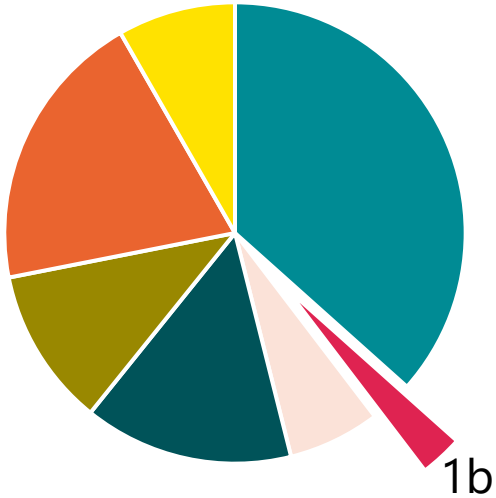
Corrosion of high temperature materials in small scale wood-pellet fired boilers

Carolina Pettersson, RISE

Project 1b: A small SME-focused project

Project members:



Budget distribution of the HTC projects

Background

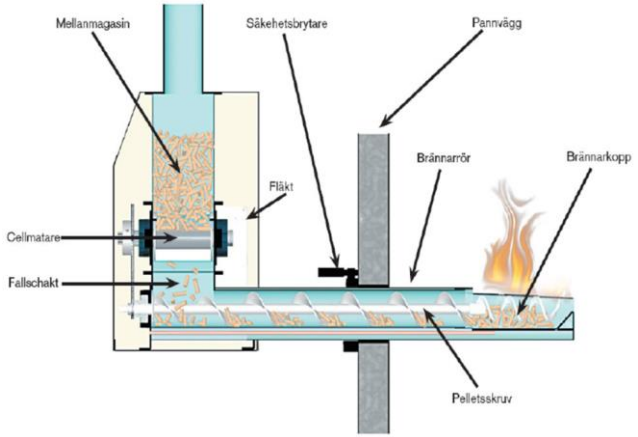
- In the combustion of bio-based fuels the critically exposed burner parts in small boilers are typically **uncooled** and are usually made of **FeCr or FeCrNi** alloys
- These materials can suffer attack from the **ash** because of the formation of **alkali chromate**
- The reaction depletes the protective oxide in chromia, leading to accelerated corrosion
- This ultimately results in failure of the boiler unit and/or is limiting the service life of critical burner components

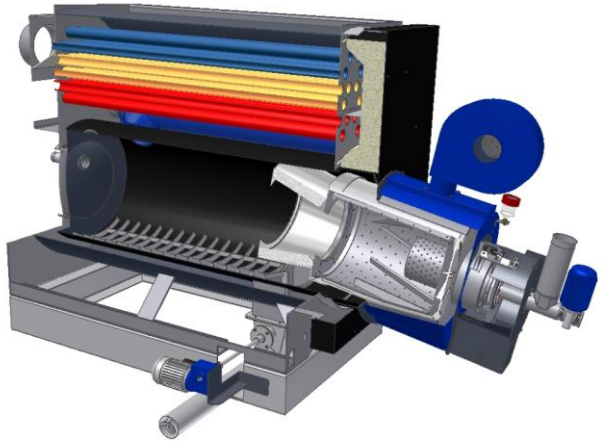
RI. SE

Small scale boilers

Typical range of kW

- Domestic homes: ~20 kW
- Detached houses (e.g. laundries, schools): 50-2 000 kW



