Workshop on Ash deposition and corrosion, Glasgow September 2006

Ash related problems in wood fired boilers and effect of additives

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Content of the presentation

- Introduction
- Co-combustion and additives
- The strategy of Vattenfall
- IACM (In-situ alkali chloride monitor)
- The ChlorOut concept
- Examples from full-scale boilers

INTRODUCTION

- Most bio-fuels fuels have a high content of alkali metals (mainly K) and chlorine, and very little sulphur
- K released during combustion can condense as chlorides (KCl) or sulphates (K_2SO_4). KCl in deposits may cause accelerated corrosion

Additives and co-combustion

- Superheater corrosion and deposit formation can be reduced by co-combustion (peat, coal) or by additives
- Additives can either prevent the release of gaseous KCl or react with KCl in the gas phase and form less corrosive components
- The additives can be added with the fuel or to the flue gases

Additives and co-combustion

- Reaction with K resulting in K-alumino silicates and consequently decrease the levels of KCl (g) in the flue gas The main constituents of them are Al_2O_3 and SiO_2
- Kaolin, sludge, peat, coal ash

- Sulphation of gaseous alkali chlorides to less corrosive alkali sulphates
- Elemental sulphur, or other sulphur containing additives

The strategy of Vattenfall

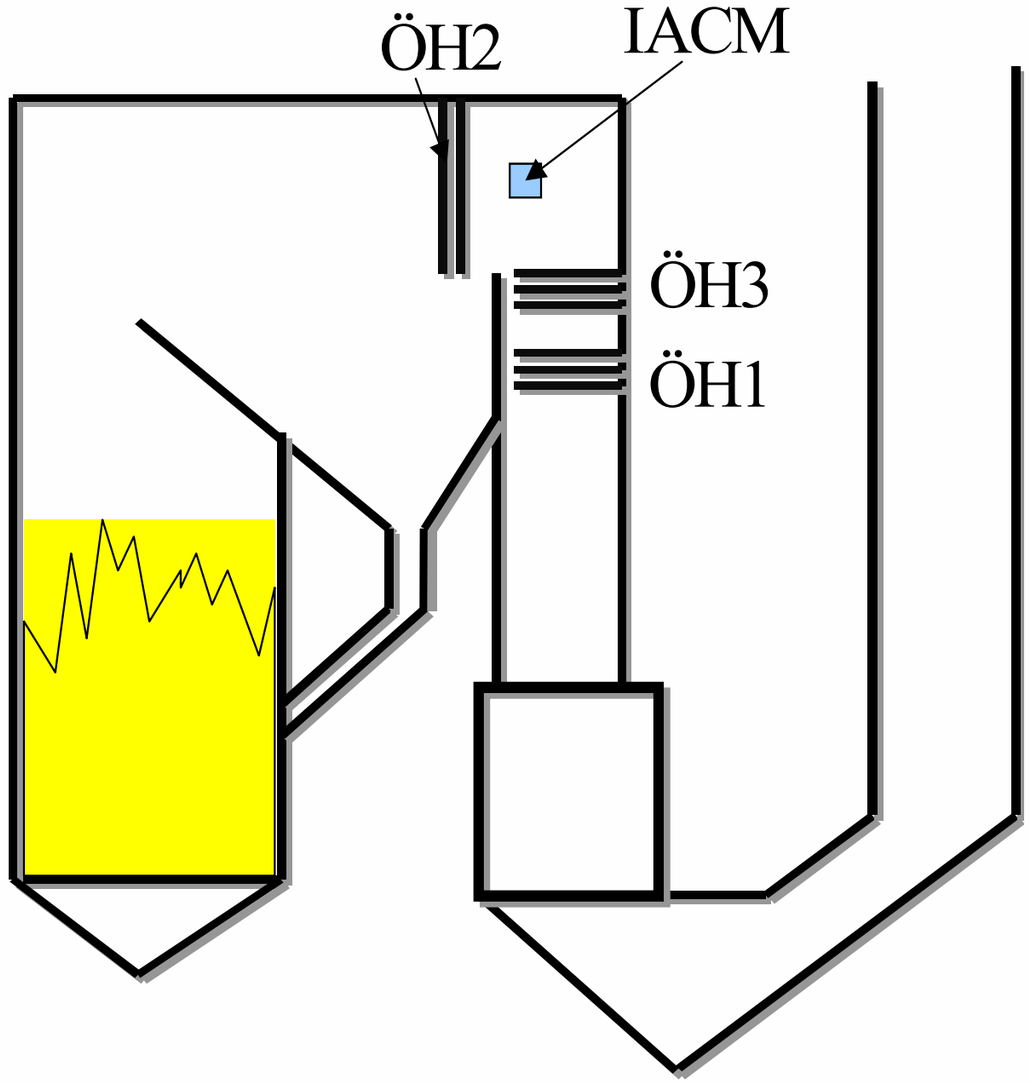
- On-line control of the in-coming fuel-mix by measuring KCl
- Reduction of alkali chlorides by a sulphur containing additive
- Measurements by means of deposit and corrosion probes, characterisation of the flue gas environment at the super heaters
- Reduced of deposit formation and super heater corrosion

The strategy of Vattenfall

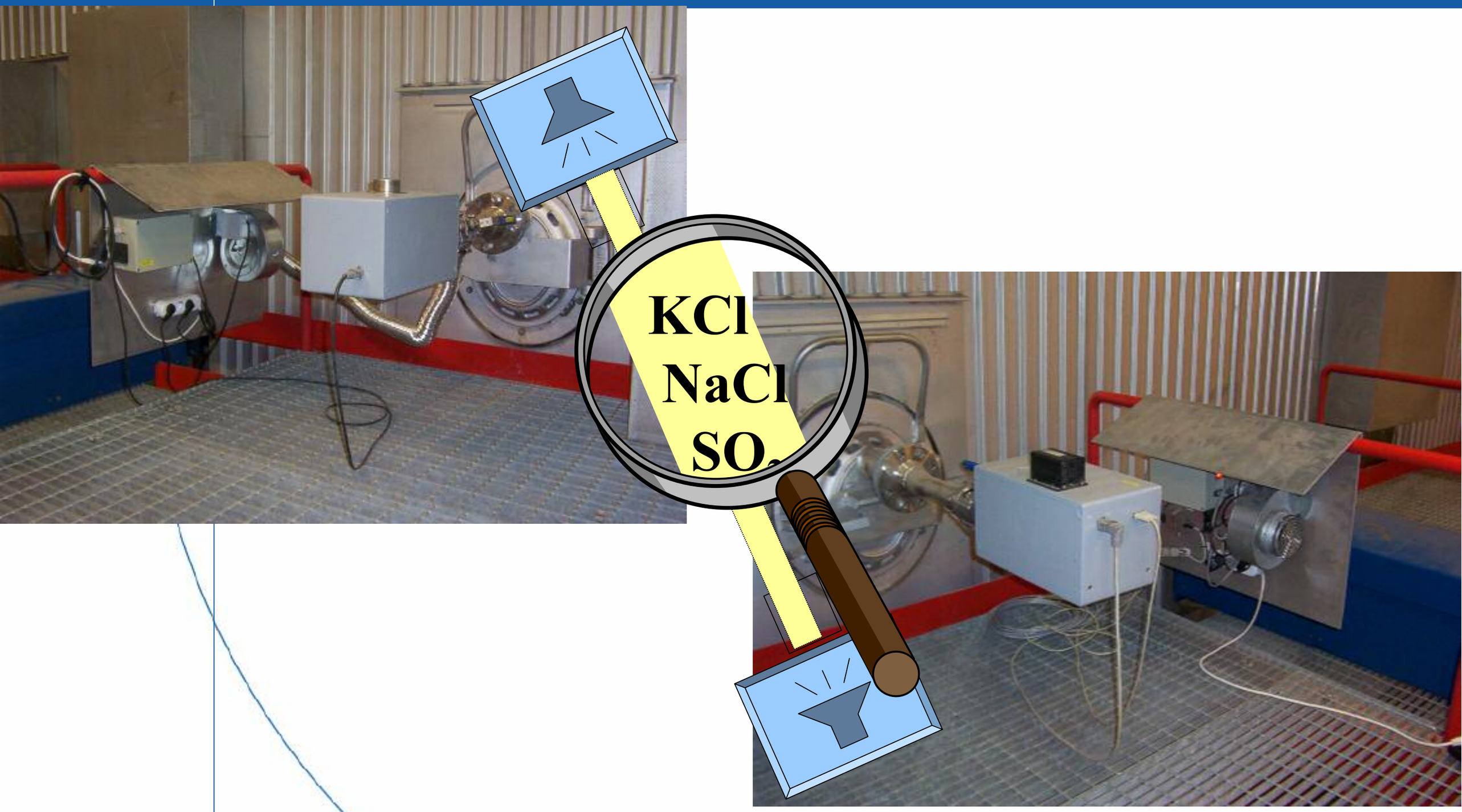
- Vattenfall has developed and patented:
- a sulphate containing additive called ChlorOut (normally ammonium sulphate) ;
- an instrument that measures KCl(g) on-line called IACM (in-situ alkali chloride monitor)
- This presentation will describe some aspects on IACM and the ChlorOut concept.
- Results from a research campaign in a typical application of the concept.

