Forskningen inom KME/HTC relaterat till högtemperaturkorrosion på överhettartuber och eldstadsväggar

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HTC - Kompetenscentrum Högtemperaturkorrosion

- Bedriver grundläggande forskning inom högtemperaturkorrosion
  - Fokus på frågor med relevans för energiapplikationer

- Centrat och projekt delfinansieras av Energimyndigheten
- Koordineras av Chalmers Tekniska Högskola
- Bildat 1996

www.htc.chalmers.se

HTC - Kompetenscentrum Högtemperaturkorrosion

- Deltagande forskningsorganisationer
  - Chalmers tekniska högskola
  - Swerea KIMAB
  - Swerea IVF
  - Kungliga tekniska högskolan

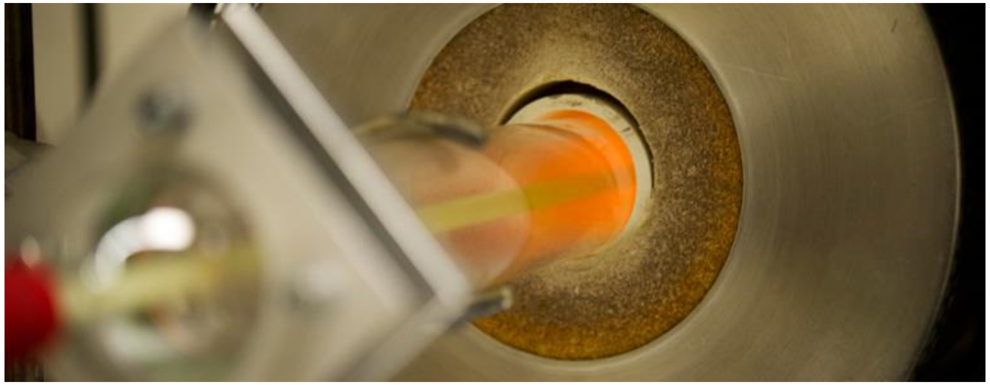
- Deltagande företag
  - Andritz Oy
  - Babcock & Wilcox Völund A/S
  - Castolin Scandinavia AB
  - Cortus Energy
  - Energiforsk
    - E.ON
    - Fortum
    - Göteborg Energi
    - m.fl.
  - Vattenfall
  - Entech Energiteknik AB
  - Foster Wheeler Oy
  - GKN Aerospace
  - Janfire AB
  - NIBE Industrier AB
  - Power Cell Sweden AB
  - Sandvik Heating Technology
  - Sandvik Materials Technology
  - Siemens Industrial Turbomachinery AB
  - Svensk Avfallskonvertering AB
  - Topsoe A/S
  - Valmet Oy

www.htc.chalmers.se

HTC - Kompetenscentrum Högtemperaturkorrosion

- Förnybara bränslen – effektivare energiproduktion och förgasning
  - Inverkan av H_2O, SO_2, HCl, KCl, $PbCl_2$ (förbränning)
  - Inverkan av H_2, H_2O, CO, HCl (förgasning)
  - Inverkan av legeringssammansättningar

- Korrosionsresistenta material för morgondagens energisystem



www.htc.chalmers.se

KME - Konsortium Materialteknik för Termiska Energiprocesser

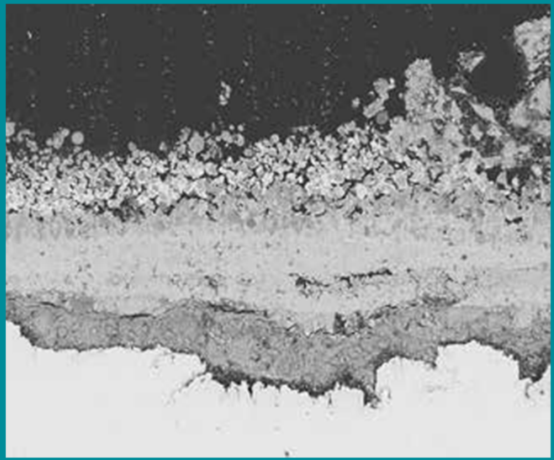
KME
CONSORTIUM MATERIALS TECHNOLOGY
for thermal energy processes

