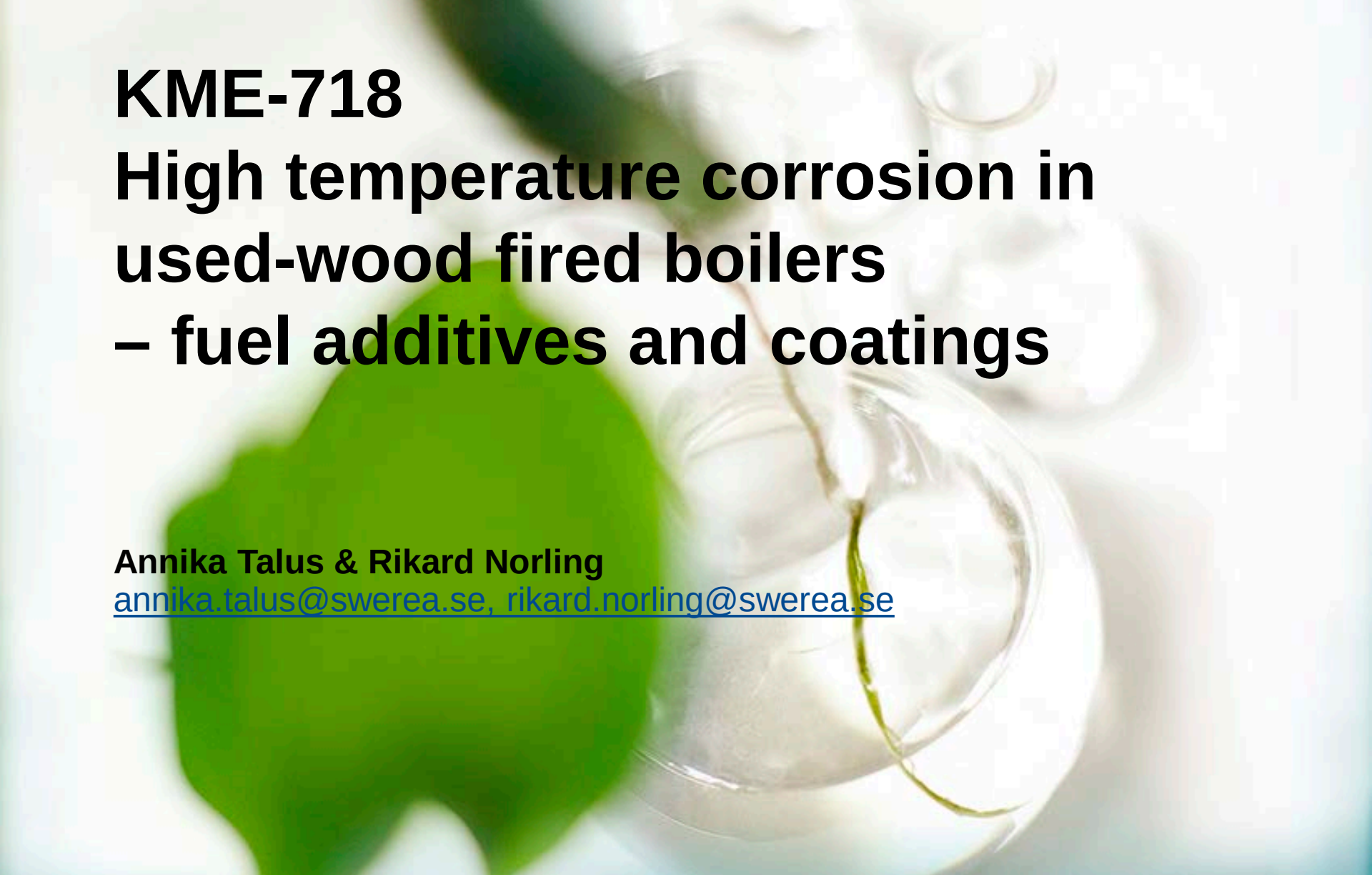




KME-718

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

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Background

The project builds on projects KME-508, KME-512 and KME-708, which for used-wood fired boilers have shown that:

