REINHOLD ENVIRONMENTAL Ltd.

2019 NOx-Combustion-CCR Round Table Presentation

February 11 & 12, 2019, in Salt Lake City, Utah / Hosted by PacifiCorp

SOOTAWAY

JOHNSEN CHEMICALS

Complete Combustion

Others work with reducing the symptoms of an incomplete combustion.

We try to solve the problem.

JOHNSEN CHEMICALS

Product information

- Combustion Catalyst for solid fuel
  (coal, waste, biomass)
- The active ingredient is a manganese complex
- Environmentally friendly
- Liquid
- 1 liter per ton fuel

JOHNSEN CHEMICALS

Combustion

Enable total combustion at lower temperatures

- Manganese complex is an oxygen scavenger that attract oxygen to surface of fuel
- All available oxygen is utilized to improve combustion

JOHNSEN CHEMICALS

Emission

Improved combustion utilizes all available oxygen.

Lack of free oxygen, reduces the creation of

- Carbon Monoxide
- Sulfur Oxide
- Nitric Oxide

JOHNSEN CHEMICALS

Particles

Reduces emission of particles

- Unburned Carbon in the particles is utilized in improved combustion

JOHNSEN CHEMICALS

Sediments

Reduces sediments

- Unburned Carbon in sediments is utilized in improved combustion

- Sediments is a very good insulation
  - 1 mm equals 8% reduction of heat transfer
  - 3,2 mm equals 20% reduction of heat transfer

JOHNSEN CHEMICALS

Corrosion

Reduces corrosion

- Reduced creation of SO2 reduces the corrosion

JOHNSEN CHEMICALS

Maintenance

Reduces maintenance

- Reduced sediments and reduced corrosion increases interval between shutdown for maintenance

JOHNSEN CHEMICALS

Fuel efficiency

- If you have a complete combustion with
  - no emission of Carbon Monoxide
  - no emission of Sulfur Dioxide
  - no building of sediments
  - no calorific value in you ash