- Bedriver tillämpad forskning inom materialteknik inklusive högtemperaturkorrosion
  - Endast frågor med industrirelevans för termiska energiprocesser
- Projekt delfinansieras av Energimyndigheten
- Koordineras av Energiforsk
- Bildat 1997

www.energiforsk.se/program/kme

KME - Konsortium Materialteknik för Termiska Energiprocesser

- Deltagande forskningsorganisationer
  - Chalmers tekniska högskola
  - Swerea KIMAB
  - Linköpings universitet
  - Kungliga tekniska högskolan
  - Lunds universitet
- Deltagande företag
  - Andritz
  - Amec Foster Wheeler
  - Babcock & Wilcox Vølund
  - GKN Aerospace Sweden
  - MH Engineering
  - Sandvik Heating Technology
  - Sandvik Materials Technology
  - Siemens Industrial Turbomachinery
- Energiforsk
  - DONG Energy
  - E.ON
  - Fortum
  - Gävle Energi
  - Göteborg Energi
  - Jämtkraft
  - Karlstads Energi
  - Kraftringen
  - Mälarenergi
  - Svensk fjärrvärme
  - Söderenergi
  - Tekniska verken i Linköping
  - Vattenfall
  - Öresundskraft



www.energiforsk.se/program/kme

KME-708, High temperature corrosion in waste-wood fired boilers

Pamela Henderson (project leader)

Rikard Norling
Annika Talus

Jouni Mahanen
Edgardo Coda Zabetta

Anna Jonasson
Colin Davis

Eva-Katrin Lindman
Jukka Meskanen

Susanne Selin
Jesper Ederth

KME-708, High temperature corrosion in waste-wood fired boilers

- Increasing use is being made of waste wood as a fuel in heat and power boilers, because it is cheaper than virgin wood.
- However waste wood causes more corrosion problems, especially in the furnace where there is a lack of oxygen (low NOx combustion).
- This project seeks to find cost effective ways of reducing the corrosion, thus saving maintenance costs, or increasing fuel flexibility.

KME-708, High temperature corrosion in waste-wood fired boilers

Some questions to be answered by the project

- Are there materials available that perform as well as conventional Ni-base alloys, but are cheaper?
- Are there materials that perform better than conventional Ni-base alloys but are more cost effective (i.e. with little or no cost increase)
- How (by what mechanisms) does sewage sludge affect the initial corrosion process ?
- By how much does the chemical composition of waste wood affect the corrosion for a low alloyed steel and a high alloyed steel or Ni-alloy ? (Find extreme cases of waste wood , say low Pb and Cl versus high Pb and Cl)
- How does Pb participate in the corrosion process ?

KME-718, High temperature corrosion in used-wood fired boilers – fuel additives and coatings

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Susanne Selin
Jesper Ederth

KME-718, High temperature corrosion in used-wood fired boilers – fuel additives and coatings

Continuation of KME-708

Focus is on long-term testing:

- Influence of fuel additives (sludges)
- Performance of coatings

KME-717, Boiler corrosion at lower temperatures – influence of lead, zinc and chlorides

VATTENFALL

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Pamela Henderson

swerea|KIMAB

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Annika Talus

ANDRITZ
Christoph Gruber

Fortum
Eva-Katrin Lindman

Åbo Akademi
Patrik Yrjas

KME-717, Boiler corrosion at lower temperatures – influence of lead, zinc and chlorides

- Extensive work has been done on high temperature corrosion (> 450℃) caused by KCl and NaCl present in wood fuels. Much less is known about corrosion at low and intermediate temperature, 150-420℃, and particularly by Pb and Zn (and their chlorides) found in used (recycled) wood.
- Laboratory testing of low alloyed steel has shown that $ZnCl_2$ is more corrosive than KCl at 250-400℃.
- Results from calculations have shown that the addition of sulphur to a fuel such as used wood could result in a sharp increase in $ZnCl_2$ and $PbCl_2$ in the gas phase.

KME-717, Boiler corrosion at lower temperatures – influence of lead, zinc and chlorides

- This project includes laboratory testing, thermodynamic equilibrium modelling, and probe testing at 150-420℃ in a real boiler firing used wood with and without use of additive.
- The full-scale testing will give new valuable knowledge about the importance of Pb and Zn for corrosion when firing used wood and waste fuels.
- From this and the results of the modelling and laboratory testing solutions for minimizing potential problems will be suggested.

KME-715, Composite Metal Polymer (CMP) for non-stick improvements in CHP plants

MH Engineering

Matti Huhtakangas (project leader)

swerea | KIMAB

Ragna Elger

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ÖRESUNDS KRAFT

Henrik Wangsell

DONG energy

Søren Aakjær Jensen

KME-715, Composite Metal Polymer (CMP) for non-stick improvements in CHP plants

- Heat and power production with ”difficult” fuels often results in extensive fouling.
- This creates problems like efficiency decrease, deposit-induced corrosion, dew-point corrosion for boiler components at low temperatures and frequent need of soot-blowing.
- The aim is to make an initial study of the properties of a new Composite Metal Polymer (CMP) based on thermal spray coating of Ni-base alloy including a hard phase together with a polymer with good non-stick properties and resistant to elevated temperatures.