- co-firing with treated sewage sludge can reduce water wall corrosion, at least in short-term tests lasting up to 14 h
- an FeCrAl alloy (Kanthal APMT) has excellent water wall corrosion resistance when tested as solid material, indicating its potential as a coating material

Participants in KME-718

9 partners:

- Amec Foster Wheeler
- Andritz
- E.ON
- Fortum
- MH Engineering
- Sandvik Heating Technology
- Sandvik Materials Technology
- Swerea KIMAB
- Vattenfall AB

Projects goals – technical and scientific

- reduce operation and maintenance costs in boilers that burn predominantly used wood by the use of additives and coatings
- acquiring new knowledge from longer term studies on the effect of using sewage sludge and one alternative sludge
- acquiring in-depth knowledge on the corrosion behaviour of materials typically used for furnace walls with and w/o fuel additives
- investigating the corrosion properties of some new coating materials and their related performance with respect to furnace wall protection

Project time-table

- Project start: 1 Feb 2016
- Project end: 15 April 2018

	2016					2017				18
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	
KME 708 (related project)	X	X	X	X						
Start-up, planning	X	X	X	X						
Corrosion testing		X	X	X	X	X	(X)			
Analysis of specimens			X	X	X	X	X			
Final project and ref-group meeting								X	X	
Reporting and publishing						X	X	X	X	

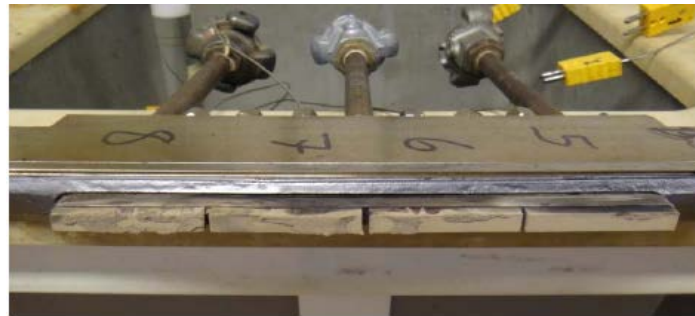
Experimental



2 test campaigns with coatings and on-welds (6 weeks each)

- Two probes, nominally 400°C at furnace wall.
- Used wood (UW) fuel
- 8 samples each test campaign
 - Sanicro 33, Alloy 625 solid, Alloy 625, Two types of coating MH Engineering, Two types of model alloy (on-welded)

WALL CORROSION PROBE TESTING



To be evaluated

Experimental

1-year test campaign with coated tube in Blackburn Meadow

- Start July 2016
- Multiple material combination, thicknesses and application methods tested. Part of a original tube cut out and replaced with this coated tube.



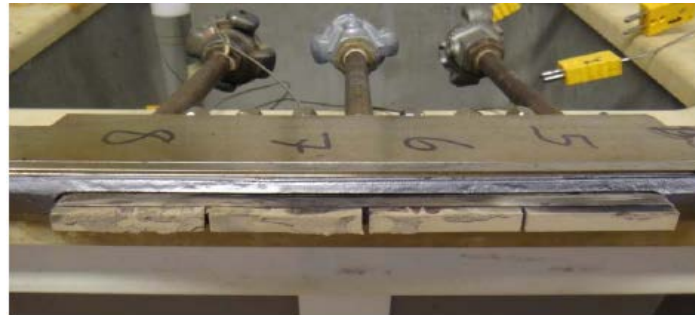
Experimental



2 test campaigns with two types of sludge (2 weeks each)

- Two probes, nominally 350°C and 400°C at furnace wall.
- 2 specimens of 16Mo3 and 2 of Alloy 625 on each wall probe

WALL CORROSION PROBE TESTING



Experimental



2 test campaigns with two types of sludge (2 weeks each)