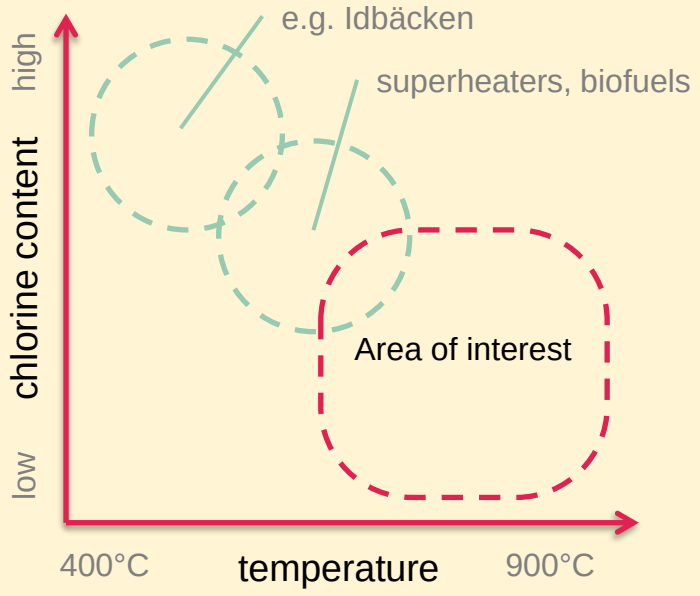


Project goals

- Gain practical knowledge on high temperature corrosion processes in small to medium sized plants fired mainly by pellet-based bio-fuels
- Minimize problems that lead to operational disturbance and increase the lifetime of critical components

Area of interest

- Medium to high temperature
- Low to medium chlorine content
- Compare new materials with commercial alloys (FeCr, FeCrAl)



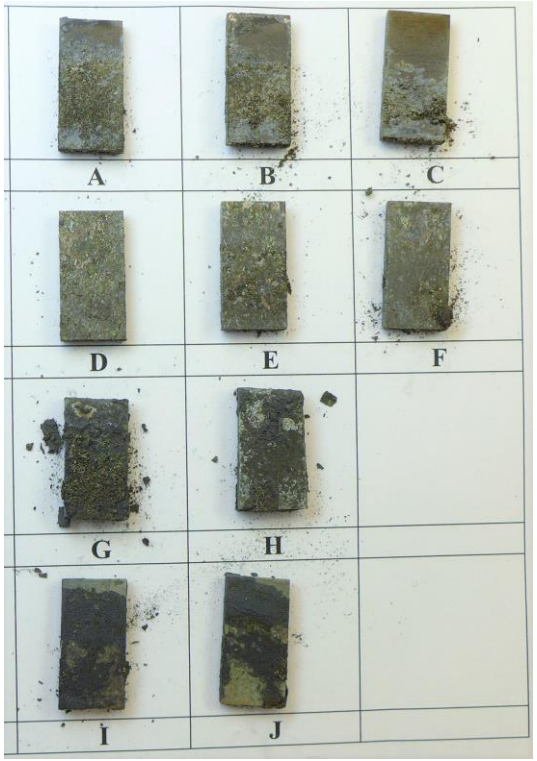
Field exposures

2 sets of field exposures within the project: 2018 and 2020

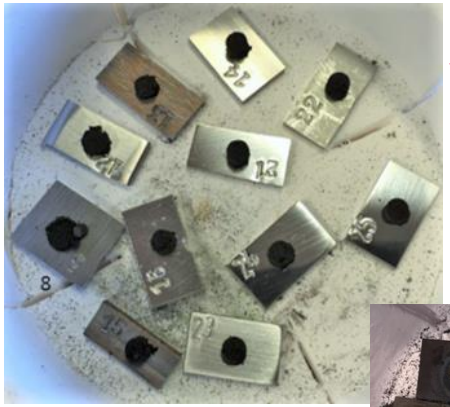
- 2018: 800°C, ~2 000h (12h/day for 5,5 months)
  Focus on experimental materials: FeCrAl with varying Cr, Al, Si
- 2020: to be decided

Laboratory exposures

- 2018: Development of new exposure set-up in alumina boxes
- 2019: 16 samples/materials, 900°C, 300h
- 2020: 10 samples (4 materials), 900°C, 300, 600 & 1000h



Previous laboratory exposure set-up



At start

After 60 cycles

- Pellets of ash are put on the ground sample surfaces
- Samples heated to 900°C, cyclic exposures for 1h
- Change of ash pellet every 10 cycles (10 hours)

New laboratory exposure set-up

- Alumina box half filled with ash
- Samples standing halfway down in the ash
- Lid partly covering the box
- Exposure at 900°C for 100 hours at a time
- Changes of ash every 100 hours

Two laboratory tests with new method

Laboratory exp. no. 4

- Screening test with 16 different materials (alumina formers and chromia formers; Fe and Ni-base)
- Exposure temperature: 900°C
- Exposure time: 300 hours (changes of ash every 100 hours)