KME-715, Composite Metal Polymer (CMP) for non-stick improvements in CHP plants

- A composite coating with combined properties of corrosion and erosion resistance together with good non-stick properties should minimize or even eliminate these problems, when applied on the heating surfaces.
- A composite material that minimizes the fouling problems will give energy producers improved electricity and heat output, increased availability, allow more flexible use of various fuels, decreased environmental impact, lower maintenance costs and shorter down-time periods.

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The High Temperature Corrosion Centre

Increased steam temperature in grate fired boilers – Steamboost
(KME 709)

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Torbjörn Jonsson
Jesper Liske
Loli Paz
Julien Phother

Bo Jönsson (SHT)
Johanna Nockert Olovsjö (SHT)
Mats Lundberg

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Overall Goal of KME709

- Research strategy and correlation to KME goals

Increase energy production in grate fired boilers

Laboratory studies – FeCrAl alloys + Generating new knowledge in boiler

CFD modeling | Boiler installations | Deposit tests | Corrosion tests

KME goals:

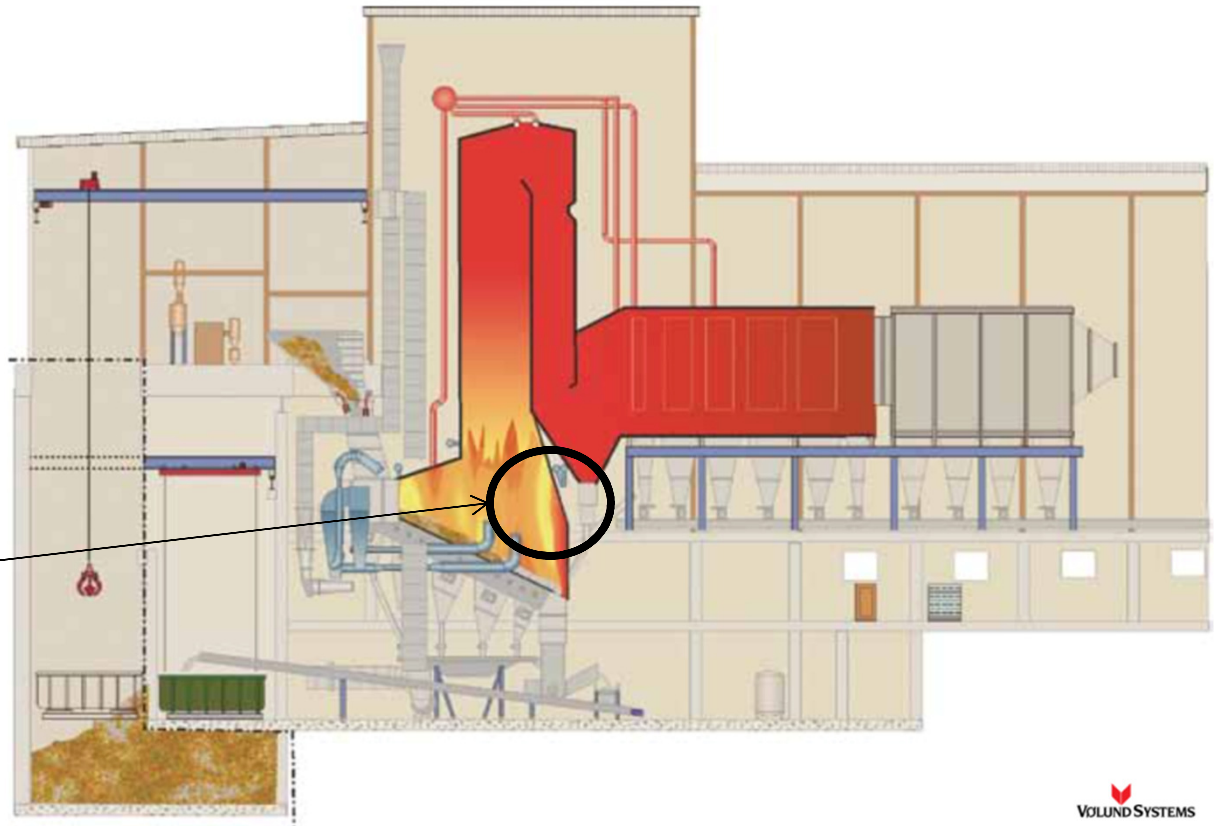
- Higher steam parameters & high electrical efficiency
- Development of novel solutions where steam is superheated in the furnace
- Develop improved material solutions – including alumina formers

Grate fired boiler

- What´s the idea behind Steamboost?