IACM

- In-situ Alkali Chloride Monitor
- Measures KCl, NaCl and SO_2 on-line at 600-1500 °C
- 3 - 15 m measuring length
- 5 sec measurement time
- ~1 ppm detection limit

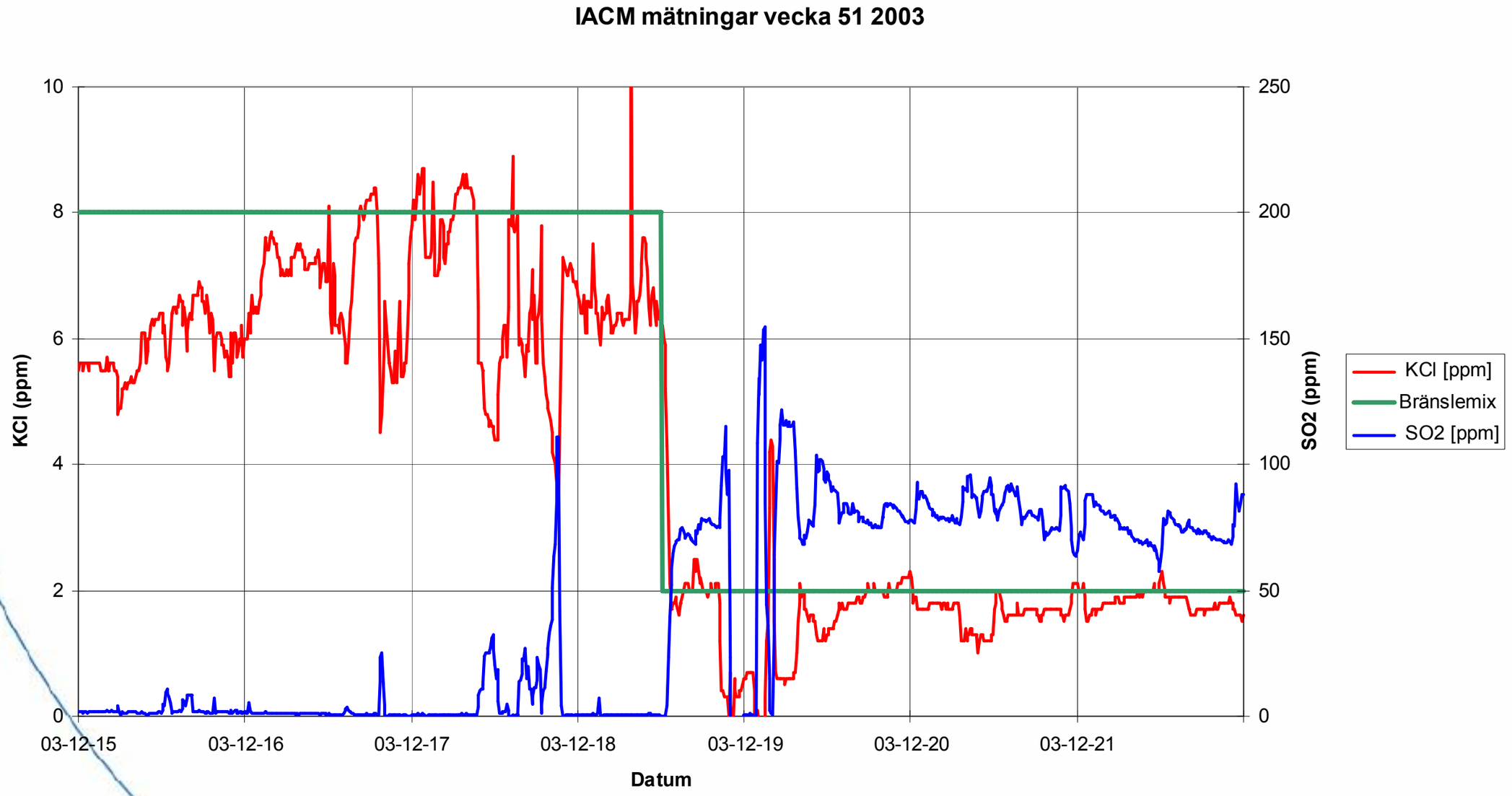


IACM



Helsingborg - On-line control of the fuel quality

Conversion of a PF burner from co-combustion of coal to 100% bio-fuel



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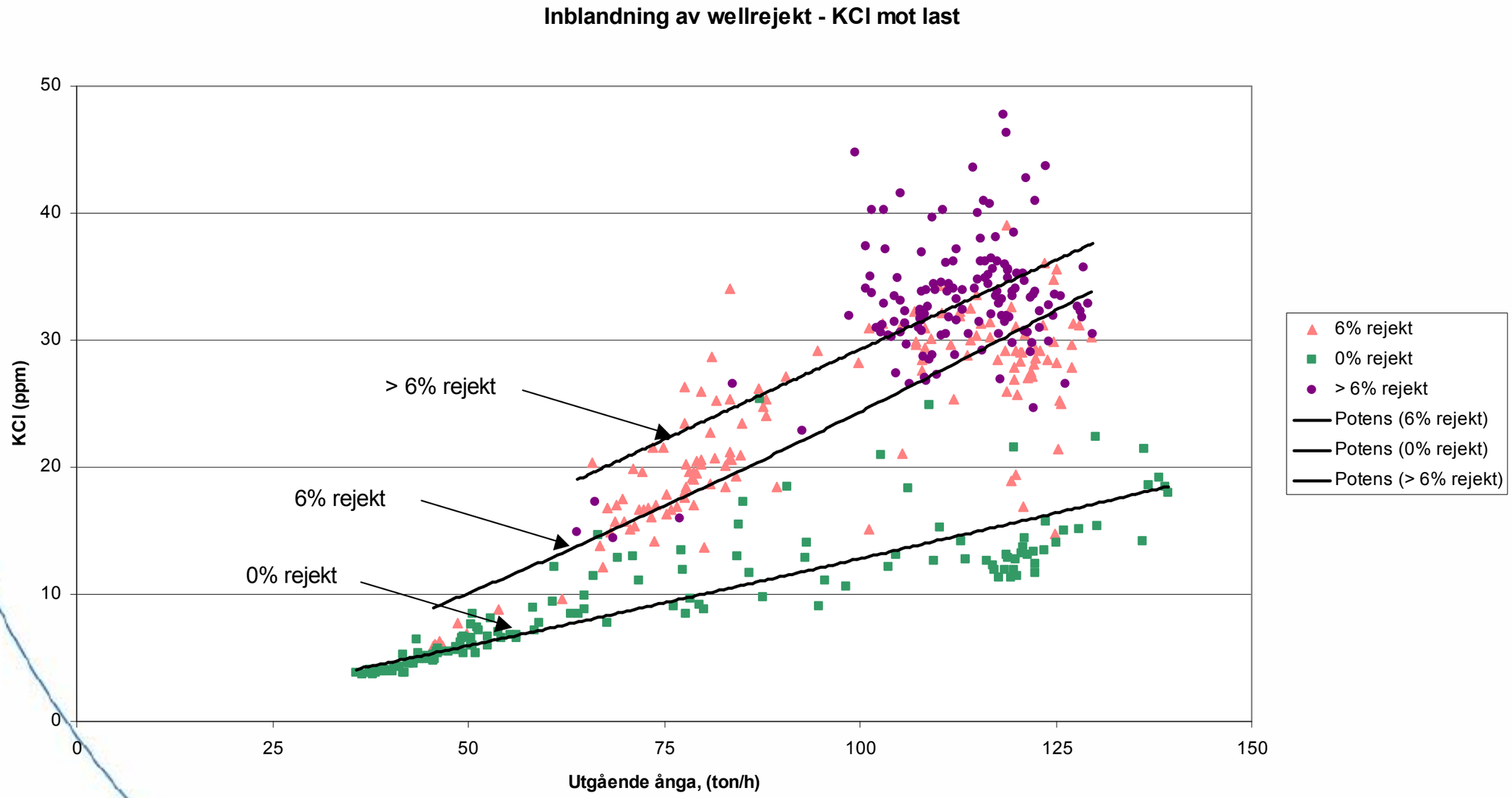
Munksund – Previous results