Laboratory exp. no. 5

- 4 materials were chosen (2 alumina formers and 2 chromia formers)
- Exposure temperature: 900°C
- Exposure time: 300, 600 and 1000 hours (Al materials only) (changes of ash every 100 hours)

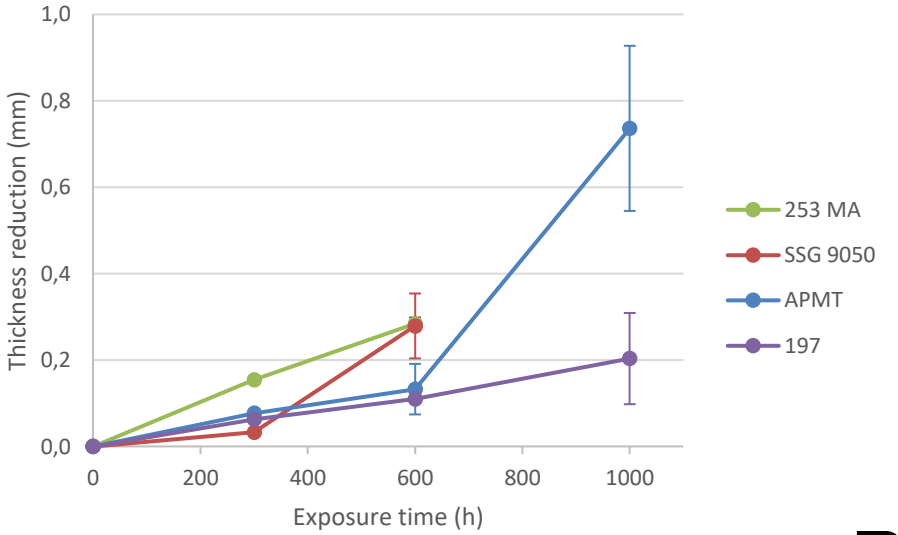
Laboratory exposure (no. 5)

Samples in the latest lab test

Material	300 h	600 h	1 000 h
197	X	X	X
APMT	X	X	X
SSG 9050	X	X	-
253 MA	X	X	-

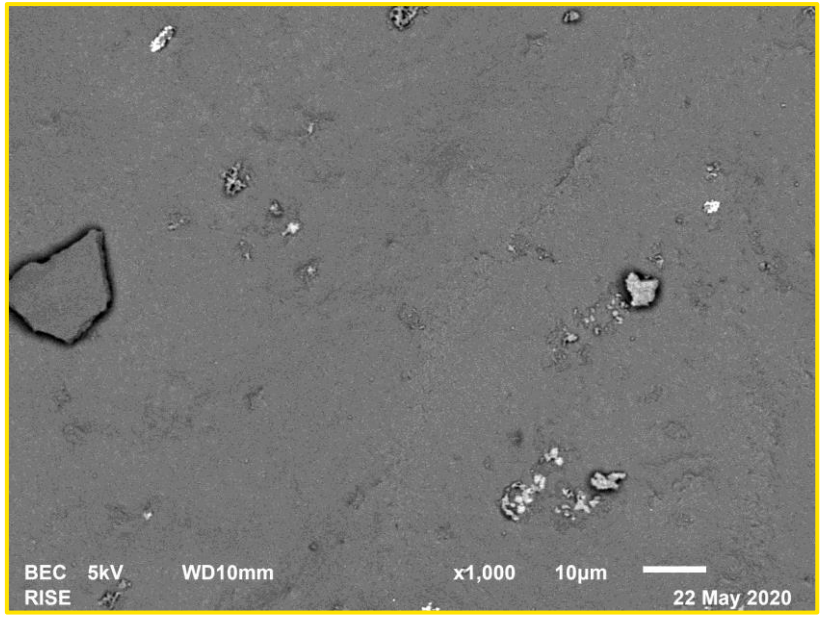
The thickness of the samples were measured in cross sections in SEM before and after exposure.