we cannot increase the fuel efficiency

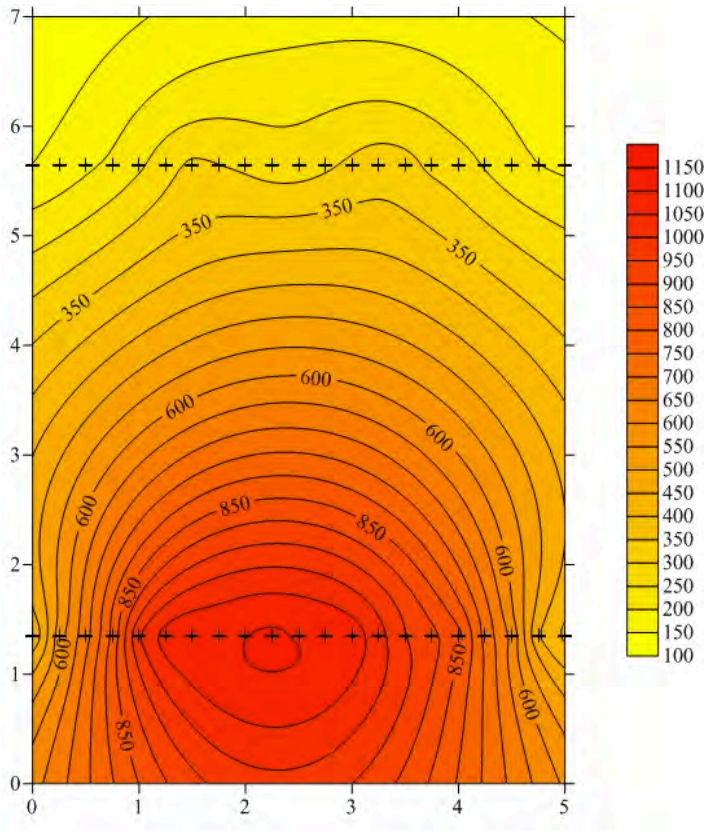
JOHNSEN CHEMICALS

Application

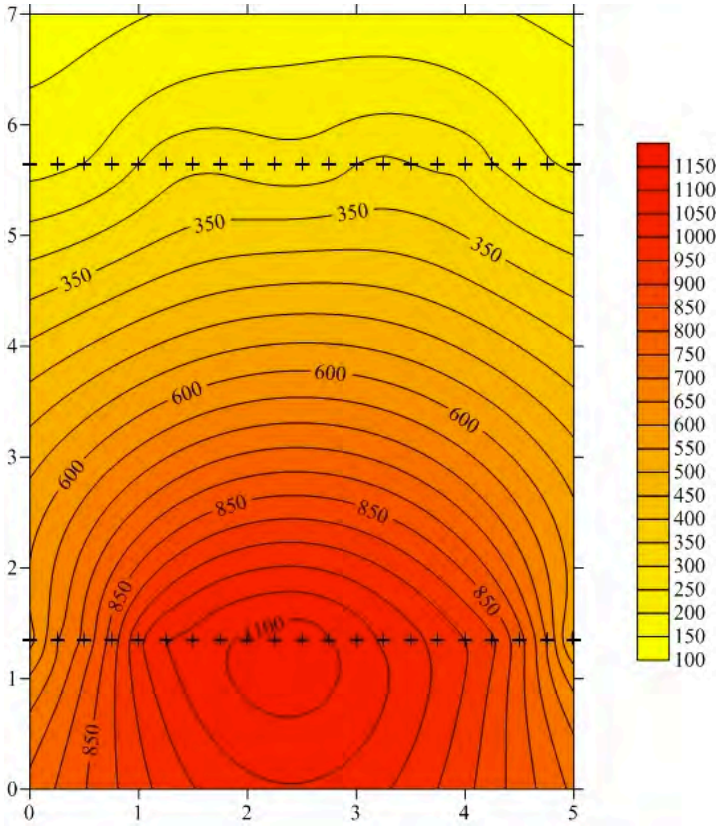
JOHNSEN CHEMICALS

Temperature

Without Sootaway



With Sootaway



JOHNSEN CHEMICALS

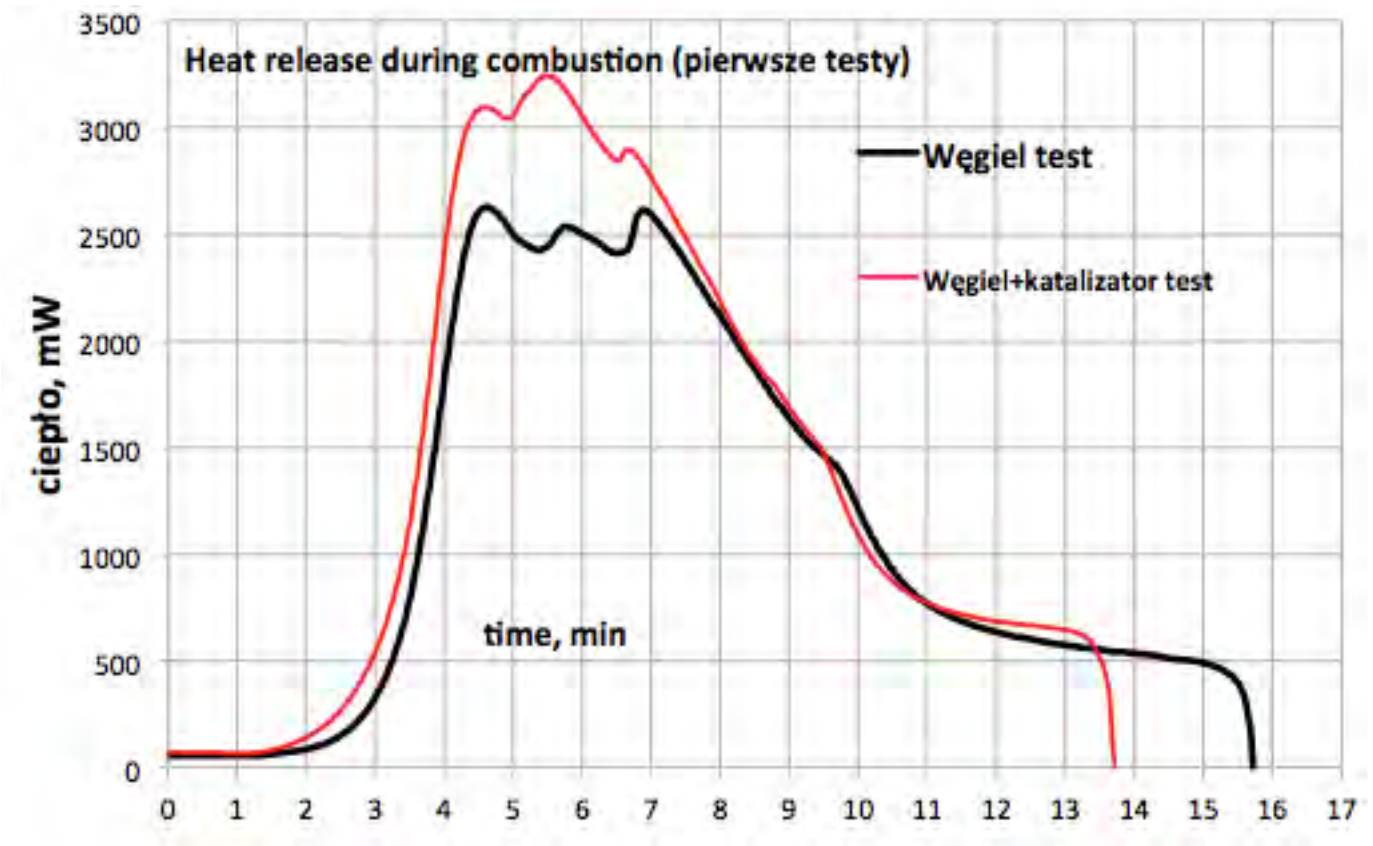
Combustion

Without Sootaway

With Sootaway

JOHNSEN CHEMICALS

Fuel efficiency



Węgiel – coal
Ciepło – heat

JOHNSEN CHEMICALS

Emission, instant

Without Sootaway

Component	Concentration	Unit
Water vapor H2O	6.86	vol-%
Carbon dioxide CO2	7.46	vol-%
Carbon monoxide CO	123.48	ppm
Nitrous oxide N2O	3.25	ppm
Nitrogen monoxide NO	122.41	ppm
Nitrogen dioxide NO2	8.84	ppm
Sulfur dioxide SO2	356.57	ppm
Hydrogen chloride HCl	23.64	ppm
Methane CH4	5.51	ppm
Formaldehyde CHOH	0.00	ppm
Methane %	-0.01	vol-%
Aceton C3H6O	71.66	ppm
Amoniak NH3	0.00	ppm
HCN	95.94	ppm
Tlen O2	9.68	

