

Multipollutant emission control with ClO₂ based technology

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Technology Scale Up

Objective:

Give an insight into our technical upscaling of this new concept for simultaneous removal of NO_x and SO_x by the use of ClO_2 gas

**ClO_2 based
emission
control
technology**

**Laboratory
scale
0.5 kW**

**Gas
boiler
100 kW**

**Slip
stream
400 kW**

Full scale

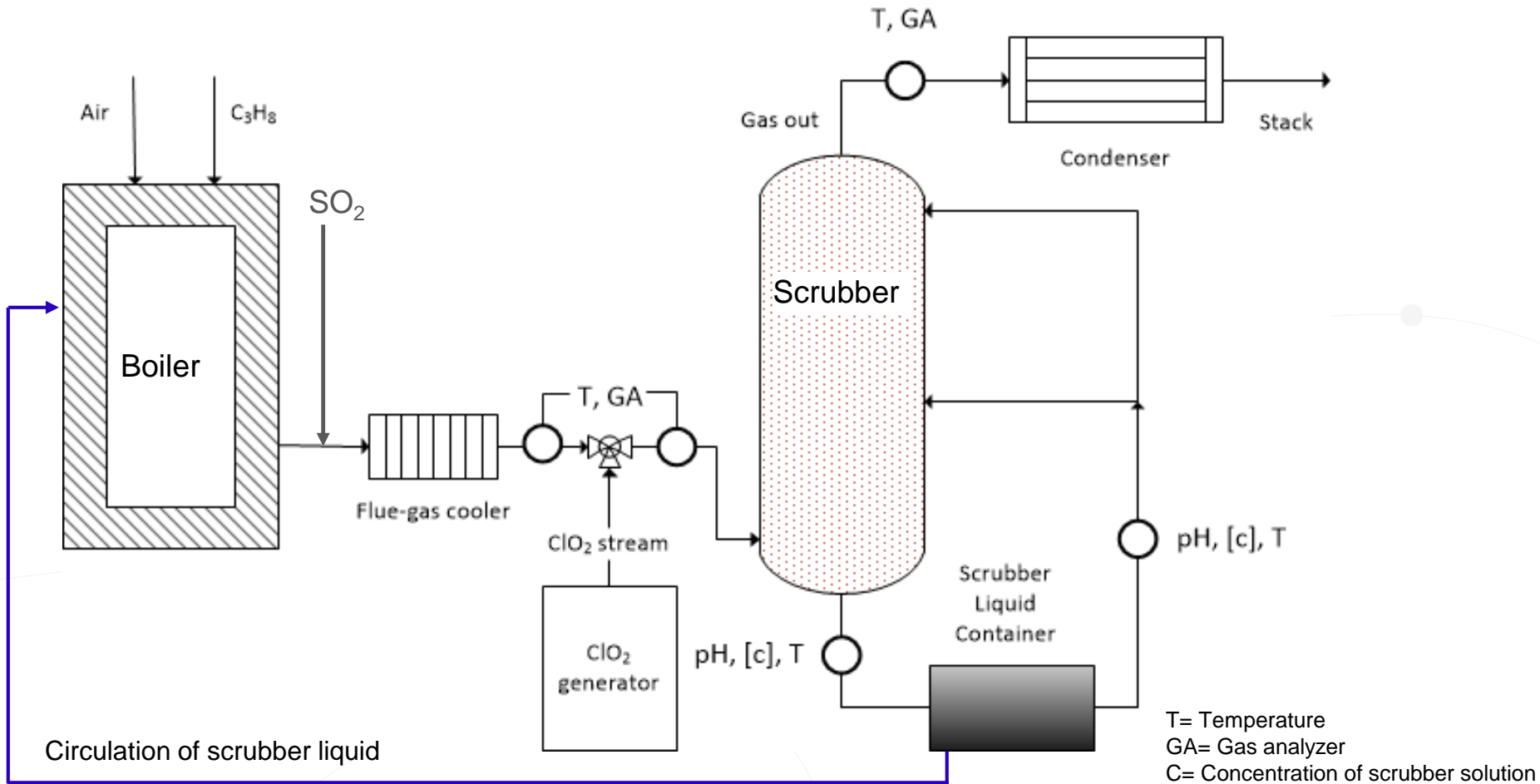
100 kW Gas boiler trials:

- Various flue gas compositions and process conditions
- Circulation of scrubber liquid
- Inspection of flue gas channel

Simulation using Aspen plus

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Gas boiler 100 kW at Chalmers - Method



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Gas boiler 100 kW at Chalmers - Method

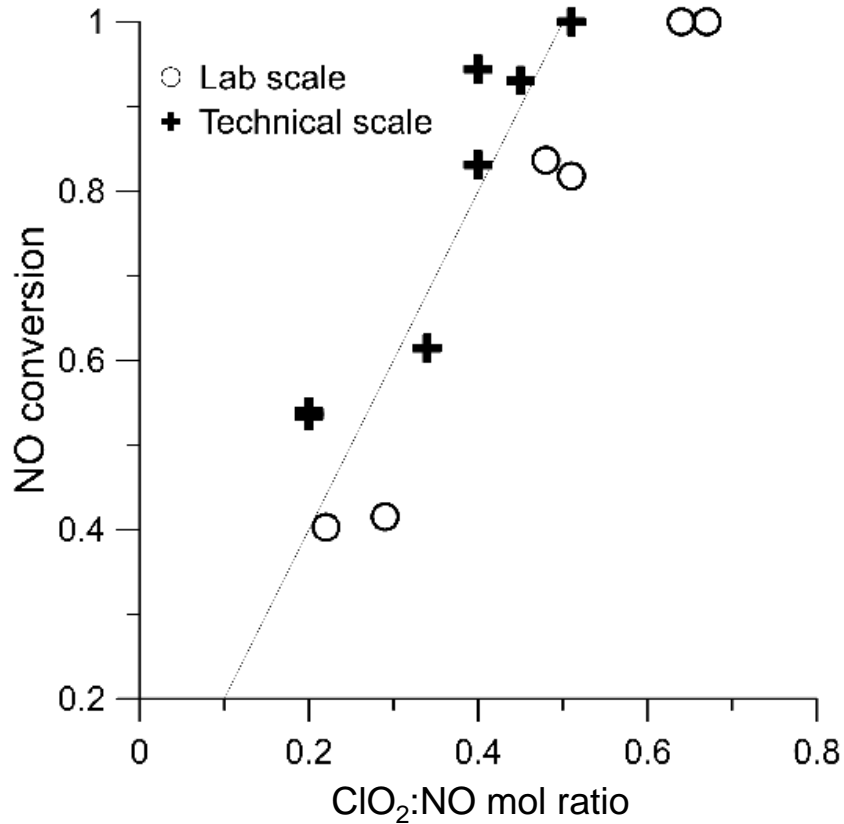


Parameter	100 kW scale
Height	2 sections: 2.6 m + 1.8 m
Diameter	0.26 m
Packing height	2 m
Packing type	Super ring Raschig, metal, NO-1.5
Pressure	1 bar



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Gas boiler 100 kW at Chalmers – Oxidation