The ChlorOut concept

- ChlorOut (ammonia sulphate) is sprayed into the flue gases and converts chlorides to sulphates, which reduces corrosion and fouling. It also reduces NOx and CO.
- Main chemical reactions:

$$(NH_4)_2SO_4 \rightarrow 2\,NH_3 + SO_3 + H_2O$$

$$SO_3 + H_2O + 2KCl \rightarrow 2HCl + K_2SO_4$$

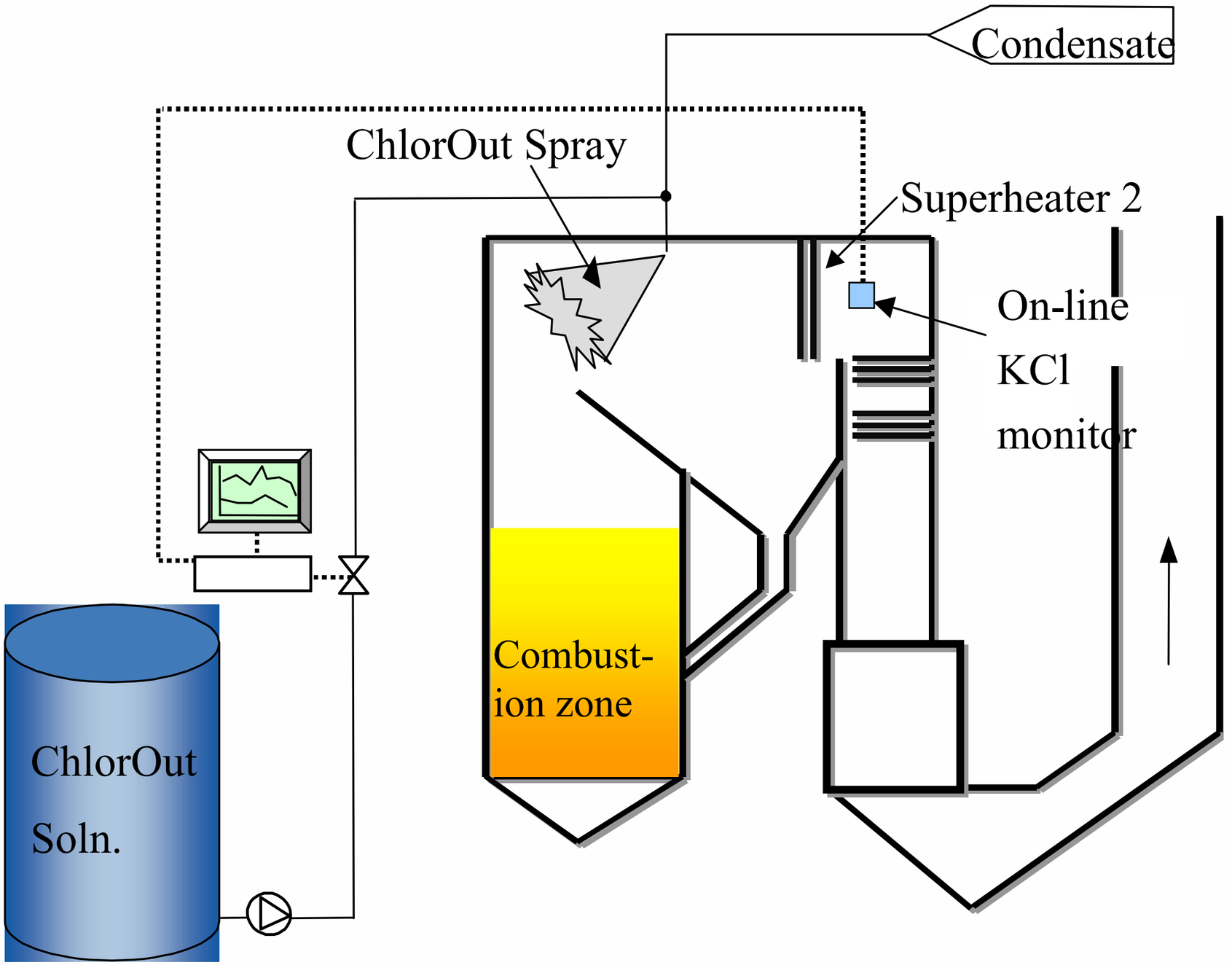
Idbäcken CHP ~ 100 MWtot BFB

Fuel:Wood chips,

demolition wood,

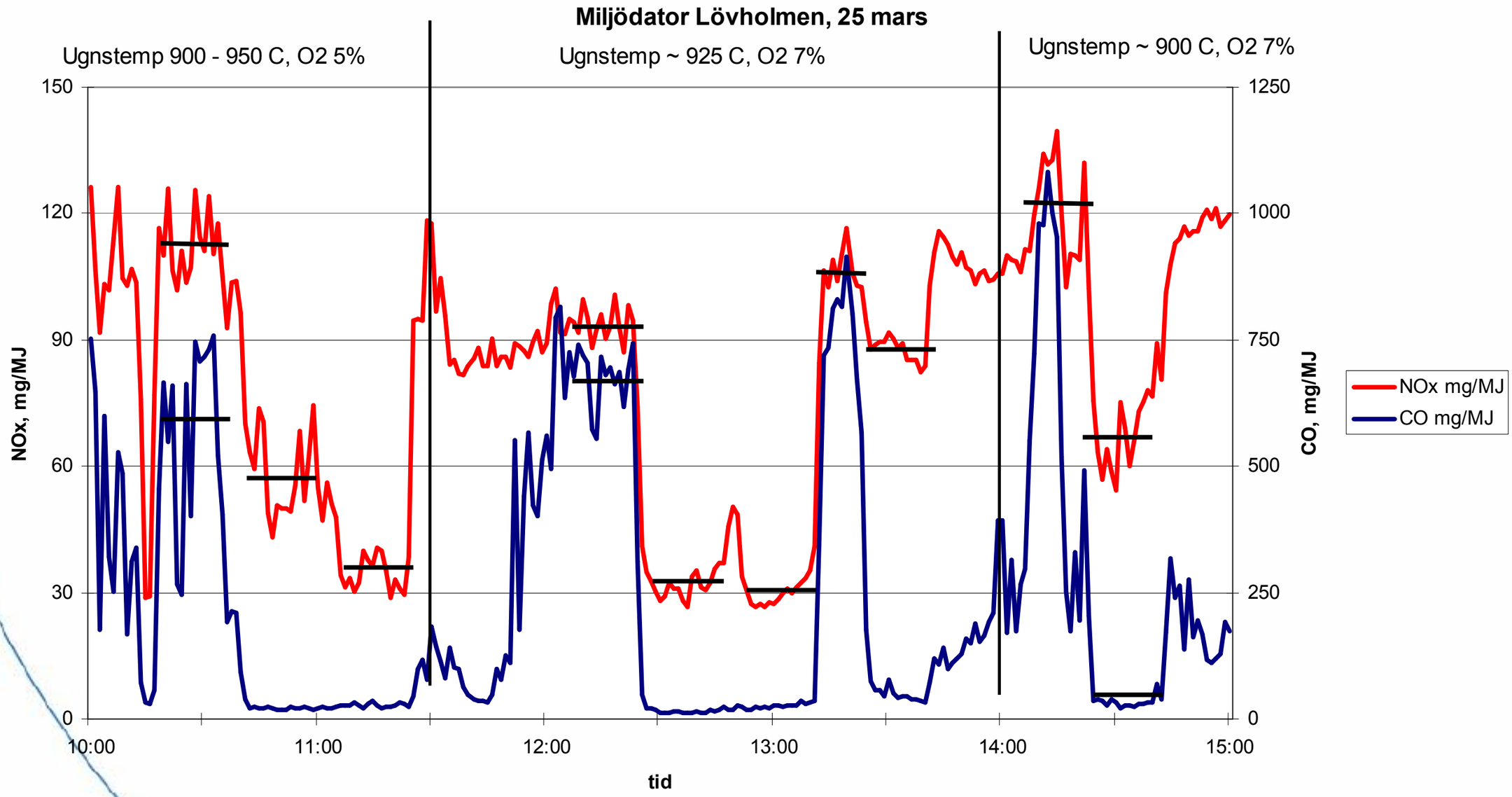
Steam data:

540°C 140 bar



Lövholmen – Reduction of NOx and CO

16 MW grate. Biofuel from a saw mill



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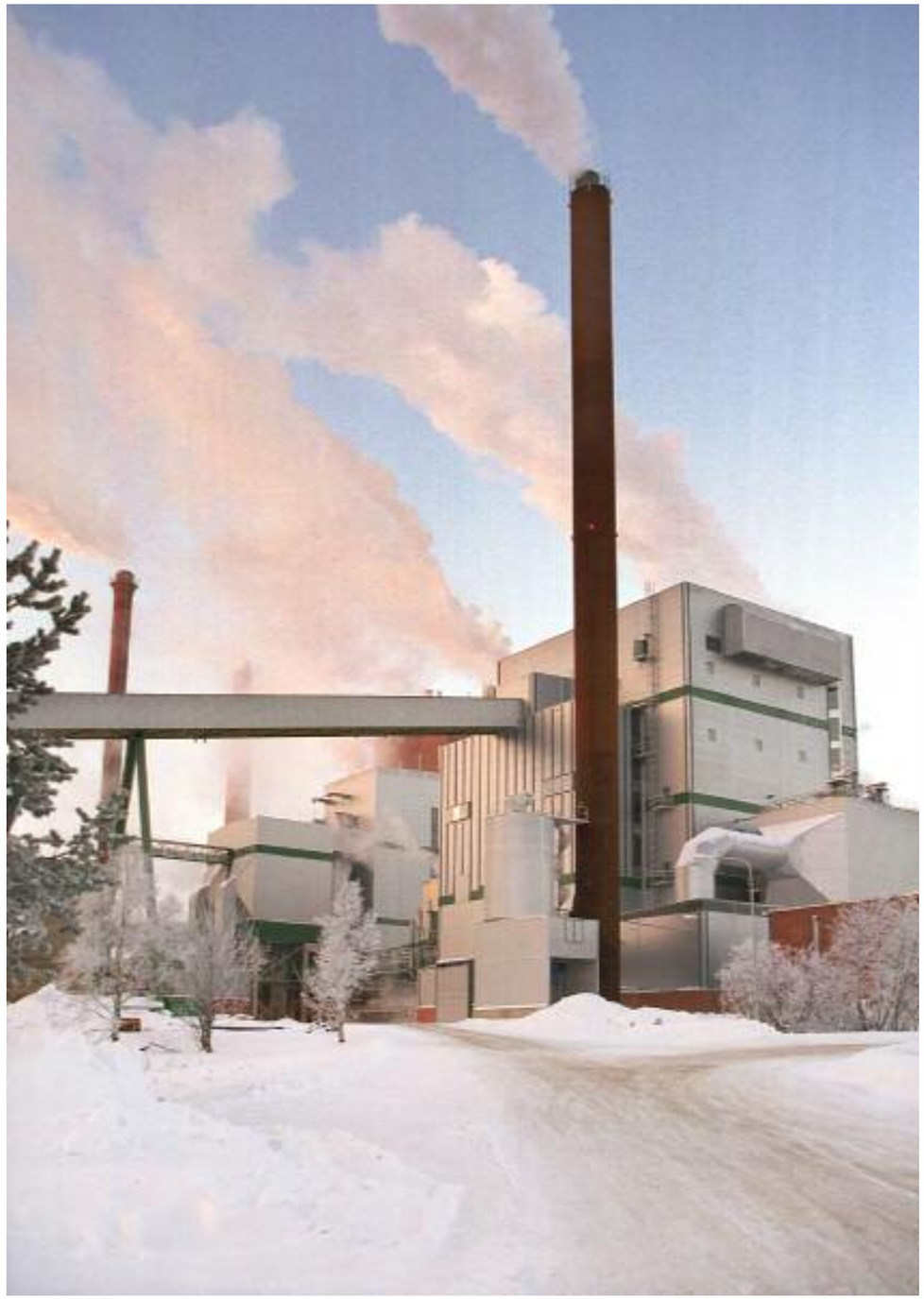
The research campaign in Munksund

98 MWth CFB boiler
Fuel: Mainly bark>80%, sawdust, wood chips, 6% plastic waste (comes from cardboard recycling)

Steam data : 420°C after SH2
480°C 60 bar after an Intrex.

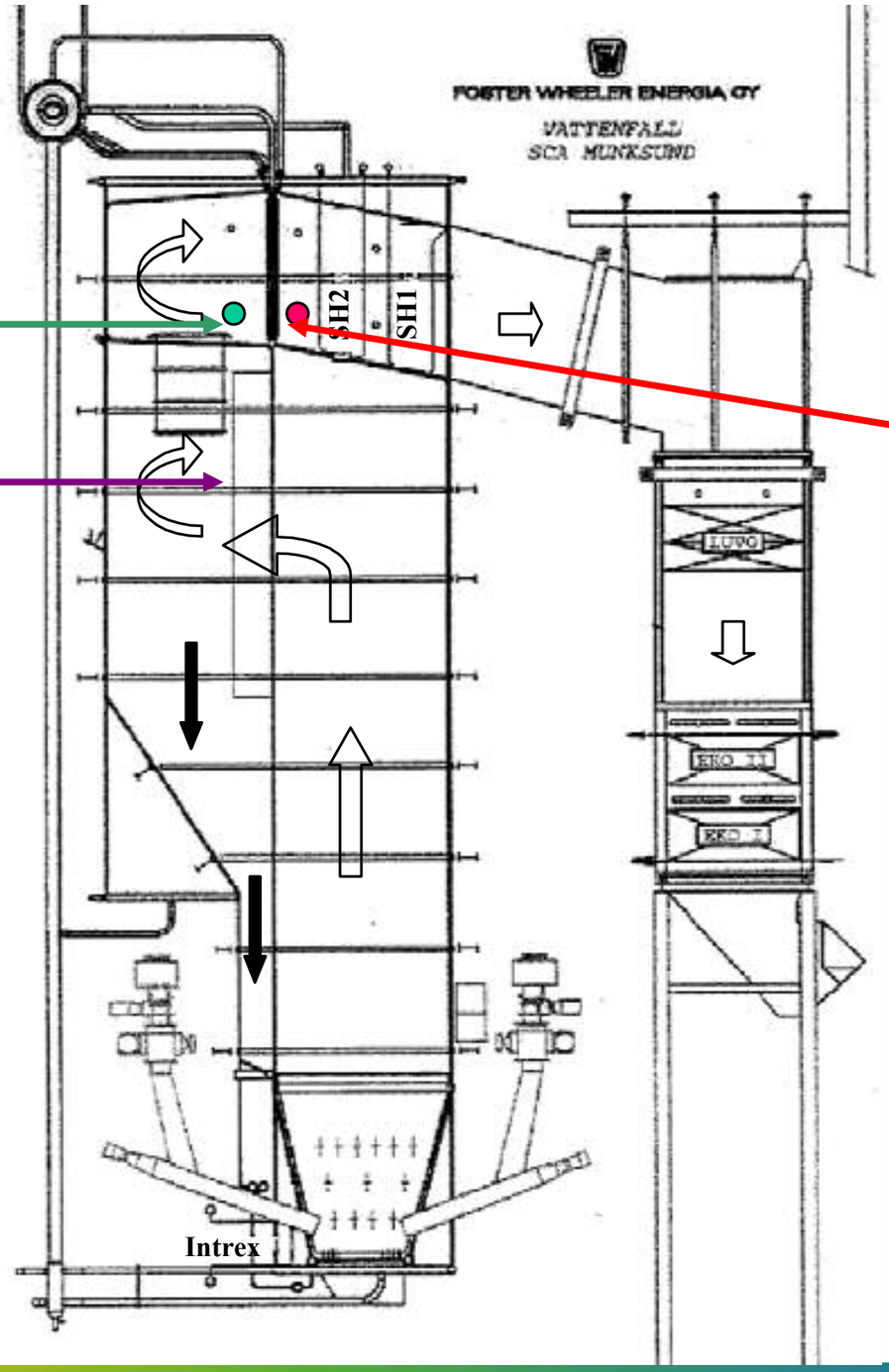
Two separate cyclones, the flue gases mix again prior to SH2