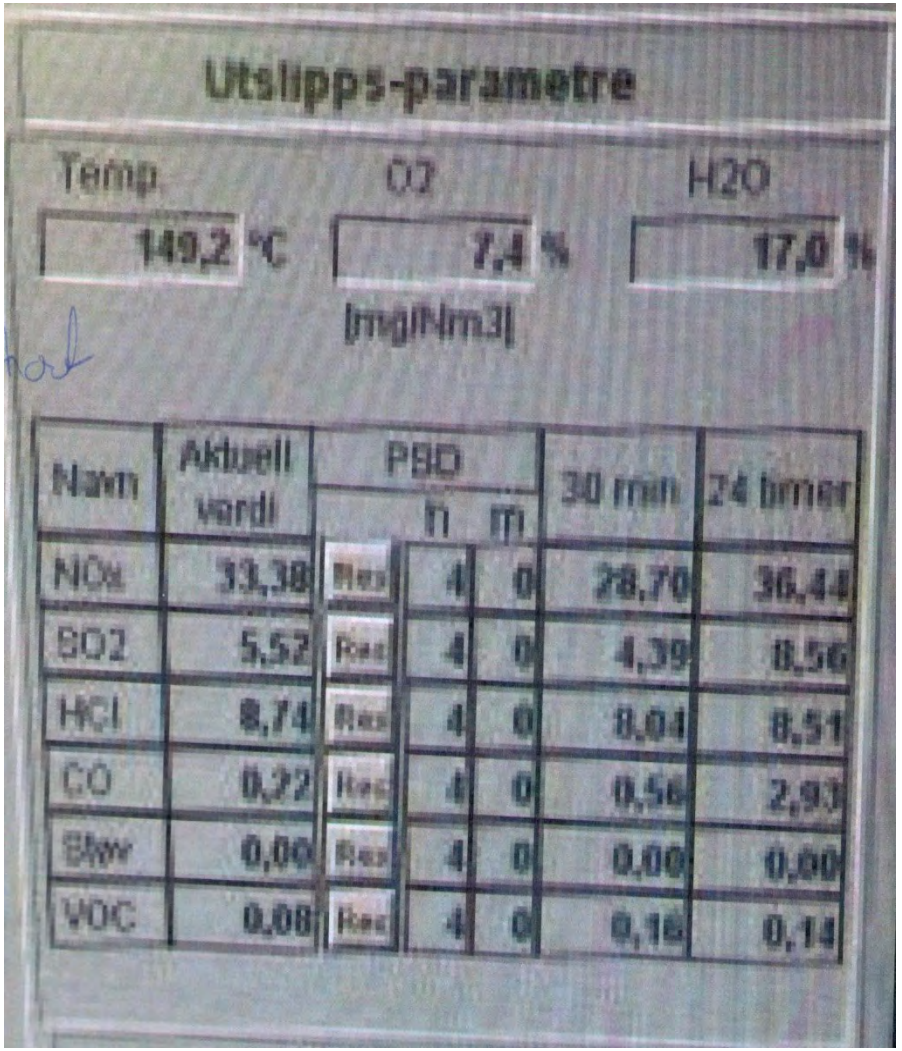
With Sootaway

Component	Concentration	Unit
Water vapor H2O	4.00	vol-%
Carbon dioxide CO2	8.60	vol-%
Carbon monoxide CO	83.22	ppm
Nitrous oxide N2O	0.00	ppm
Nitrogen monoxide NO	92.30	ppm
Nitrogen dioxide NO2	1.08	ppm
Sulfur dioxide SO2	234.53	ppm
Hydrogen chloride HCl	35.71	ppm
Methane CH4	0.32	ppm
Formaldehyde CHOH	0.00	ppm
Methane %	-0.00	vol-%
Aceton C3H6O	0.00	ppm
Amoniak NH3	0.00	ppm
HCN	14.66	ppm
Tlen O2	7.98	