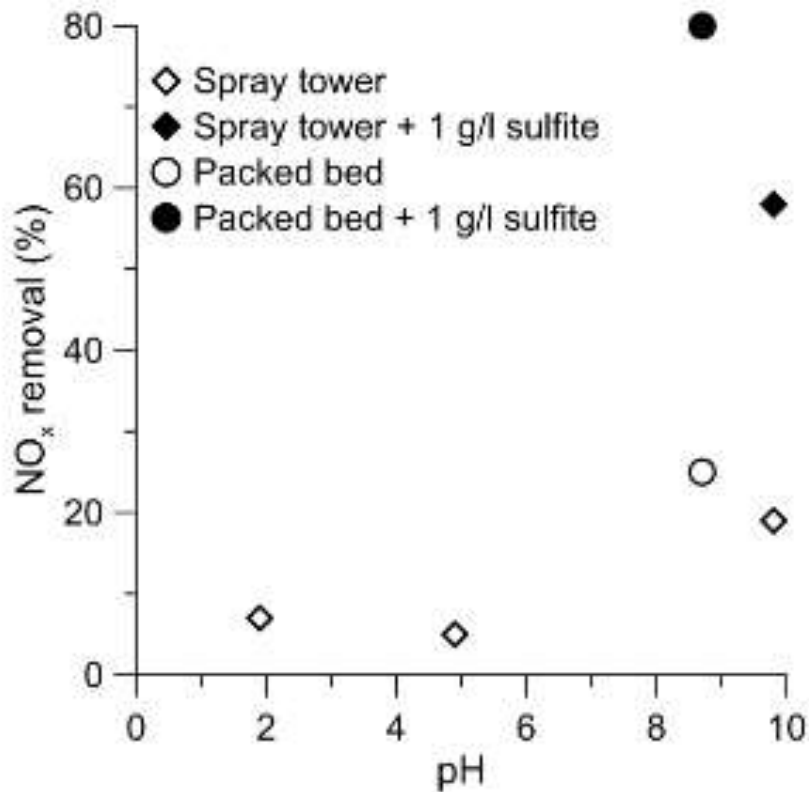


ClO₂

- Very high efficiency in NO oxidation (close to theoretical maximum)
- High selectivity towards NO (No SO₂ oxidation)

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Gas boiler 100 kW at Chalmers – Absorption

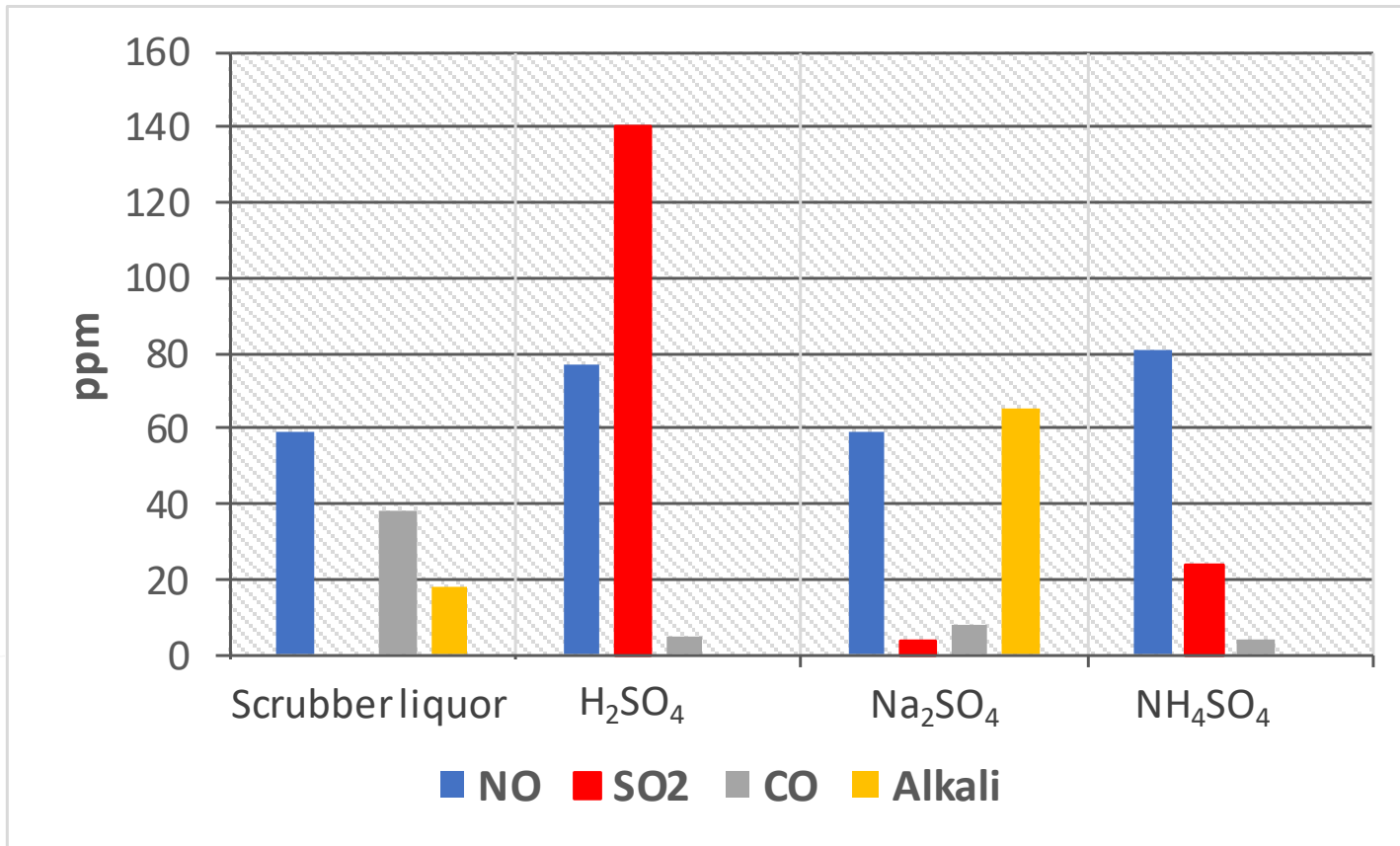


Scrubber:

- 100% SO₂ removal efficiency
- 82% NO_x removal efficiency with sodium sulfite (1 g/L) as scrubber liquid and pH 9
- Important parameters;
 - Packed bed
 - Residence time
 - Scrubber liquid composition

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Gas boiler 100 kW at Chalmers – Injection of liquid in the flame*



SID: Surface ionization detector for alkali

* Dan Gall "S reduction oxy-fuel investigation 2019"

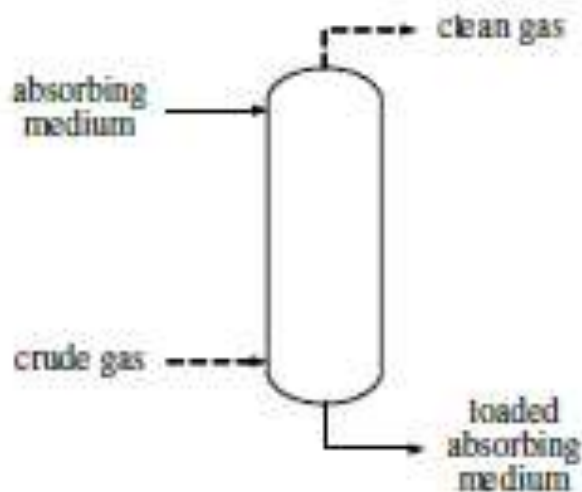
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Gas boiler 100 kW at Chalmers – Inspection of flue gas channel



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Gas boiler 100 kW at Chalmers – Simulation using Aspen Plus*



Simulation:

- Rate-based modelling using Aspen Plus ®'s *RateSep* add-on for the *Radfrac* block
- Physical properties calculated with ELECNRTL activity coefficient model
- Consideration of mass transfer resistance (two film model) and reaction kinetics

Concluding remarks:

- Absorber model matches experimental results well
- Improved NO₂ absorption:
 - Packing height
 - Sulfite concentration
- Higher liquid-to-gas ratio and volumetric surface area do not improve the absorption significantly

*Sarajlic, N. "Simulation of the removal of NO_x and Sox from flue gas using a direct contact column in Aspen Plus" 2019.

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Slip stream trials - Skid 400 Nm³/h

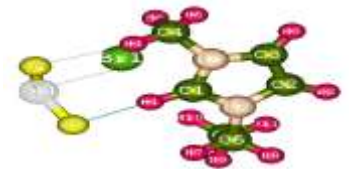


40 ft transportable container incl:

- ClO₂ generator and mixing zone
- Quench
- Scrubber
- Analyzing system flue gas
- Process control

Slip stream trials:

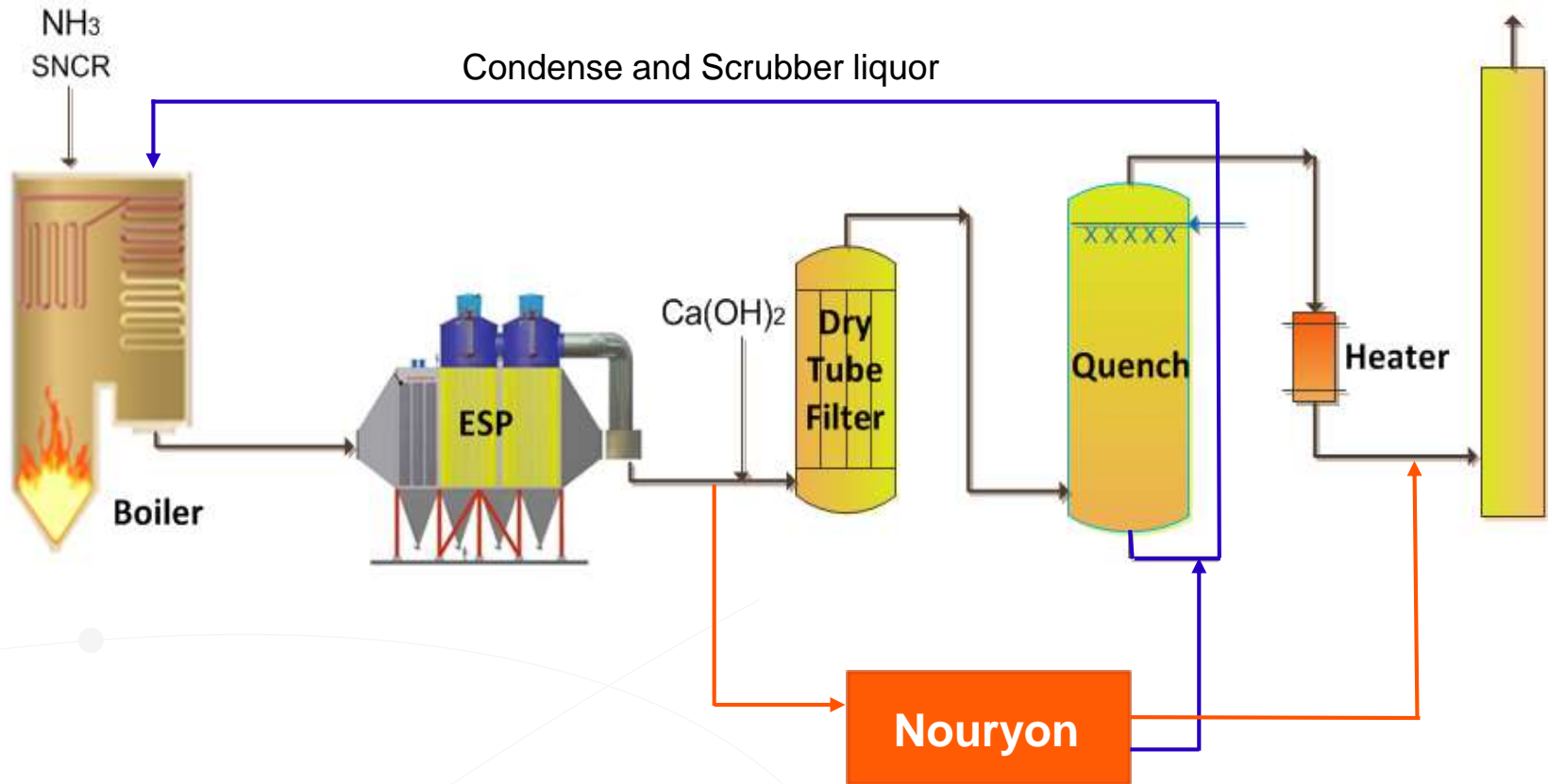
- Avesta waste combustion plant in Sweden
- Pulp mills (Norway and Sweden)
- Coal fired power station (Israel) in co-operation with Clairion using their technology
 - MPRT-IL™ a multipollutant control technology using ClO₂ and Ion liquid



MPRT-IL= Multi-pollutant removal technology-Ionic liquid

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Slip stream trials at Avesta waste combustion plant

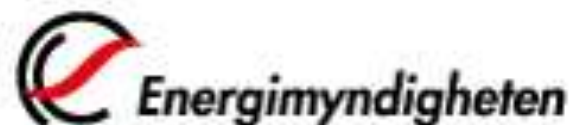


SNCR= Selective noncatalytic reduction
 ESP= Electrostatic precipitator
 Dry tube filter

Conclusions

- Technical-scale trials at Chalmers university (100 kW) confirmed high selectivity of ClO_2 gas to oxidize NO to NO_2 at various flue gas compositions and process conditions.
- Complete NO oxidation to NO_2 was reached at a ClO_2 : NO ratio of about 0.4 versus 0.5 for the lab scale.
- High absorption efficiency of SO_2 in the wet scrubber was confirmed while absorption of NO_2 was somewhat lower in comparison with that of lab scale.
- A new flexible and transportable skid for slip stream trials (400 Nm^3/h) has been designed and built and is now installed and initially tested with water at Avesta waste combustion in Sweden.

Acknowledgement



The background is a solid orange color. It features two thin white curved lines that sweep across the frame. One line starts from the left edge, curves upwards and then downwards towards the right. The other line starts from the bottom left, curves upwards and then downwards towards the right. There are two small colored dots: a blue dot on the upper white line on the left side, and a green dot on the lower white line on the right side.

Thank You!

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