Combined heat and power plant
AffaldPlus, Denmark

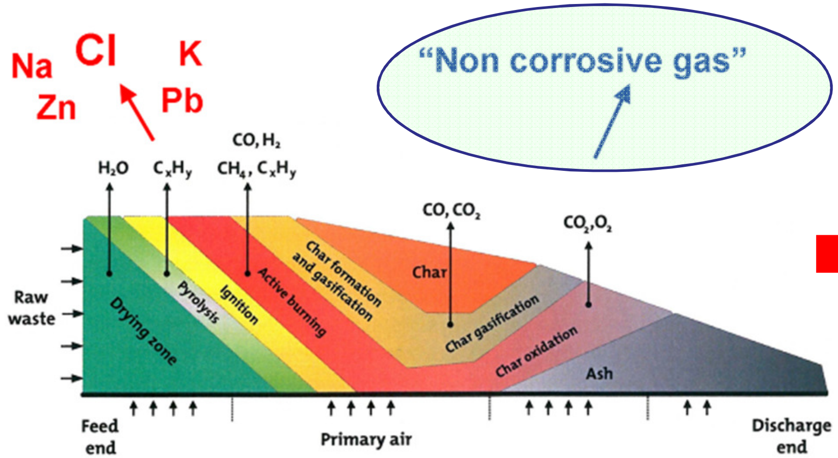
- Waste fired boiler.
- Different processes over the grid.
- **CFD calculations indicates a position over the grid with less corrosive species.**
- **New position of superheaters!**



What´s the idea behind Steamboost?

Waste incineration is a complex combustion process

Several processes over the grate



B&W vølund

KME709 strategy field exposures

CFD calculations ⟶ Gas composition

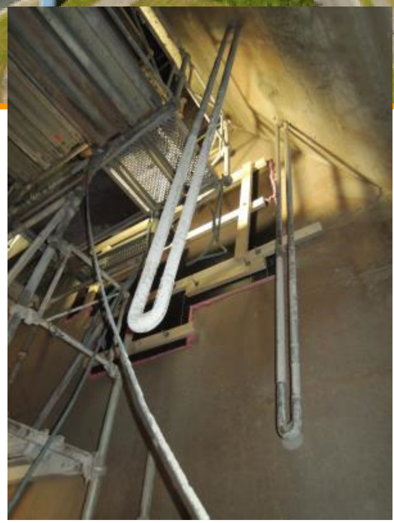
+

Deposit probes ⟶ Deposit composition

+

Deposit composition ⟶ Corrosion attack

Naestved- Steamboost



CONSORTIUM MATERIALS TECHNOLOGY

The High-Temperature Corrosion Center

KME711

Combating superheater corrosion by new materials and testing procedures - Corrosion experiments in the waste fired CFB boiler P15 at Händelö

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Magnus Eriksson

Per Oxelmark

Anna Jonasson, Bengt-Åke Andersson, Magnus Liljegren, Erik Skog (consultant)

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Goal of the Project

Improve plant economy by enabling an increased green electricity production and optimum material selection