JOHNSEN CHEMICALS

Emission, long term

Without Sootaway



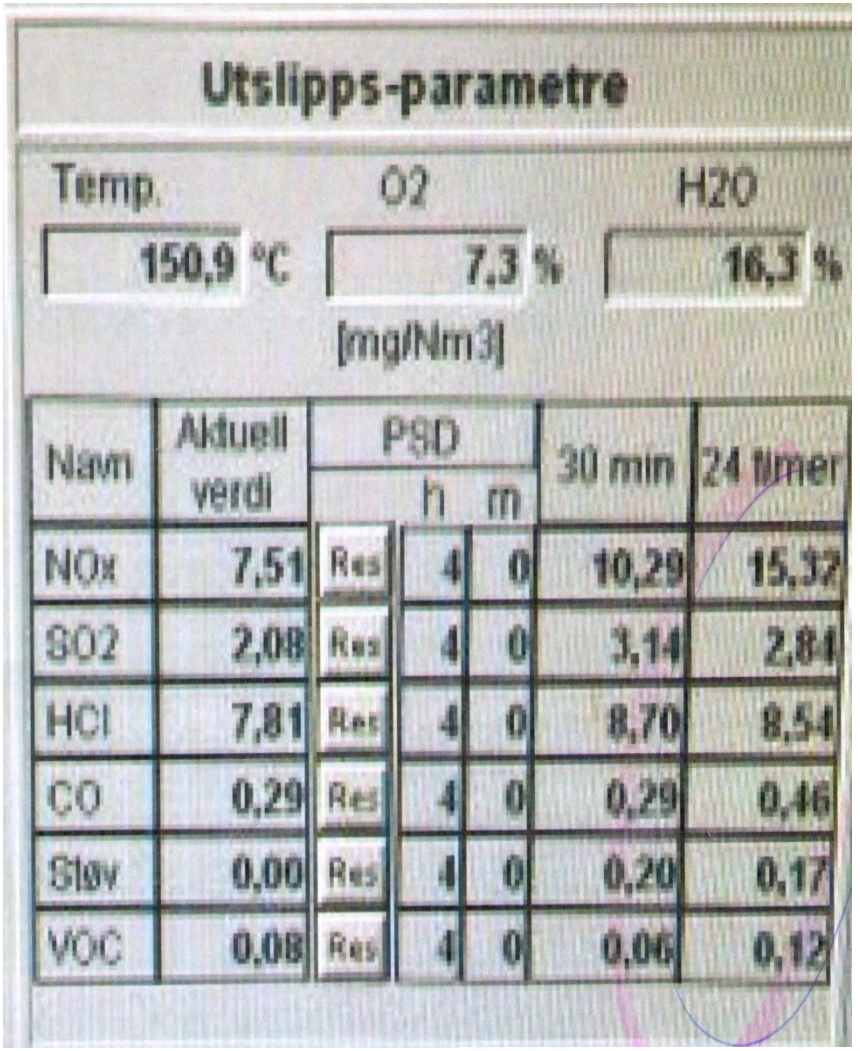
Utslipps-parametre

Temp.	O2	H2O
149,2 °C	7,4 %	17,0 %

[mg/Nm3]

Navn	Aktuell verdi	PSD	h	m	30 min	24 timer
NOx	33,38	Res	4	0	28,70	36,44
SO2	5,52	Res	4	0	4,39	8,56
HCl	8,74	Res	4	0	8,04	8,51
CO	0,22	Res	4	0	0,56	2,93
Støv	0,00	Res	4	0	0,00	0,00
VOC	0,08	Res	4	0	0,16	0,14

With Sootaway



Utslipps-parametre

Temp.	O2	H2O
150,9 °C	7,3 %	16,3 %

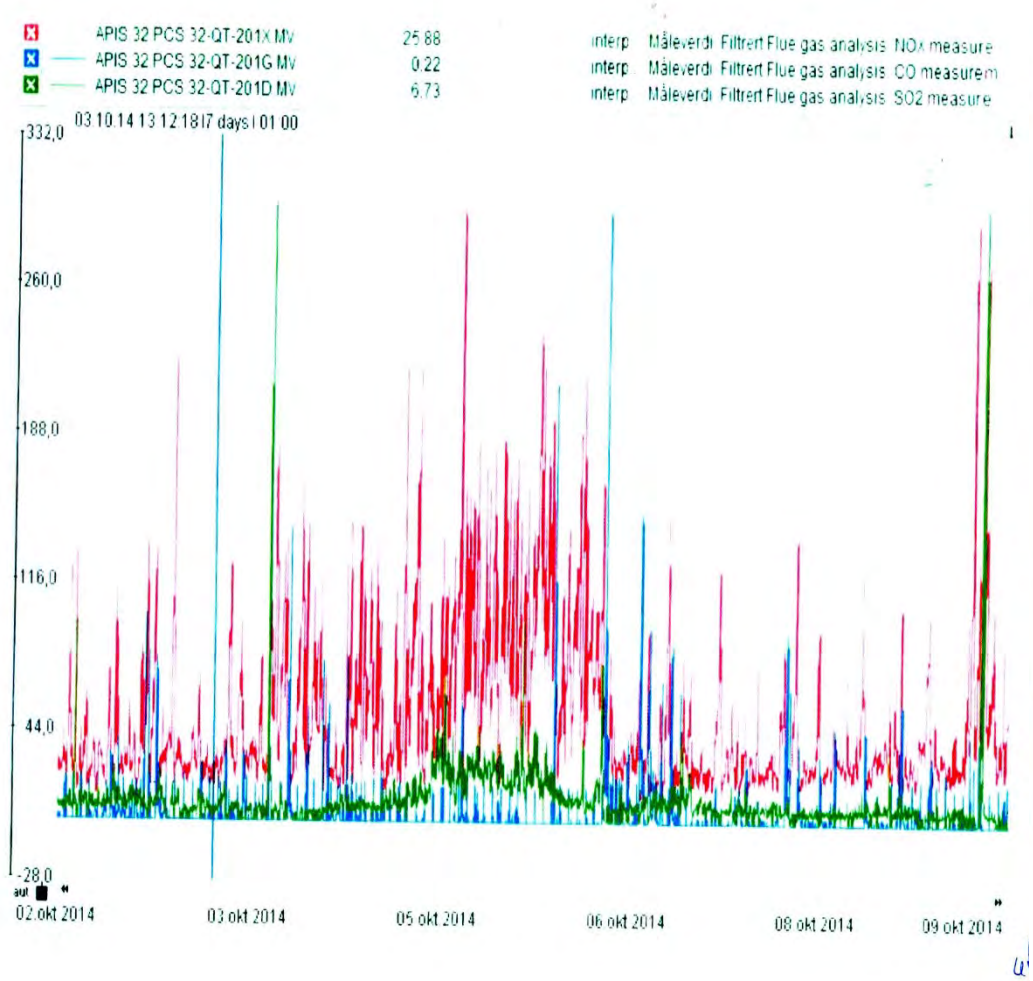
[mg/Nm3]