The research campaign in Munksund

- A short term-measurement campaign: Normal fuel mix, Normal + ChlorOut, 20% Peat + Normal, IACM, deposit probes, DLPI impactor, FTIR
- Right side injection of ChlorOut: Normal fuel mix, Normal + ChlorOut, IACM, deposit and corrosion probes,
- Long-term measurements: IACM, ChlorOut, Corrosion probes, data recording from the plant including stack emissions

The Munksund boiler



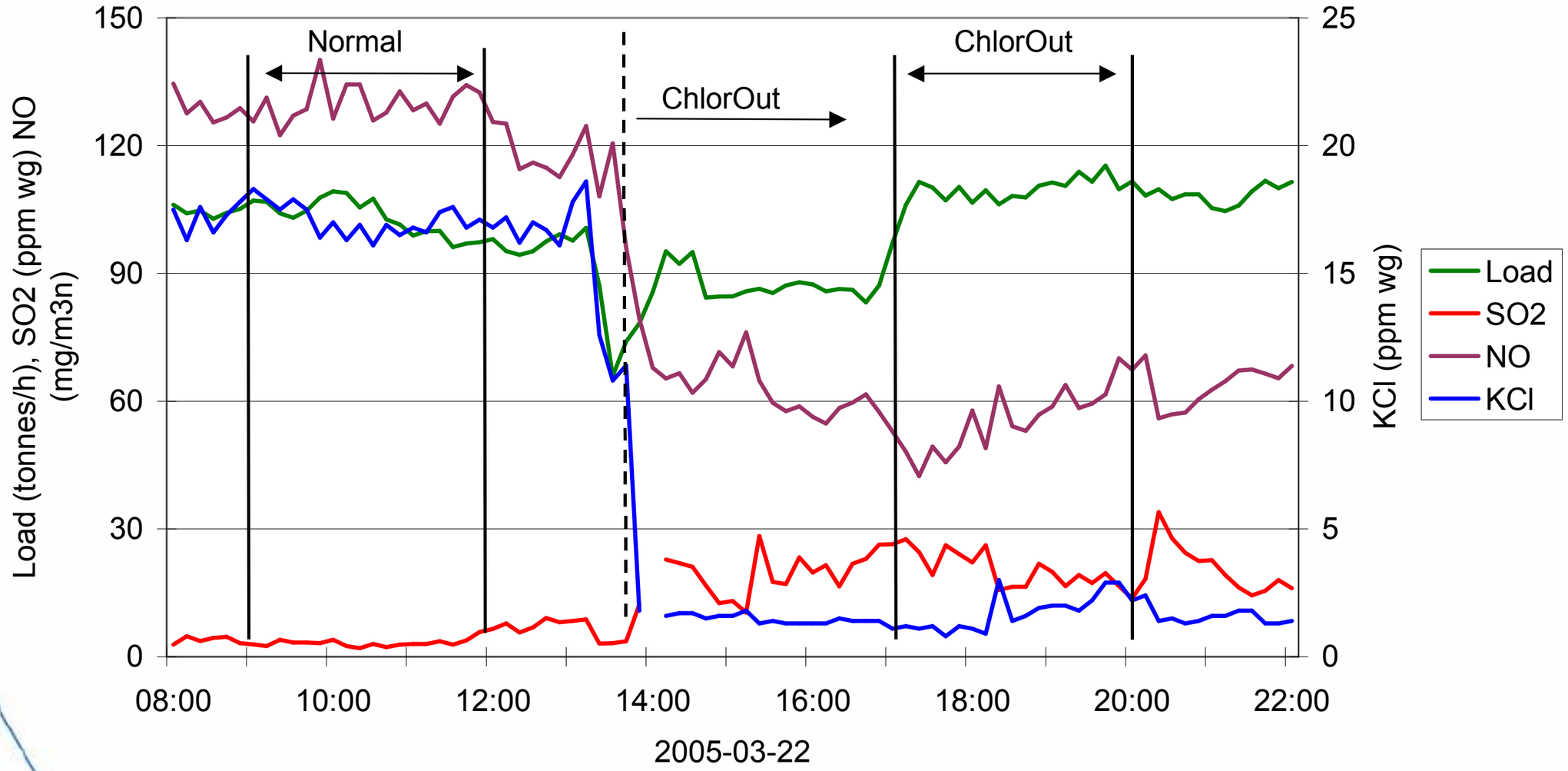
IACM

ChlorOut

Corrosion/ deposit probes

FTIR

Short-term – Reduction of alkali chlorides



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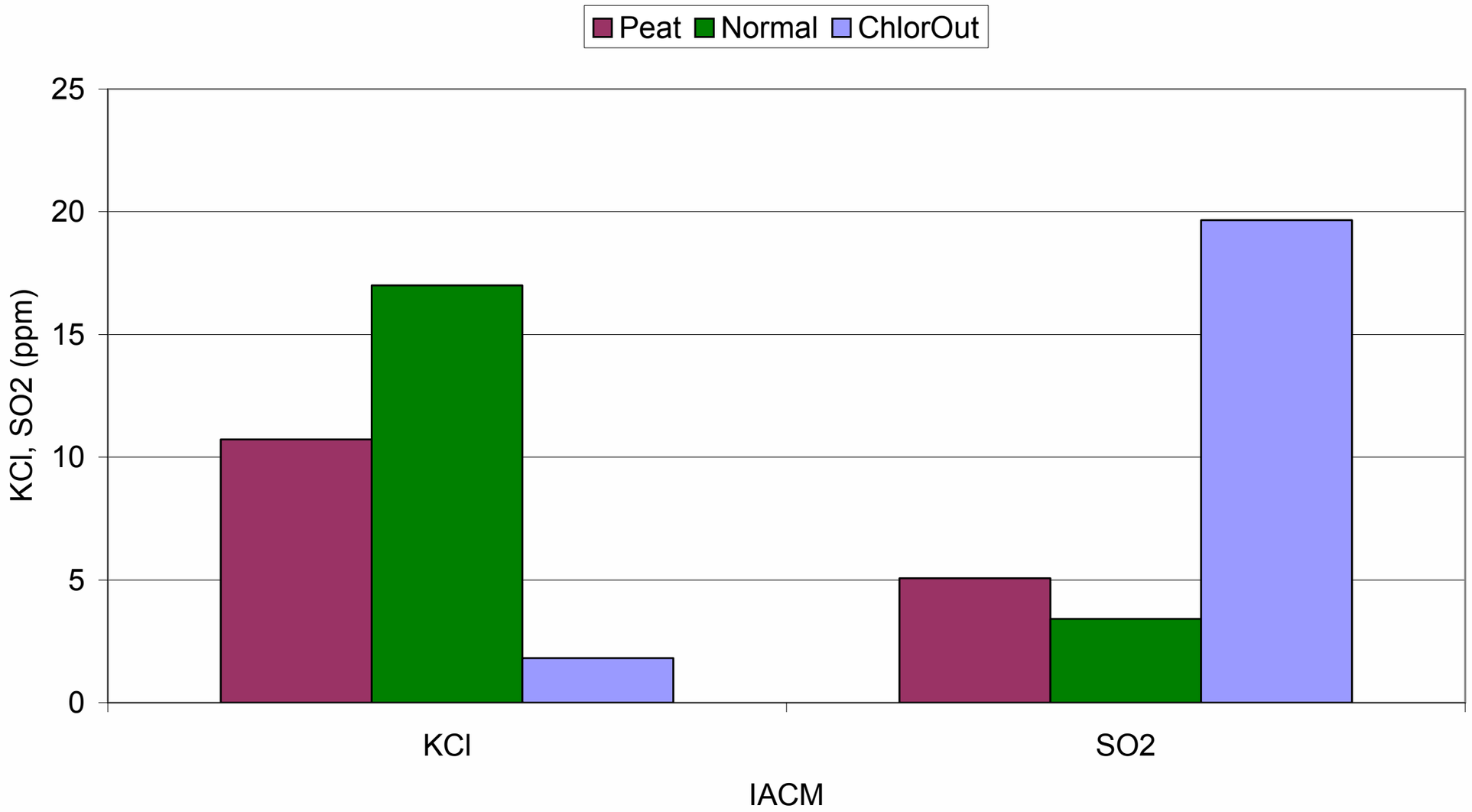
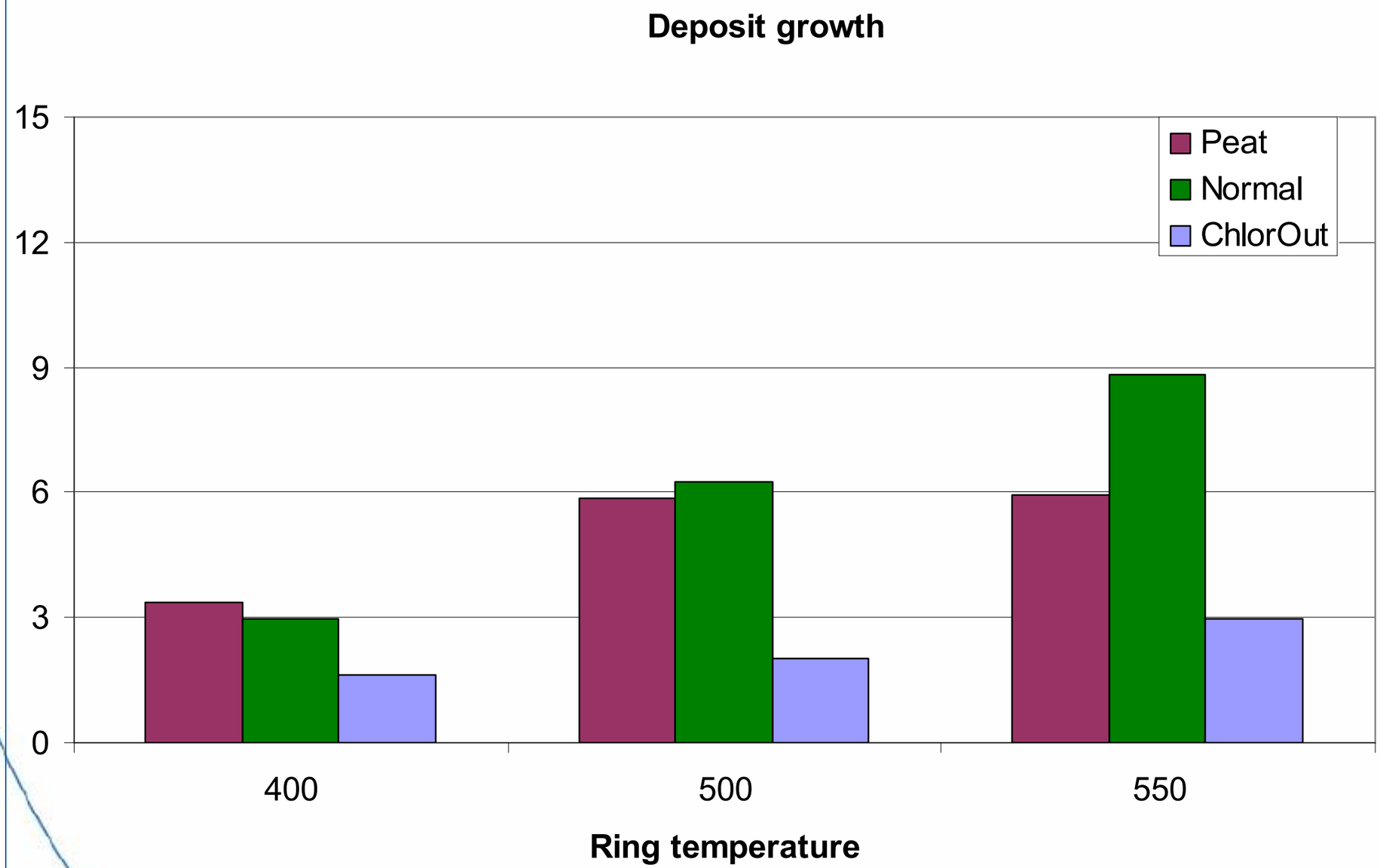
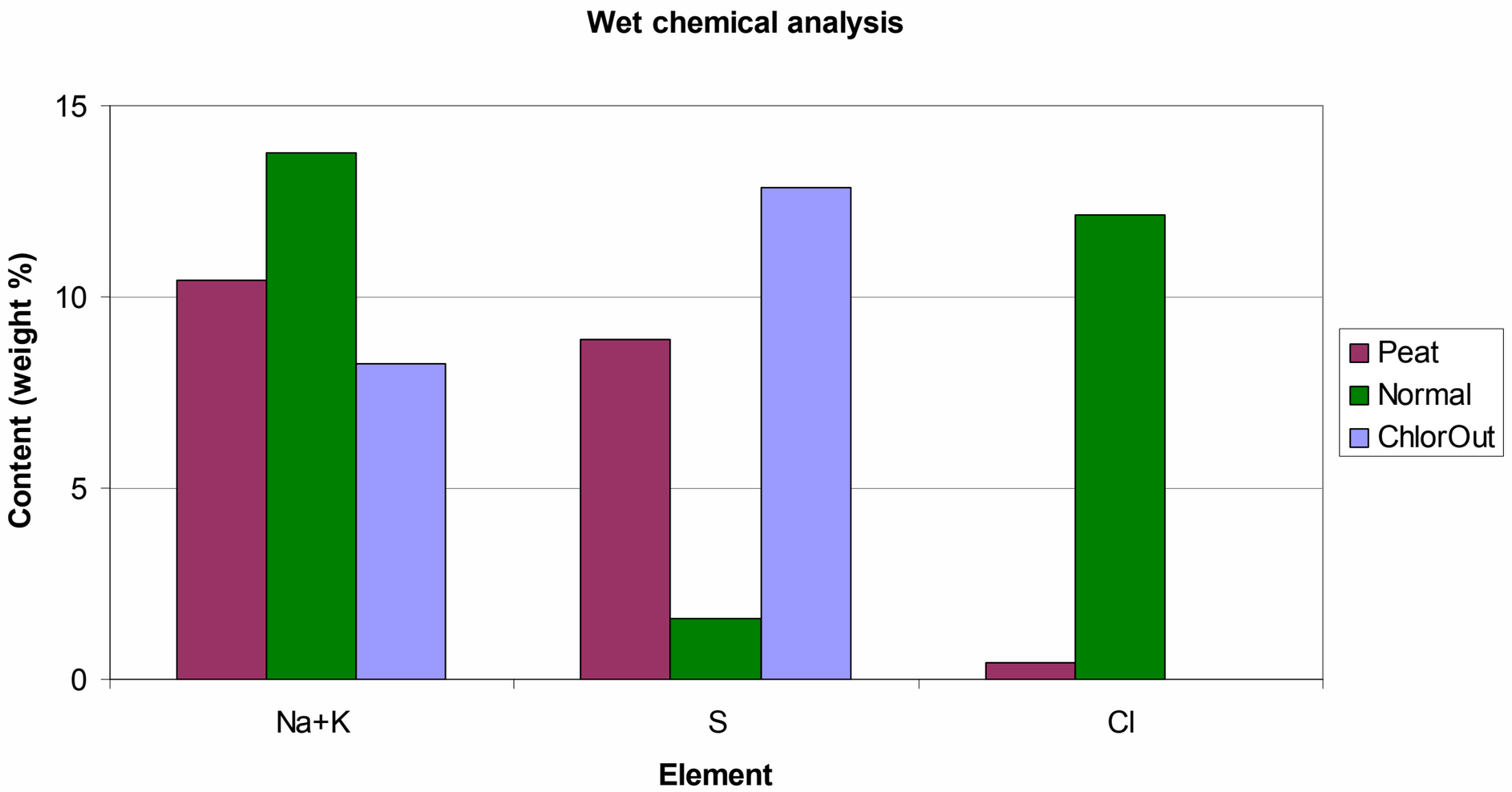


