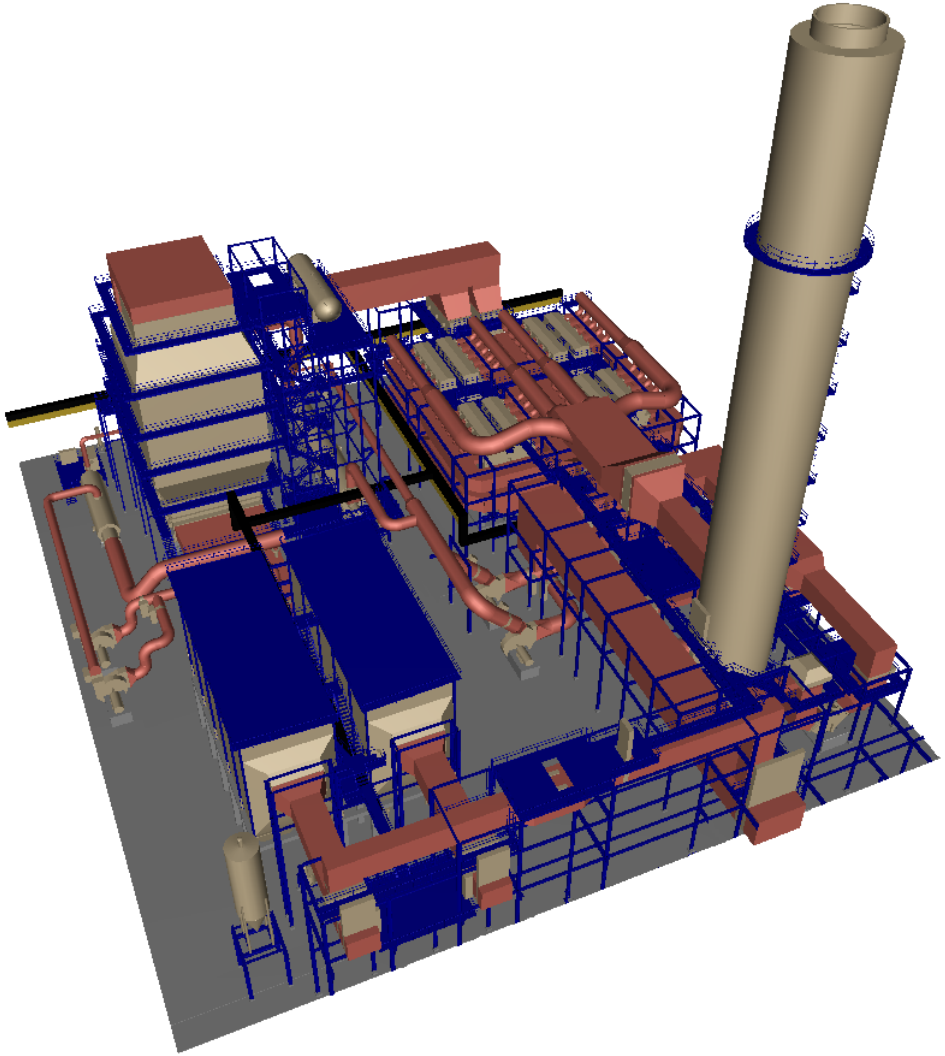
Petrobras RNEST SNOX™ – birds view



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Why PETROBRAS chose a technology like SNOX™

- **Avoid lime stone and gypsum in the refinery**
  - Infrastructure, storage
  - Avoid dust and CO_2 emission
- **Limited water consumption**
- **Handling of other sulphur waste streams**
  - H_2S and SWS gas
  - Claus tail gas
- **Energy efficiency**
  - Recycle of hot, preheated air to the boilers
  - Production of medium pressure steam