Navn	Aktuell verdi	PSD	h	m	30 min	24 timer
NOx	7,51	Res	4	0	10,29	15,37
SO2	2,08	Res	4	0	3,14	2,84
HCl	7,81	Res	4	0	8,70	8,54
CO	0,29	Res	4	0	0,29	0,46
Støv	0,00	Res	4	0	0,20	0,17
VOC	0,08	Res	4	0	0,06	0,12

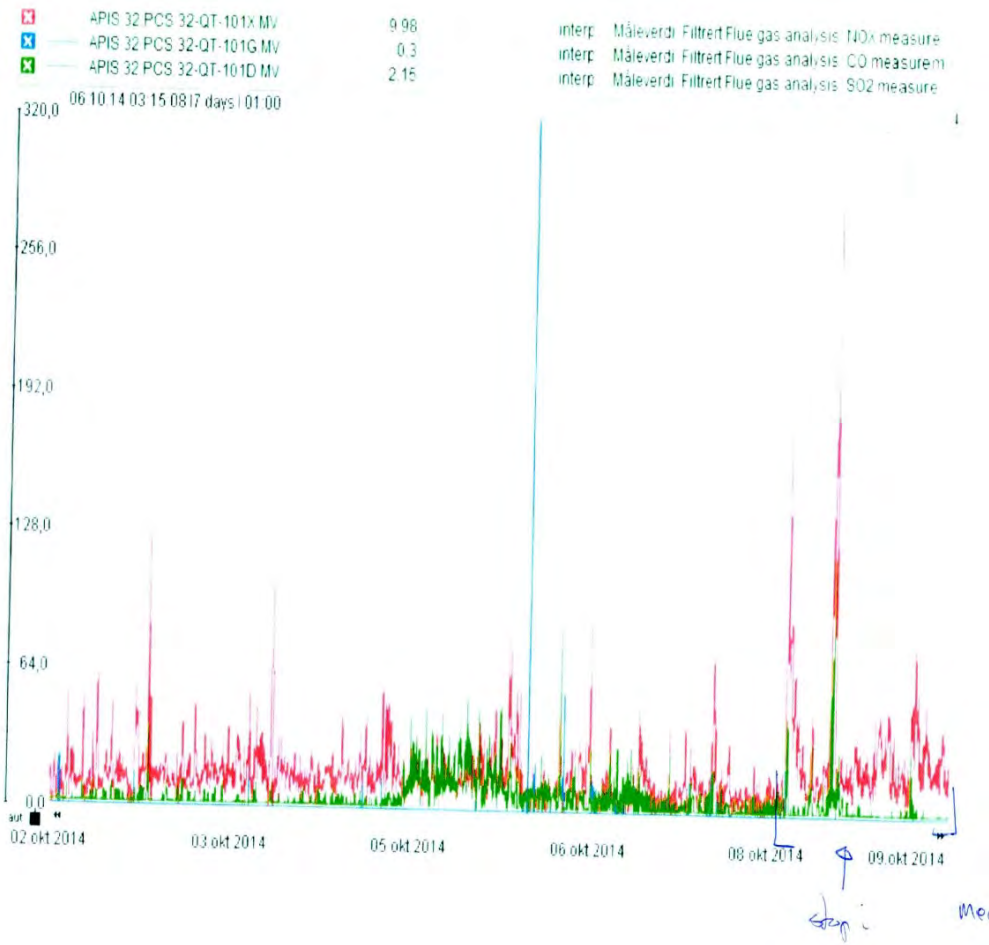
JOHNSEN CHEMICALS

Emission

Without Sootaway



With Sootaway



JOHNSEN CHEMICALS

Emission

“In addition, some instable compounds O- H- C such as CHOH, C3H6O and HCN disappeared completely. HCl emission decreased significantly (in the final tests G the emission of HCl was close to zero).”