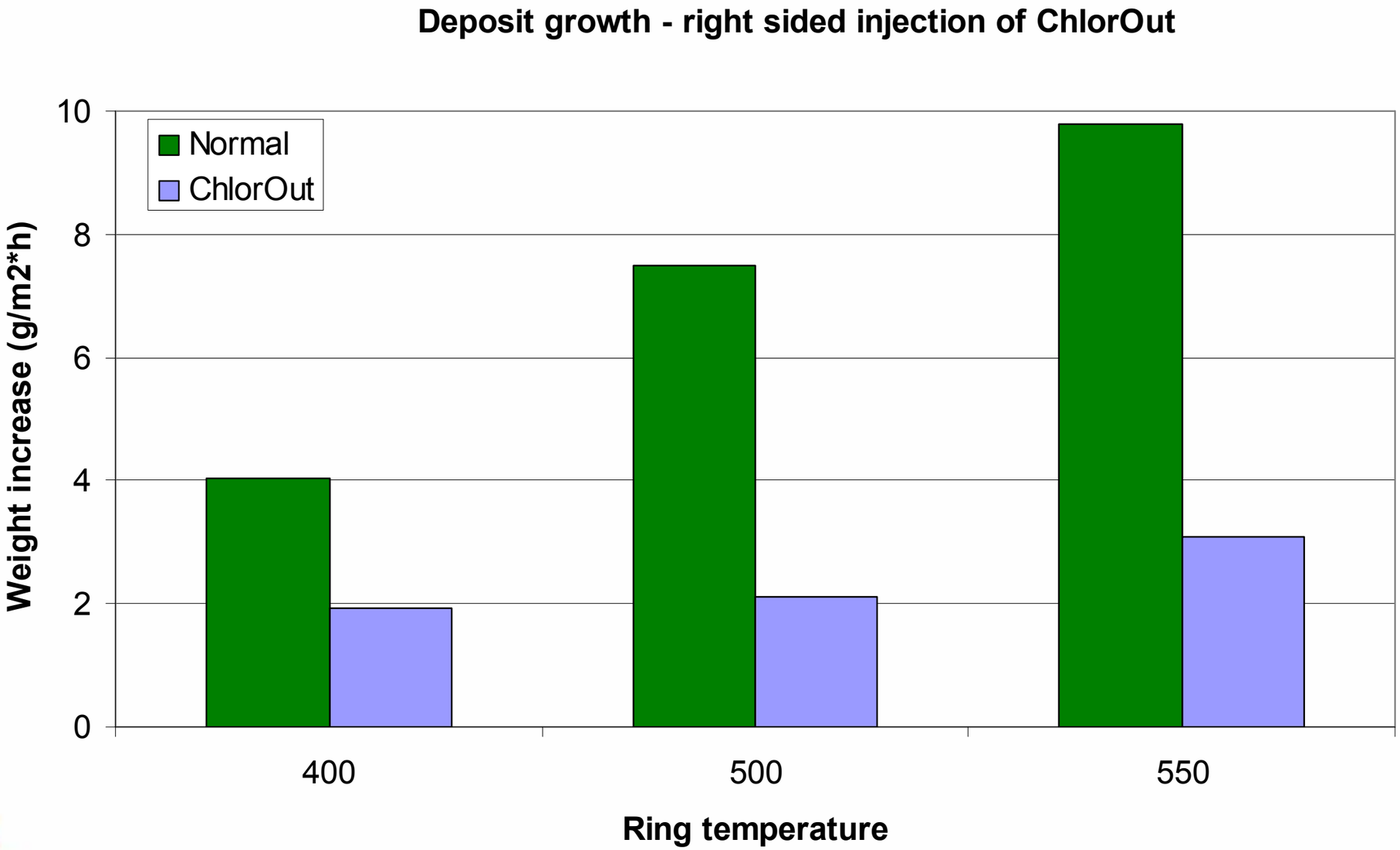
Short-term – Deposit growth



Short-term – Wet chemistry, 500°C



Right sided injection – Deposit growth



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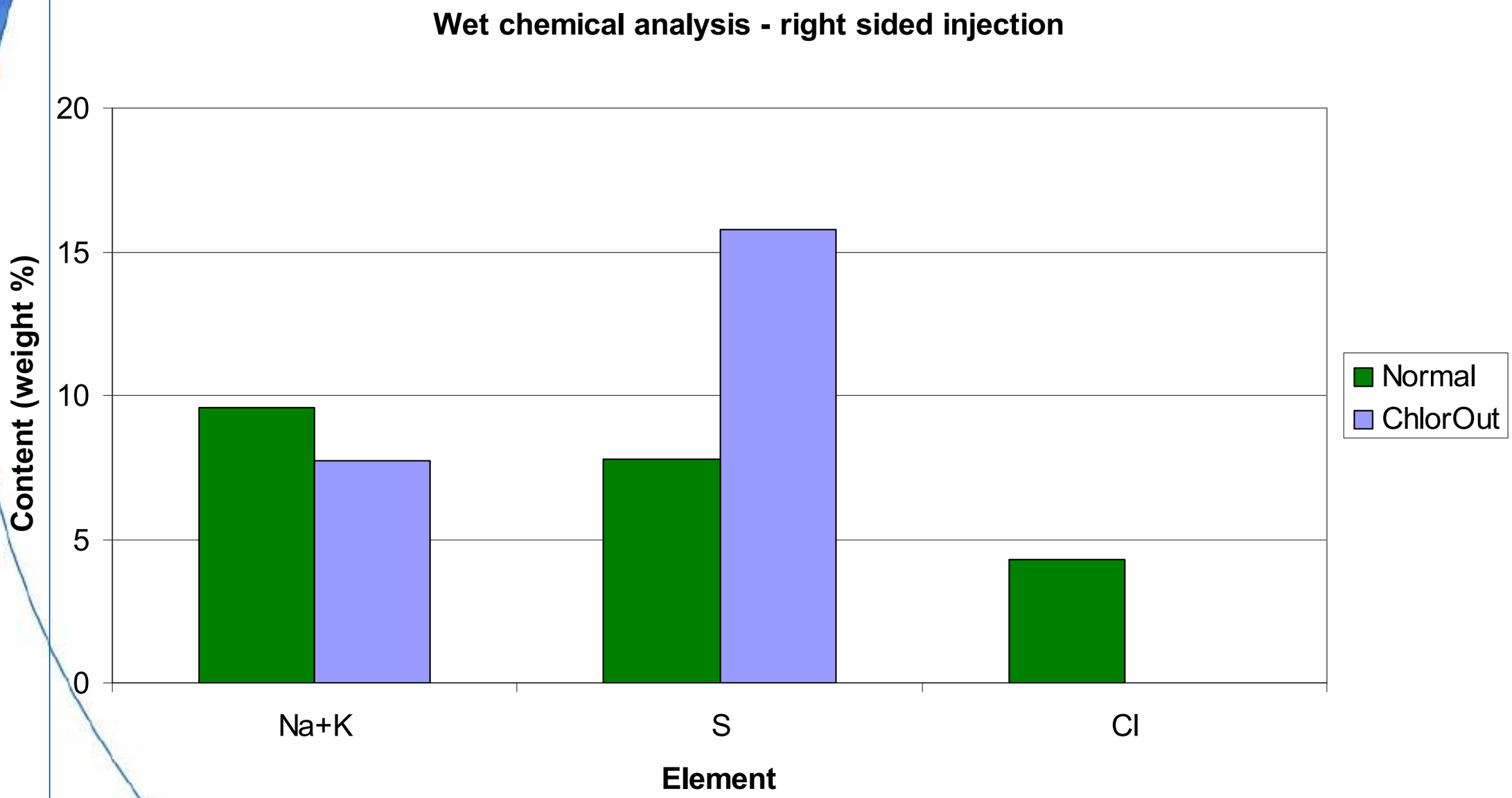