Correlating corrosion ➔ Flue gas

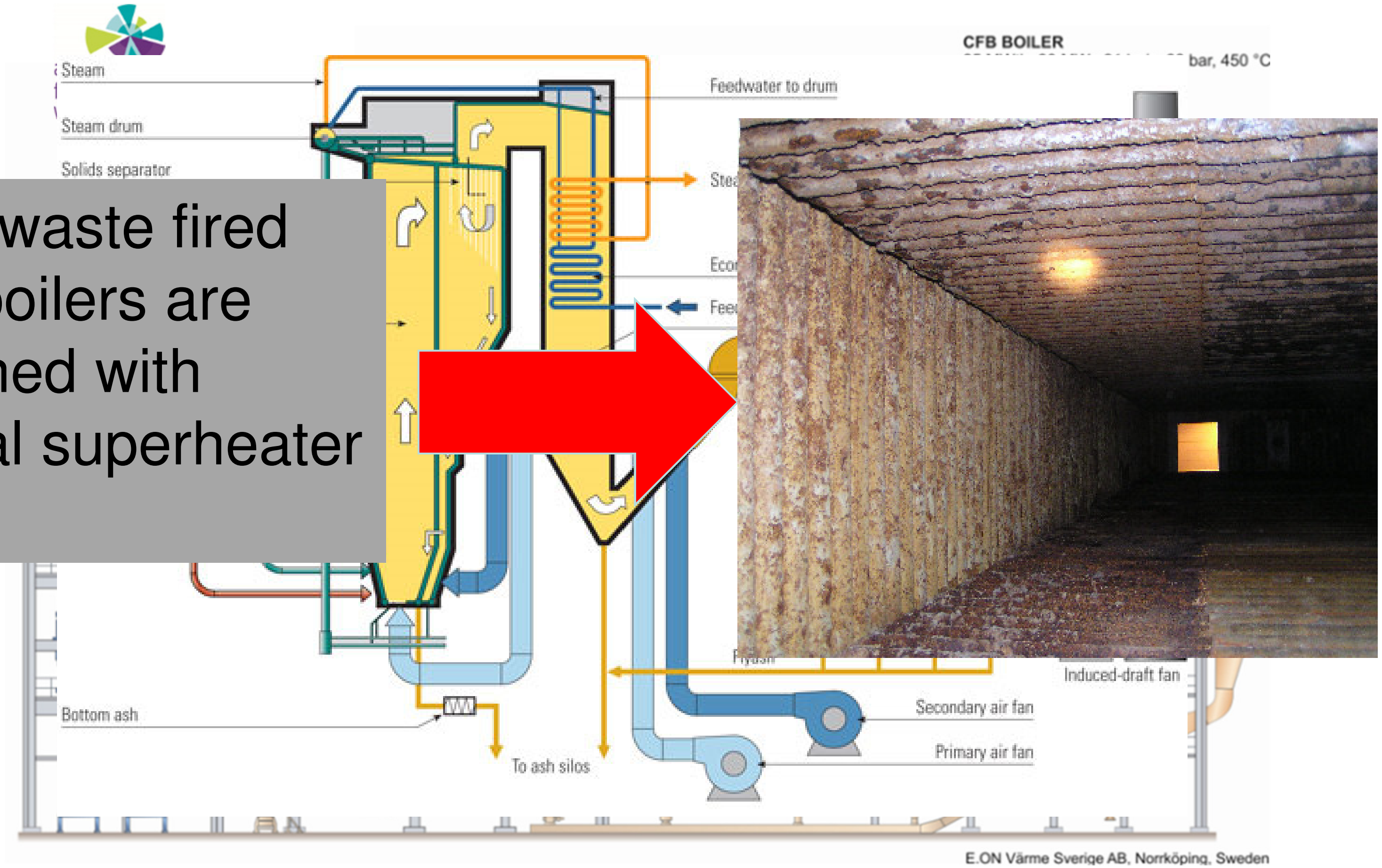
Quantifying corrosion rates for different materials and coatings

Verifying corrosion test in horizontal designed boiler

Comparing different corrosion testing methods

Background

Many waste fired CFB boilers are designed with vertical superheater bank



Project Plan

1

Investigate corrosion of the superheaters in a boiler with horizontal design using 3 different corrosion testing methods

2

How does the corrosivity of flue gas varies depending on its temperature and chemistry?