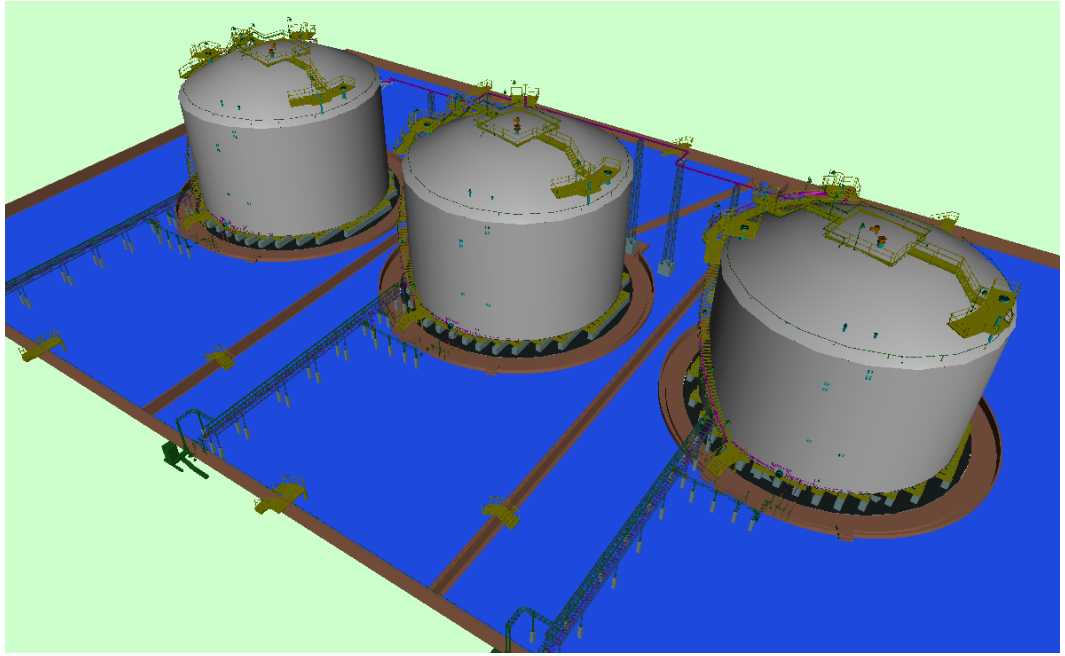
SNOX Treatment Performance compared to Brazilian Legislation for Atmospheric Emissions

- CONAMA requirements and SNOX performance guarantees:

CONAMA 382			SNOX	Unit
Oil Boilers (>70MW)	Ammonia Converter	Claus Plant		
100	-	-	<1	PM (mg/Nm^3; 3% O_2 B.S; max.)*
1800	-	-	1203	SO_x (mg/Nm^3; 3% O_2 B.S; max.)**
1000	-	-	119	NO_X (mg/Nm^3; 3% O_2 B.S; max.)***
-	720	-	132	NO_X (mg/Nm3; 1%O_2 B.S; max.)***
-	98	-	100	Ammonia Destruction Eff. (%; min.)
-	-	96	97	Sulfur Recovery (%; min.)

Sulphuric Acid Handling Facilities

- Three tanks of 7,000 m3;
- Ship Loading (70% of the acid production);
- Truck Loading Station;
- Stainless Steel Pipeline;
- Pump Station.



- Approx. 80% of total sulfur is recovered from crude oil as H_2SO_4 (700MTPD)

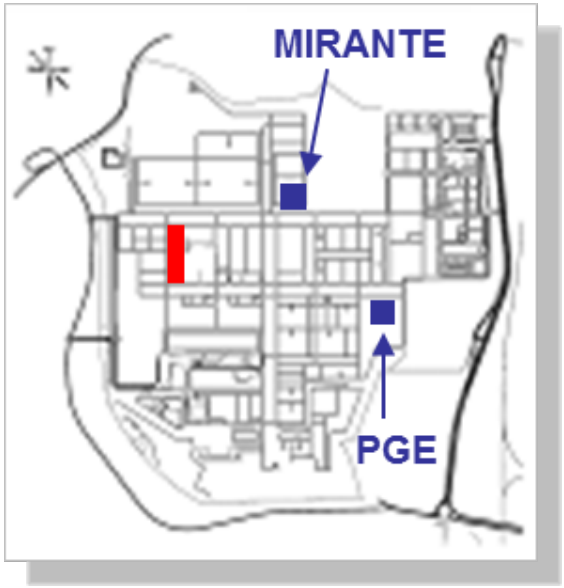
SNOX Contribution for Refinery Energy Saving