Right sided injection – the corrosion probe

- A corrosion probe exposed during 4 weeks
- Left side: Normal fuel mix
- Right side: Normal fuel mix + ChlorOut

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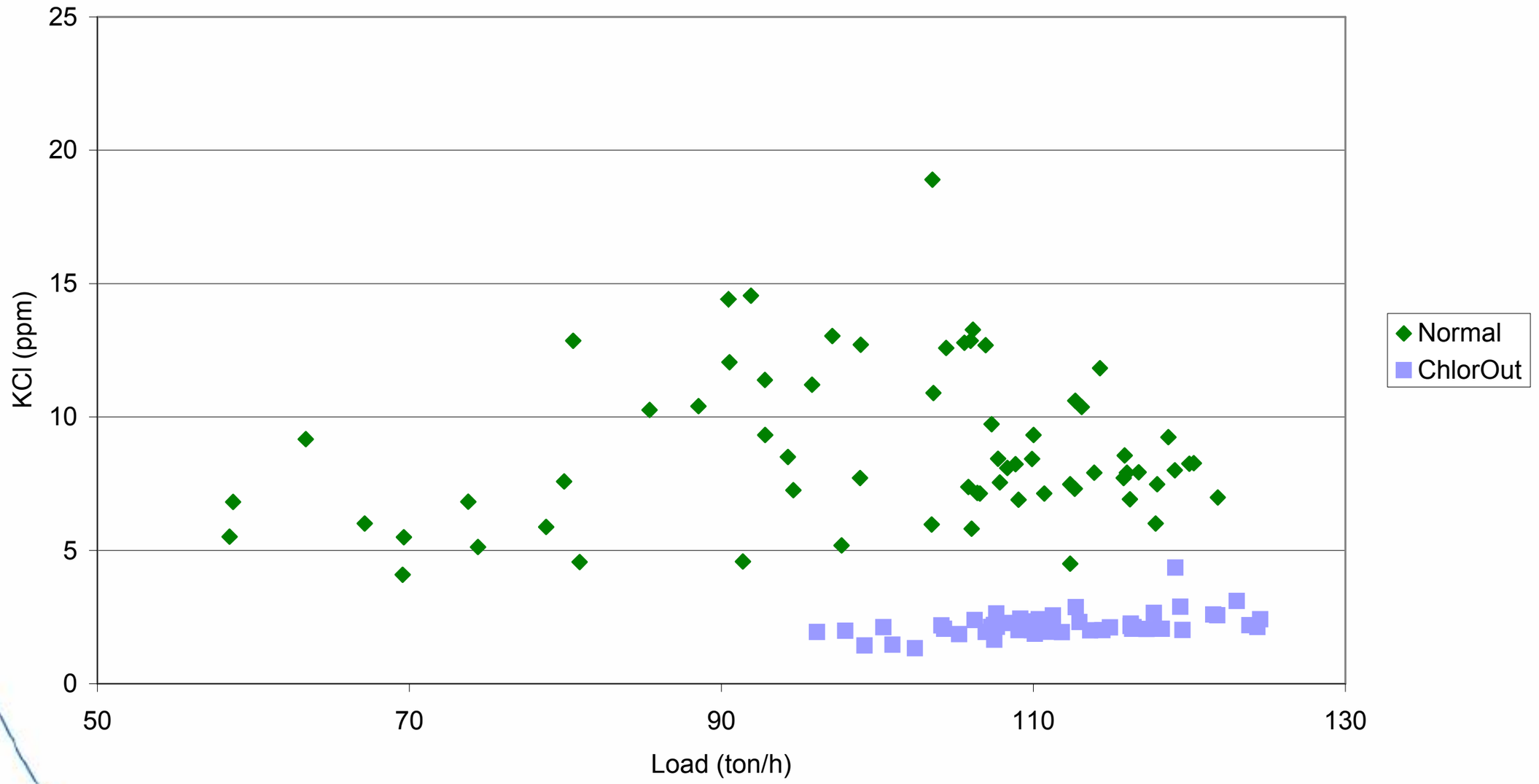
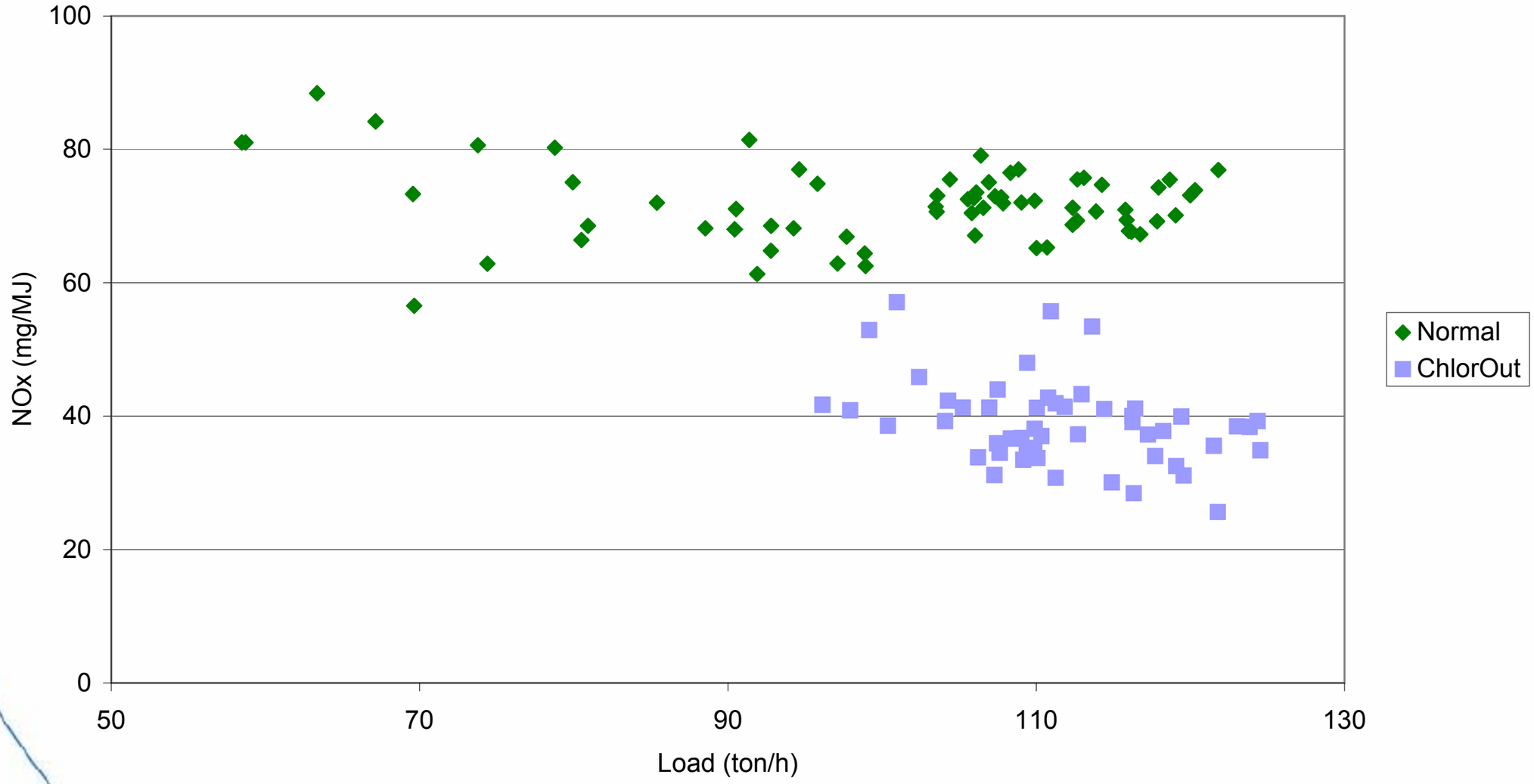
Long-term measurements – KCl vs load



Long-term measurements – NOx vs load



Conclusions – the research campaign

- It was possible to measure KCl (g) on-line with IACM. It was also possible to distinguish between normal fuel-mix with and without an additive
- The deposit growth decreased during ChlorOut
- The deposits content of Cl decreased during both ChlorOut and co-combustion with peat
- NOx was significantly reduced during ChlorOut