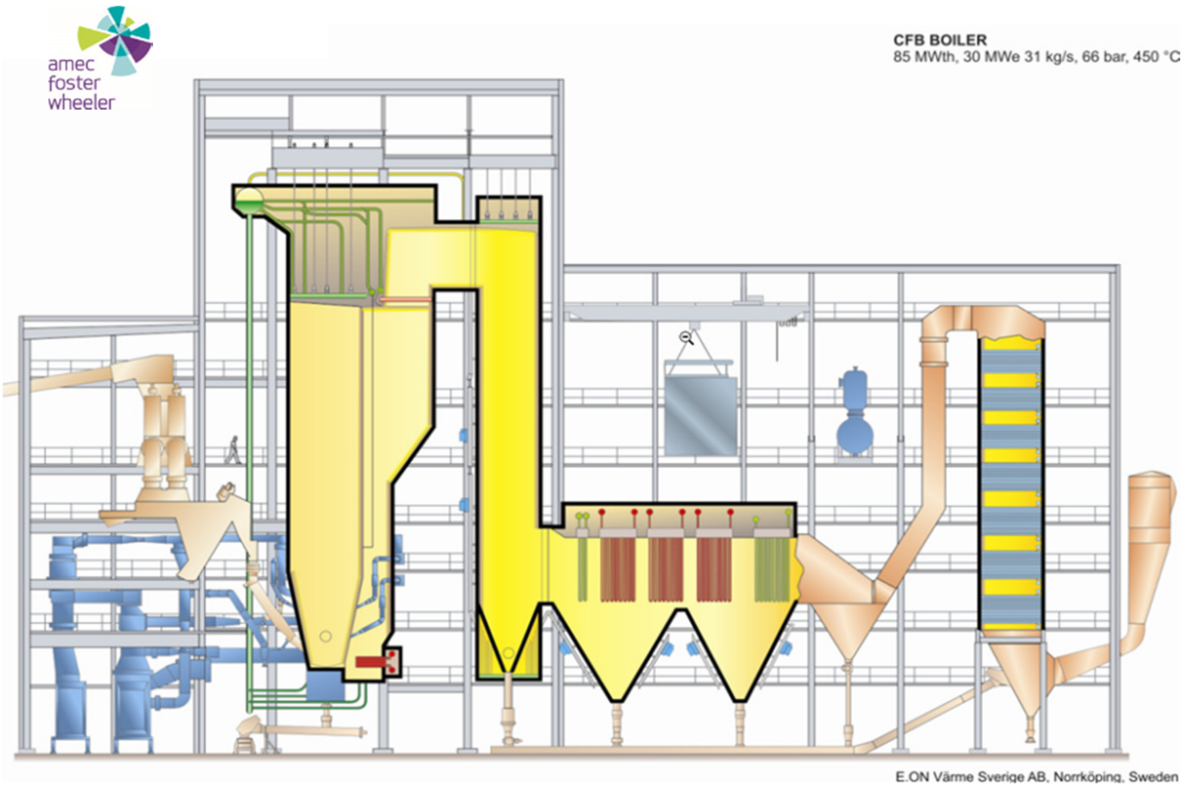
3

Test usability of FeCrAl alloys and coatings and comparison towards state-of-the-art SS and conventional SS and steels

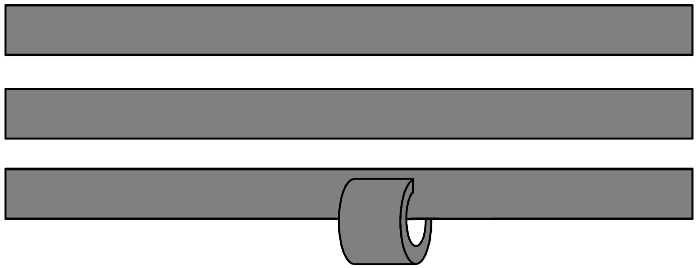
Investigate corrosion of the superheaters in a boiler with horizontal design using 3 different corrosion testing methods

Corrosion testing methods

- Probes
- Coils/tubes
- Clamps



We aim to generate new knowledge of how corrosion testing is performed in an optimun way of lifetime prediction…



Sulfur recirculation and improved material selection for high temperature corrosion abatement (KME714)