Energy Balance - Utility (MWe)	
Production	
MP Steam	+6.7
Hot Air	+10.4
Consumption	
Fuel Gas	-1.3
Electricity	-5.5
Balance	+10.3

- Positive net balance of 10.3 MWe
- 3% of fuel oil consumed by the power plant
- Contribution energy efficiency index.

Assembly and construction figures

- Piping : 698 t
- Steel Structure: 3.166 t
- Concrete: 7.204 m³



Pictures

Boilers, SNOX and Sulphur Block - Overview

Sulphur Block - Overview

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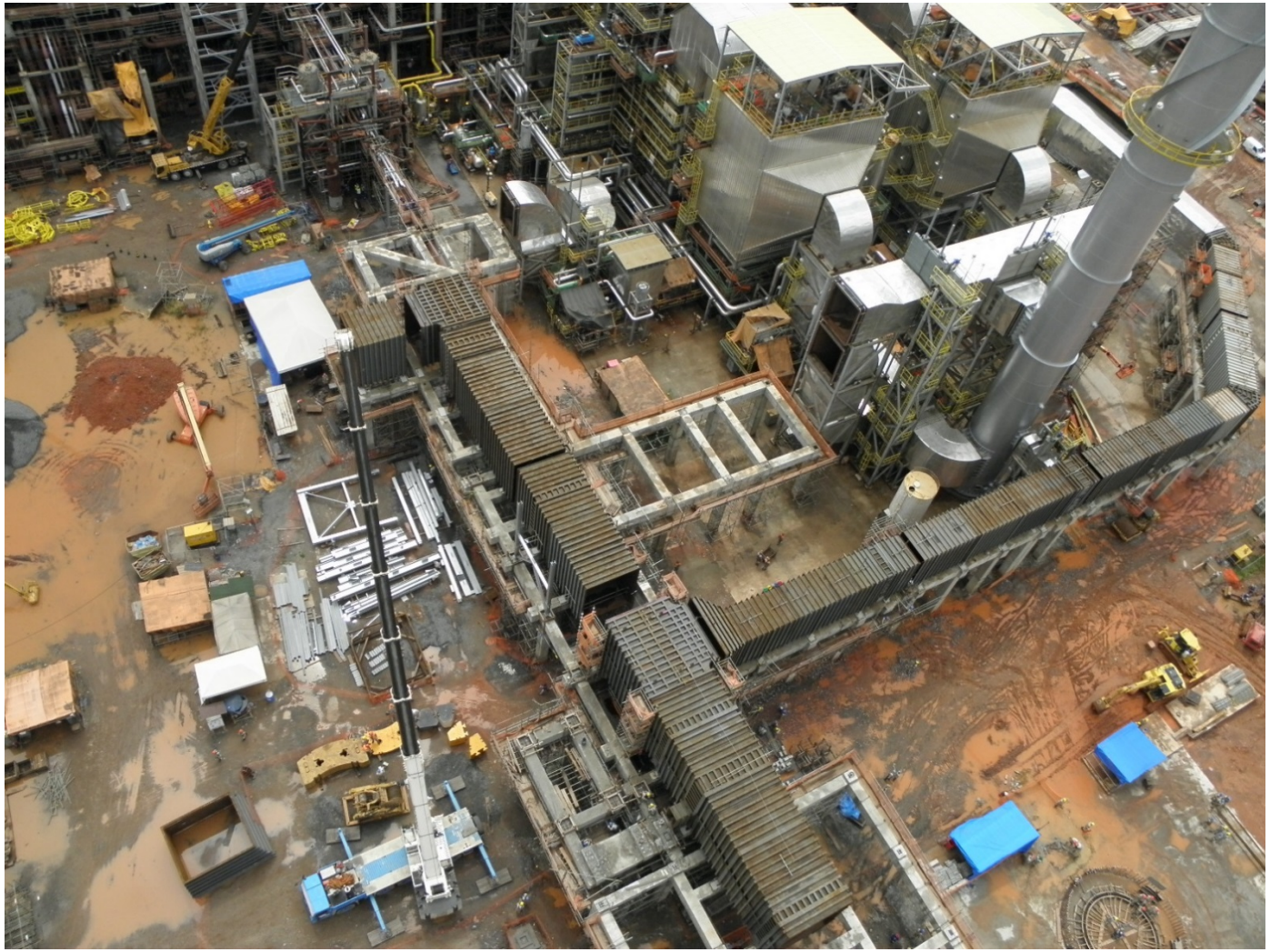
Boilers - Overview