Material loss as a function of exposure time

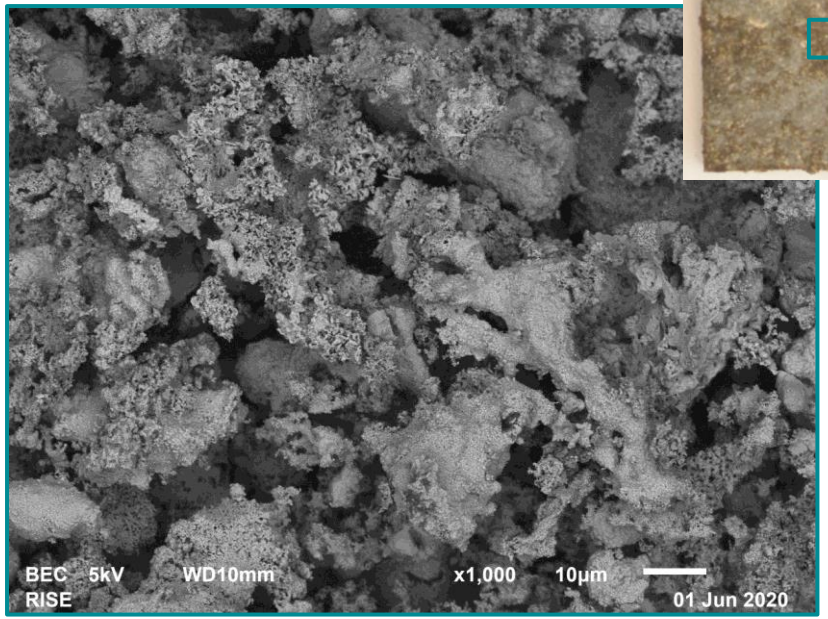


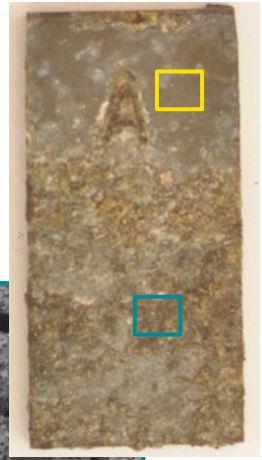
Alloy 197, 300h, surface

Gas



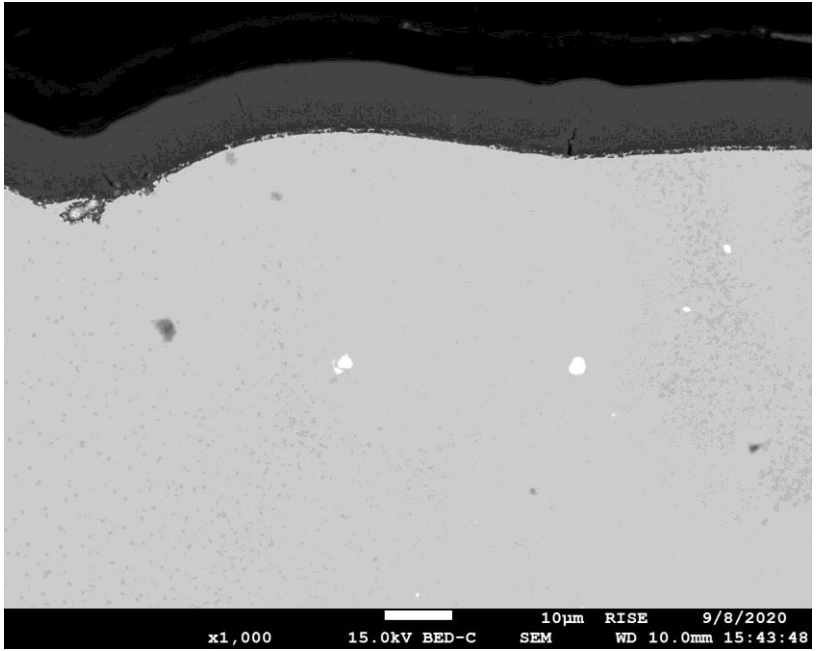
Ash



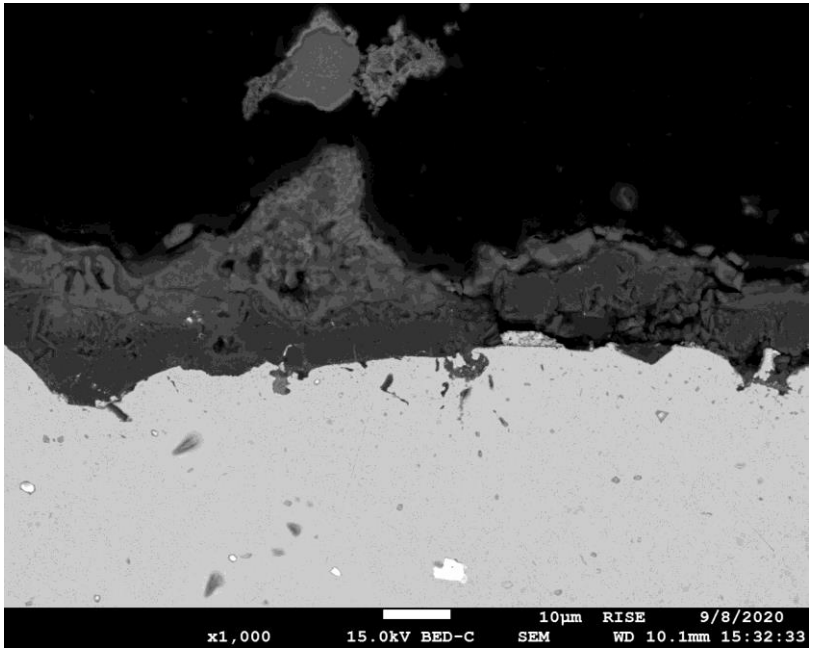


Alloy 197, 300h, cross sections

Gas