– Investigating different aspects of corrosion memory

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Jesper Liske
Loli Paz

MEC Bio Heat & Power
Michelle Hart
Niels Peder Hansen

DTU
Kristian Vinter Dahl

B&W Vølund
Thomas Norman
Lars Mikkelsen

Götaverken Miljö AB
Sven Andersson

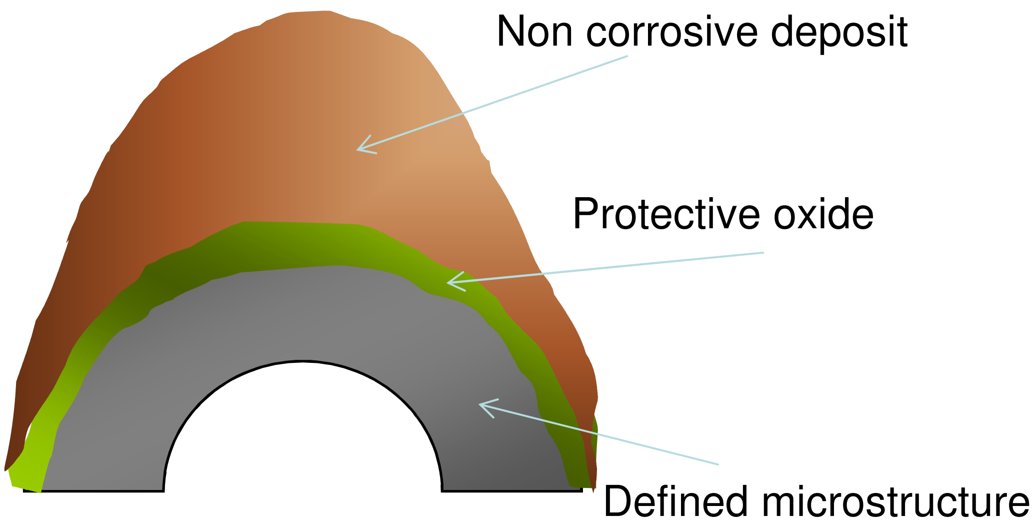
Dong Energy
Søren Aakjær Jensen

Project leader: Torbjörn Jonsson
Contact: tj@chalmers.se

Corrosion memory – definition

***Oxide scales**, **alloy microstructure** and **thick deposits** from the past influencing future corrosion attack.*

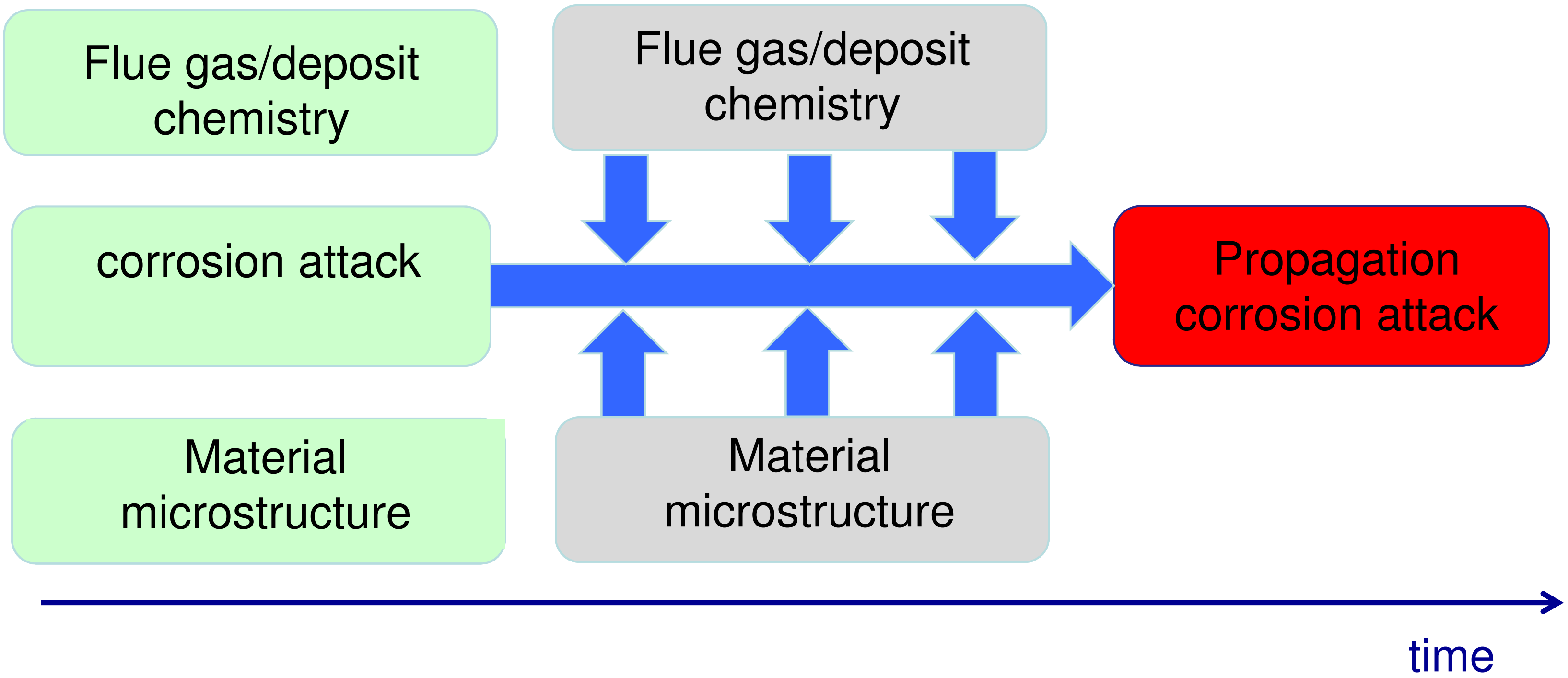
Flue gas from non-corrosive fuel



Flue gas from a corrosive fuel

?

What are the challenges in studying the propagation?



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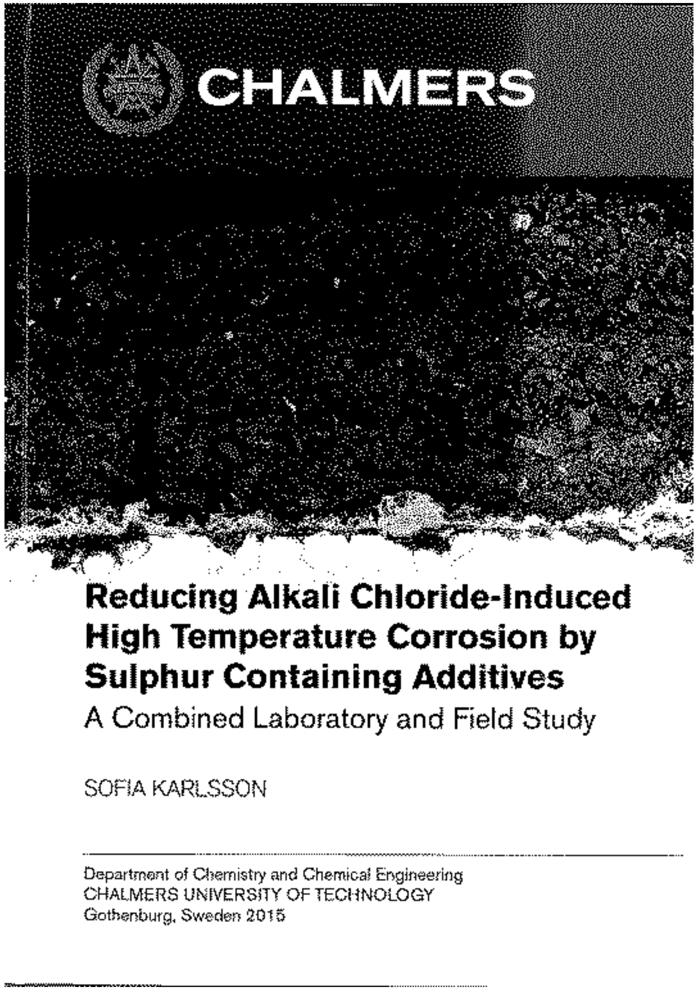
The High Temperature Corrosion Centre