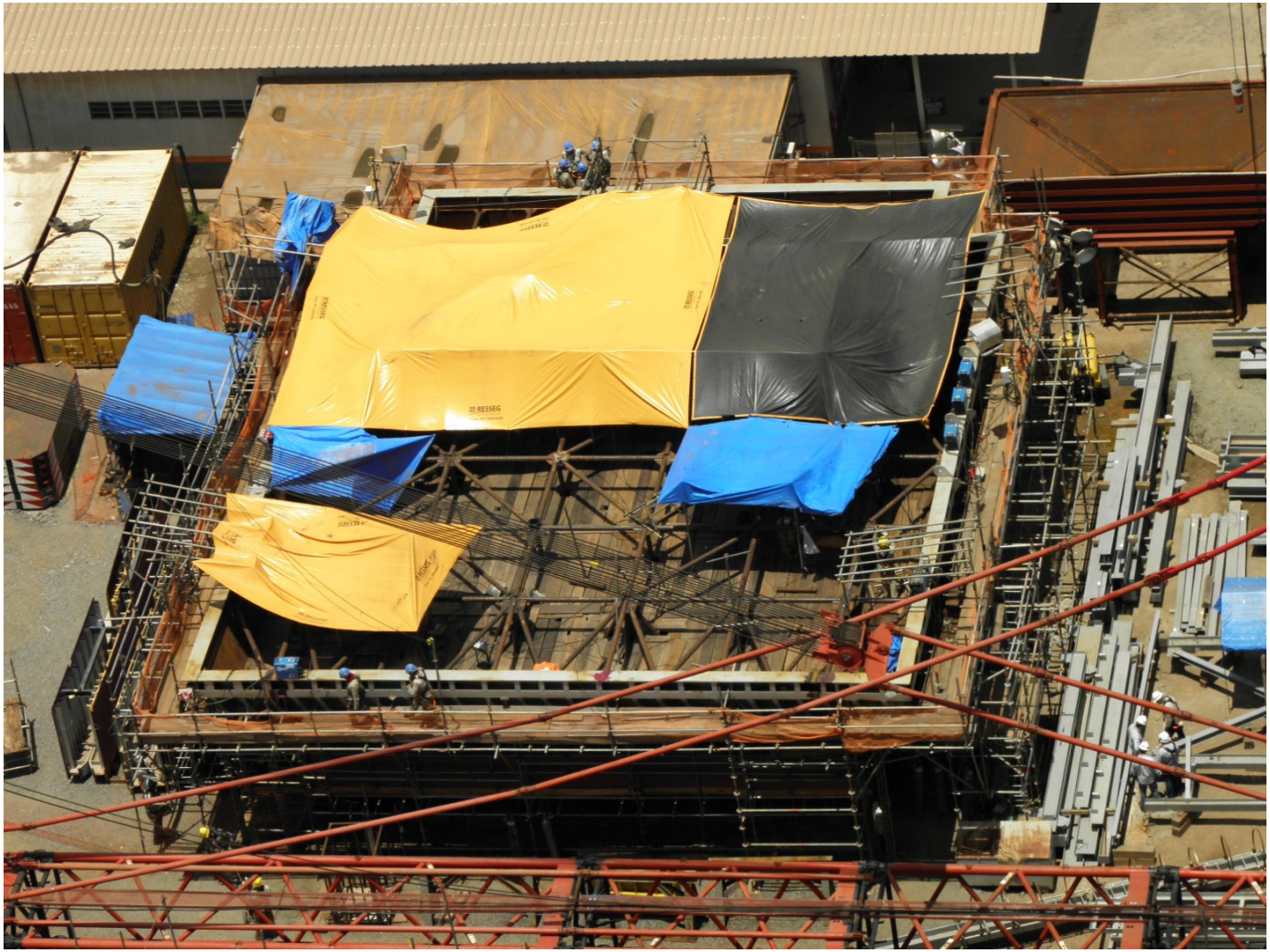
SNOX Overview

SNOX – ESP front view

SNOX – ESP side view

SNOX – Gas/Gas H.Ex.

SNOX - Reactor (base)



Combustor 2 and Structure for Steam System

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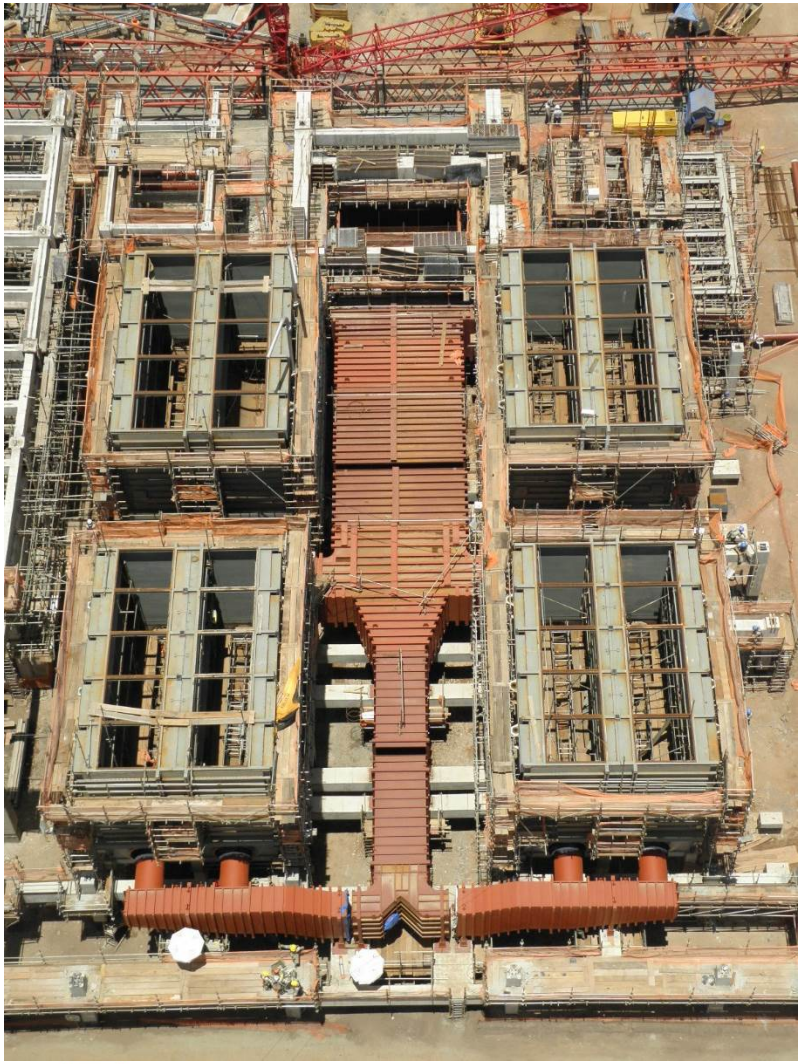
SNOX - WSA Condenser



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SNOX - Stack (external wall)

SNOX – Stack View – Plume Directions






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Questions

- Thank you for your attention.

- Any questions?