Wroclaw University of Technology, January 2015. PhD Halina Pawlak-Kruczek

JOHNSEN CHEMICALS

Fuel efficiency

JOHNSEN CHEMICALS

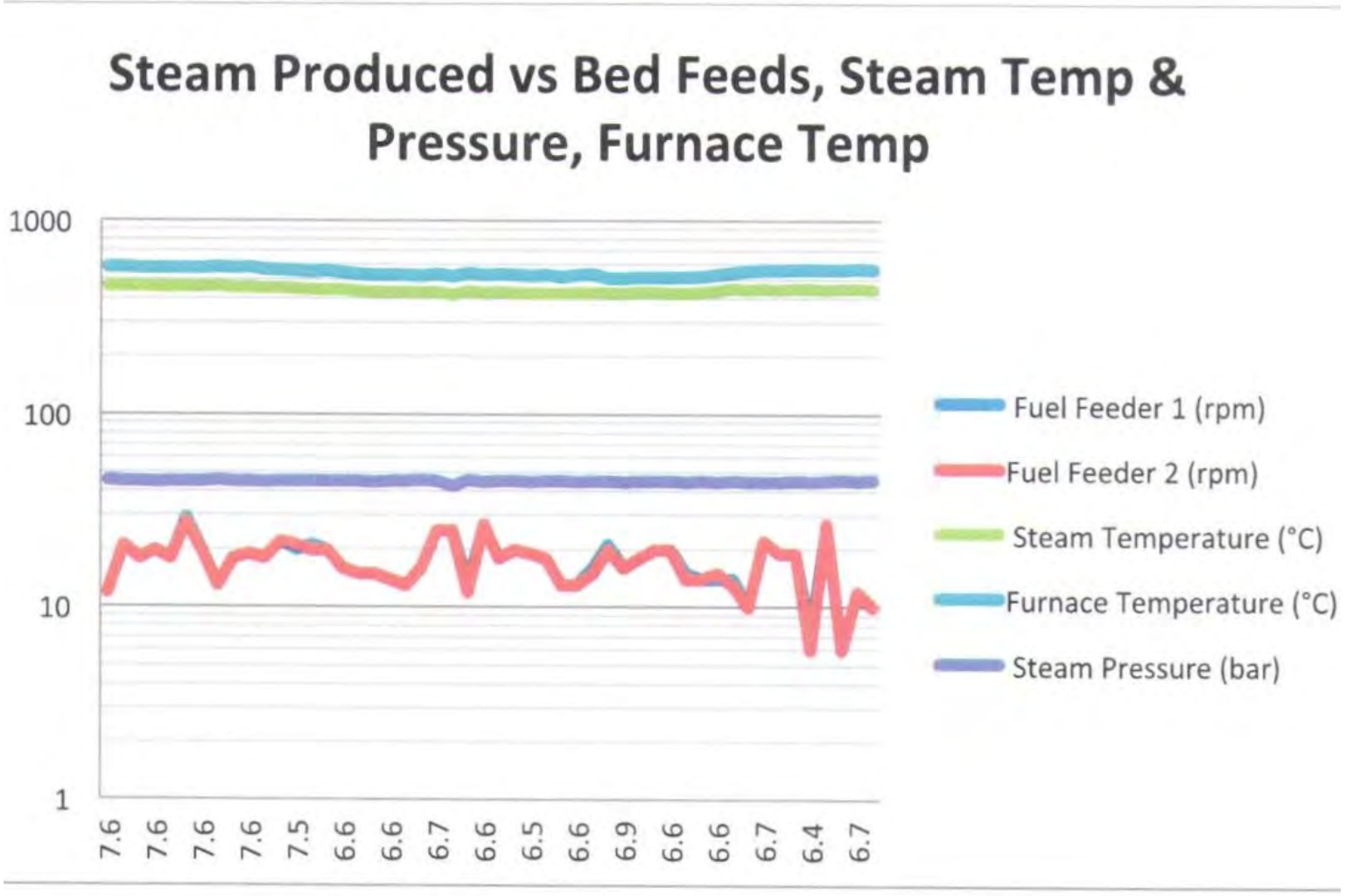
Fuel efficiency

JOHNSEN CHEMICALS

Fuel effiency

JOHNSEN CHEMICALS

Fuel efficiency



JOHNSEN CHEMICALS

Fuel efficiency

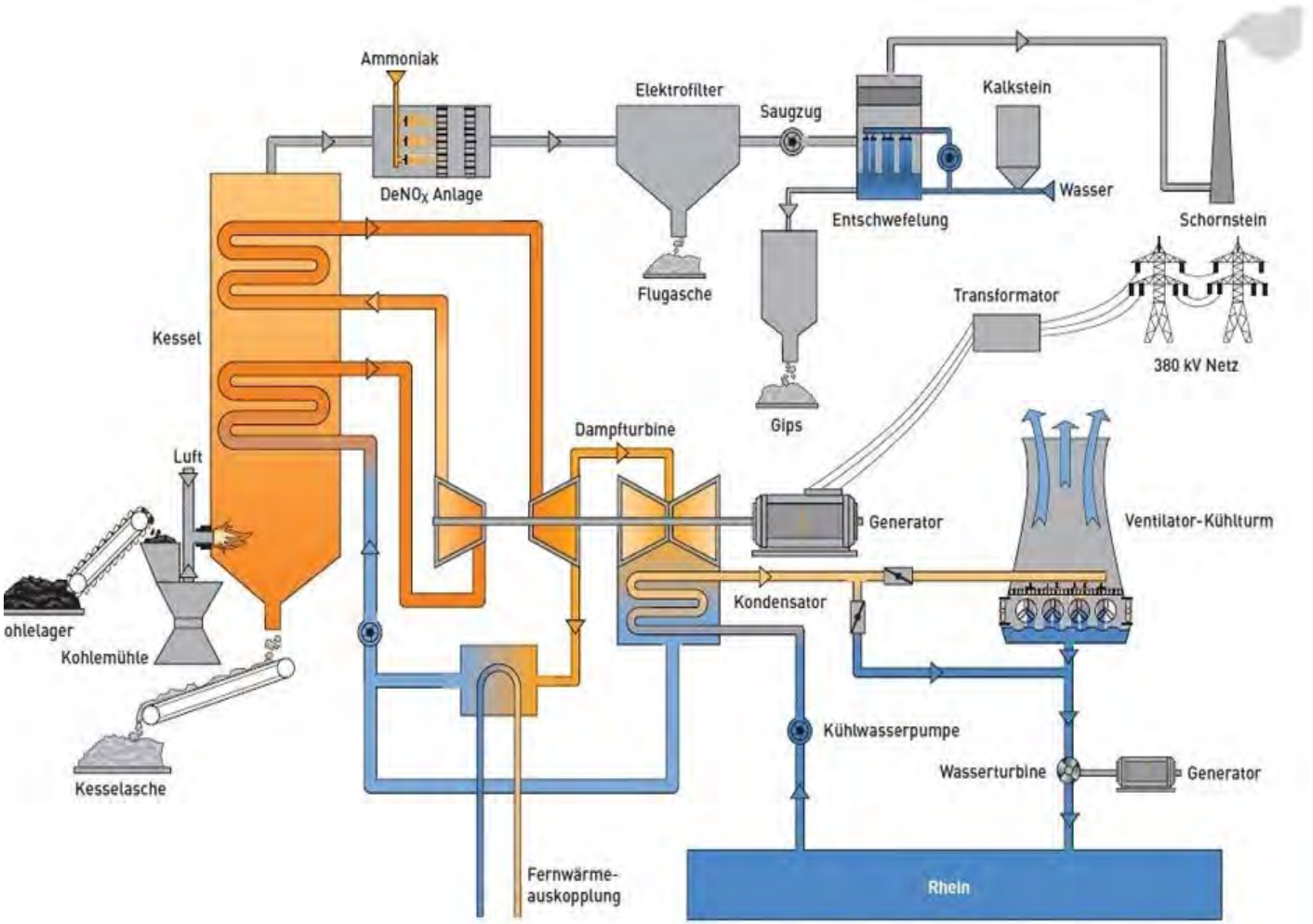
Ongoing installations in India

- 4 * 135 MW Fluidised Bed
- 4 * 200 MW Pulverized

JOHNSEN CHEMICALS

Summary

- 95% CO
- 58% NOx
- 50% PM
- 67% SO2



JOHNSEN CHEMICALS

2019 Nox-Combustion

February 11-12 2019

Marriott, Salt Lake City

Leif Vebenstad

leif@johnsenchemicals.com

+47 913 31 089

JOHNSEN CHEMICALS