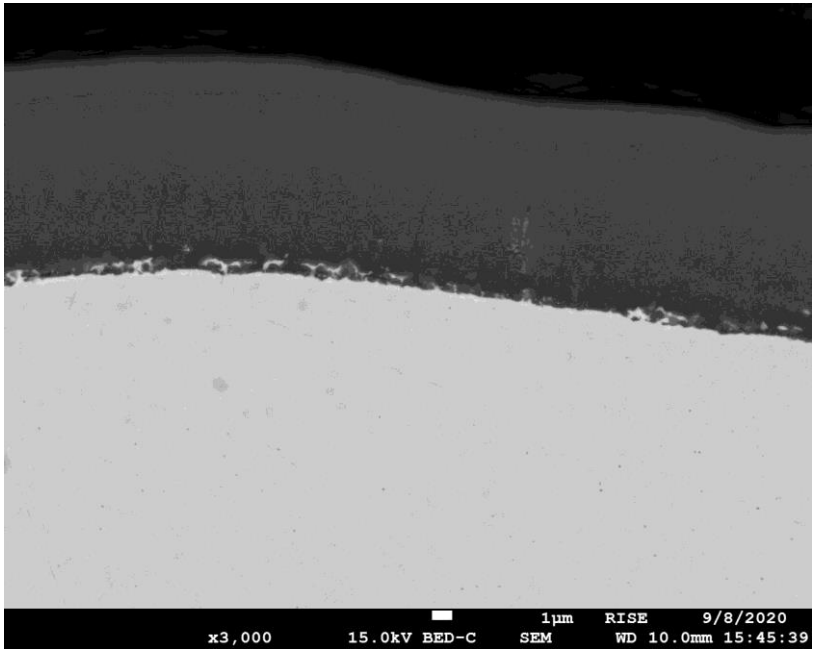


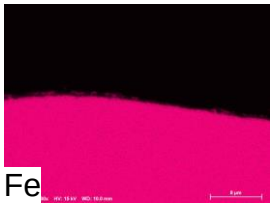
Ash

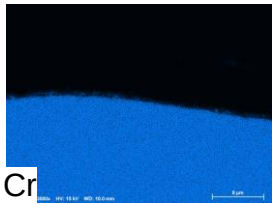


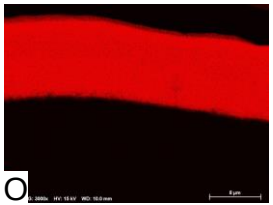
Alloy 197, 300h, cross section

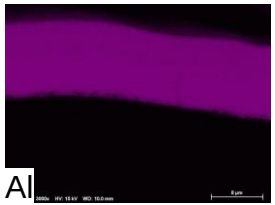
Gas: Al-rich oxide, ~10 µm