Background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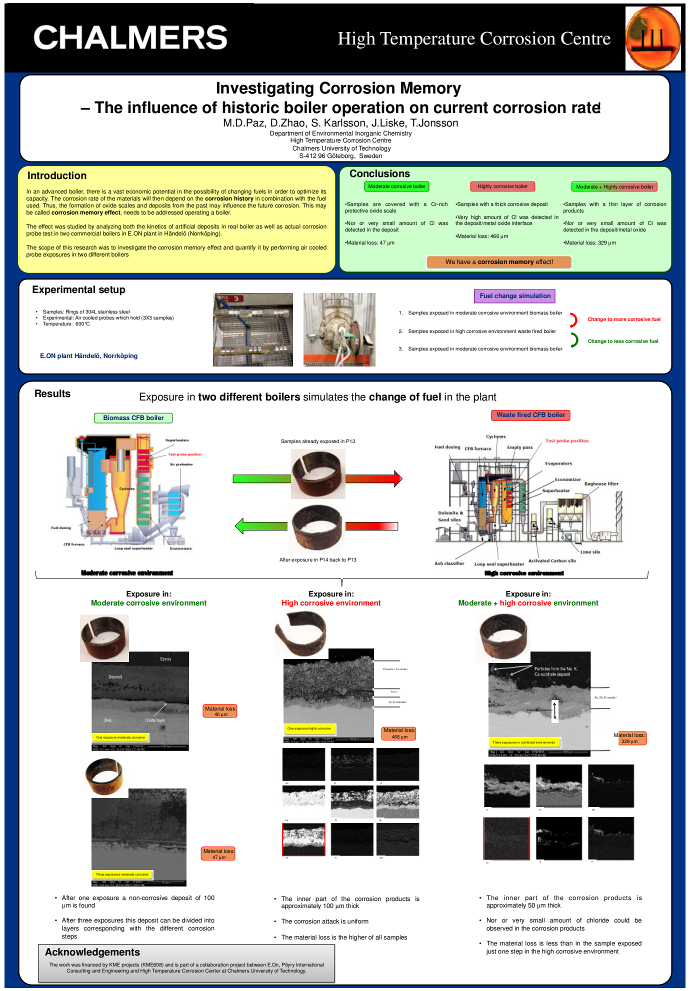
Reducing Alkali Chloride-Induced High Temperature Corrosion by Sulphur Containing Additives

A Combined Laboratory and Field Study

SOFIA KARLSSON

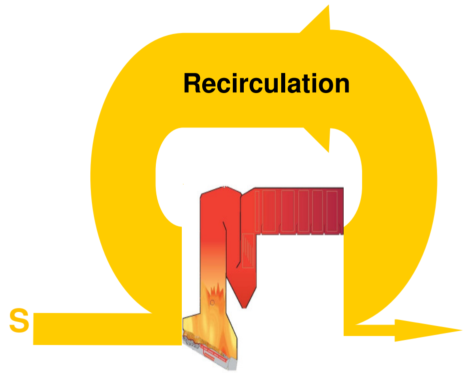
Department of Chemistry and Chemical Engineering
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2015

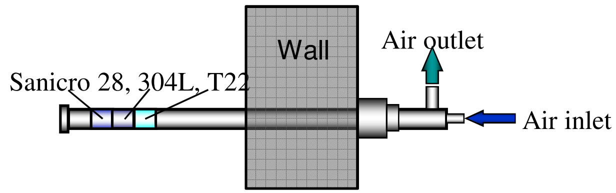


Research strategy

Demonstrating full-scale installation of the corrosion mitigation technique “Sulfur recirculation”.

Investigate the dynamic interplay between changes in the fuel mix and the corrosion attack over time (corrosion memory – environment).





Field exposures

MEC Bio Heat & Power

Waste-to-Energy

- Two identical lines with a capacity of 10 tons/h waste.
- Sulfur recirculation will be installed on one line.

Vi arbetar på vetenskaplig grund för att skapa industrinytta.
www.swerea.se