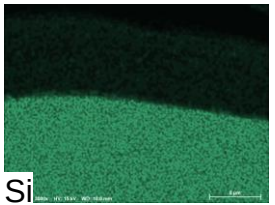


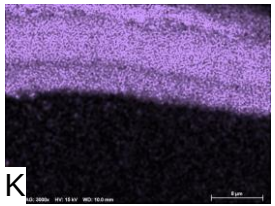






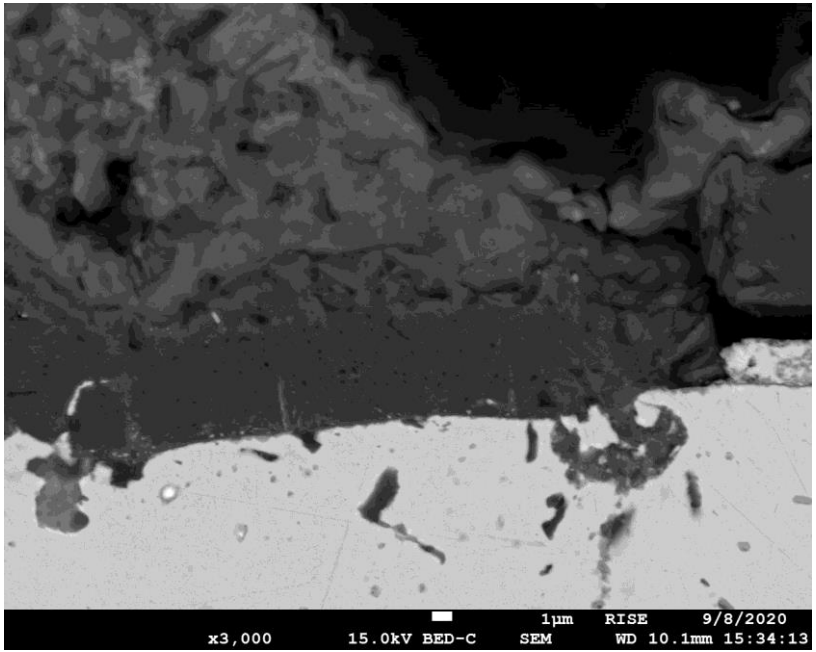


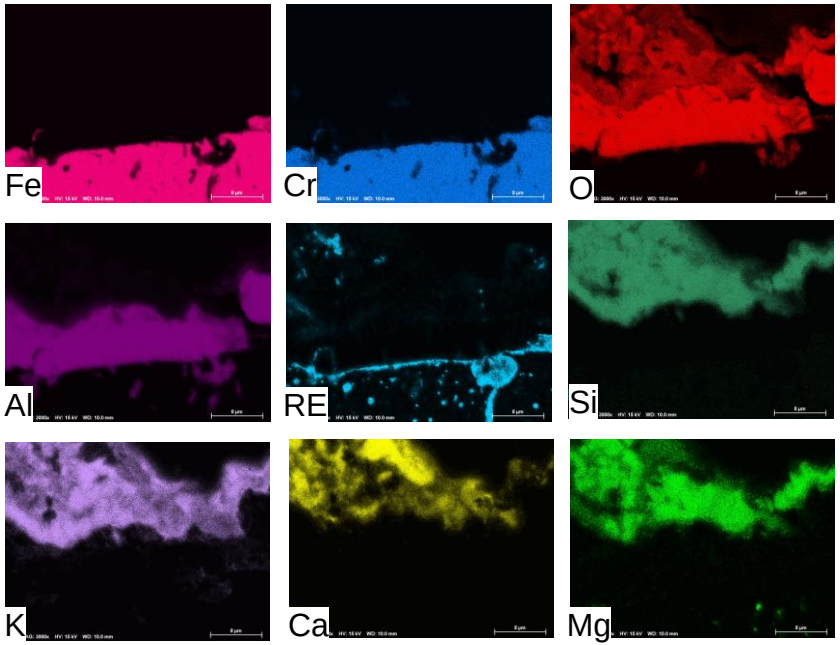




Alloy 197, 300h, cross section

Ash: Al-rich oxide, ~5-10 µm





Carolina Pettersson

carolina.pettersson@ri.se
010-228 47 37