- Two probes, nominally 350°C and 400°C at furnace wall.
- 2 specimens of 16Mo3 and 2 of Alloy 625 on each wall probe
- Superheater deposit probe. 3 hour test, 350,450,550°C

DEPOSIT PROBE TESTING IN SUPERHEATER REGION



Experimental

2 test campaigns with two types of sludge (2 weeks each)

- 13% sludge as delivered mixed with used wood (UW).
- 4.6 wt% (dry basis)

Composition of mixed fuel into boiler

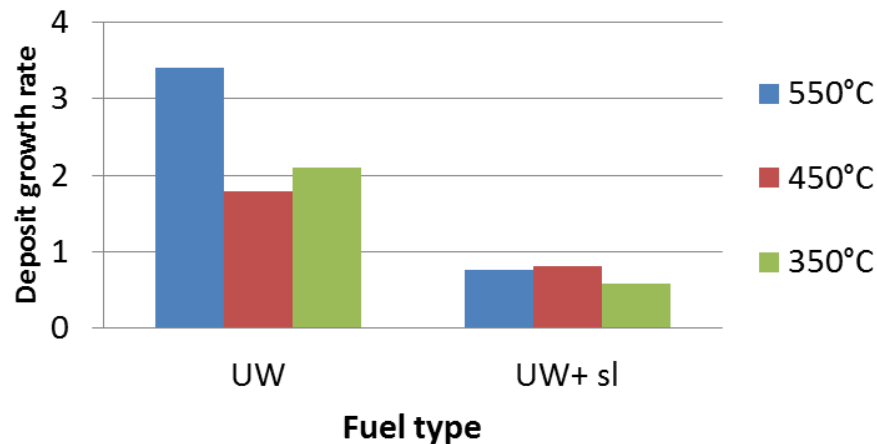
	Moist -ure %	Ash % d.b.	Cl % d.b.	S % d.b.	Ca ppm d.b.	K ppm d.b.	Na ppm d.b.	Pb ppm d.b.	Zn ppm d.b.	P ppm d.b.
UW 1	35	3.6	0.13	0.07	4044	995	1611	38	398	89
UW 2	22	5.8	0.20	0.07	5117	900	976	136	122	118
UW2 + sewage sludge	33	5.1	0.12	0.13	7250	1145	994	87	201	1830

Preliminary results – deposit analysis EDS

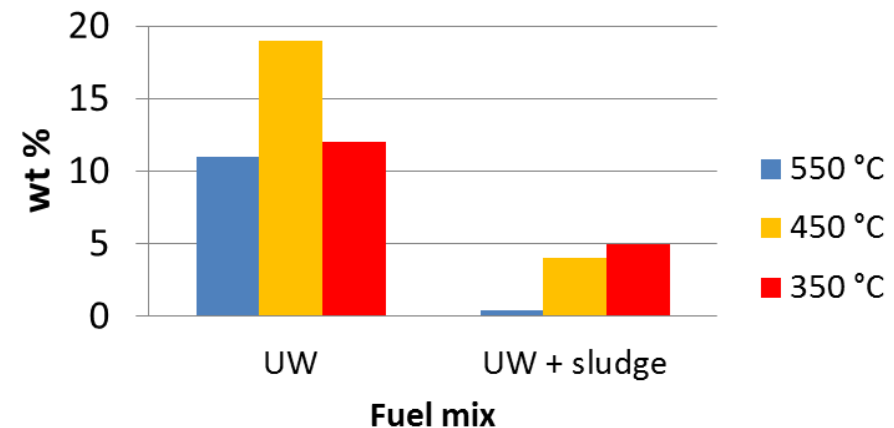
Superheaters 3h deposit probe

- More deposits on only used-wood samples
- Decreased chlorine content in deposit at super heater position when sewage sludge is co-fired.

Growth rate in mg/cm²/h



Cl content of SH deposits

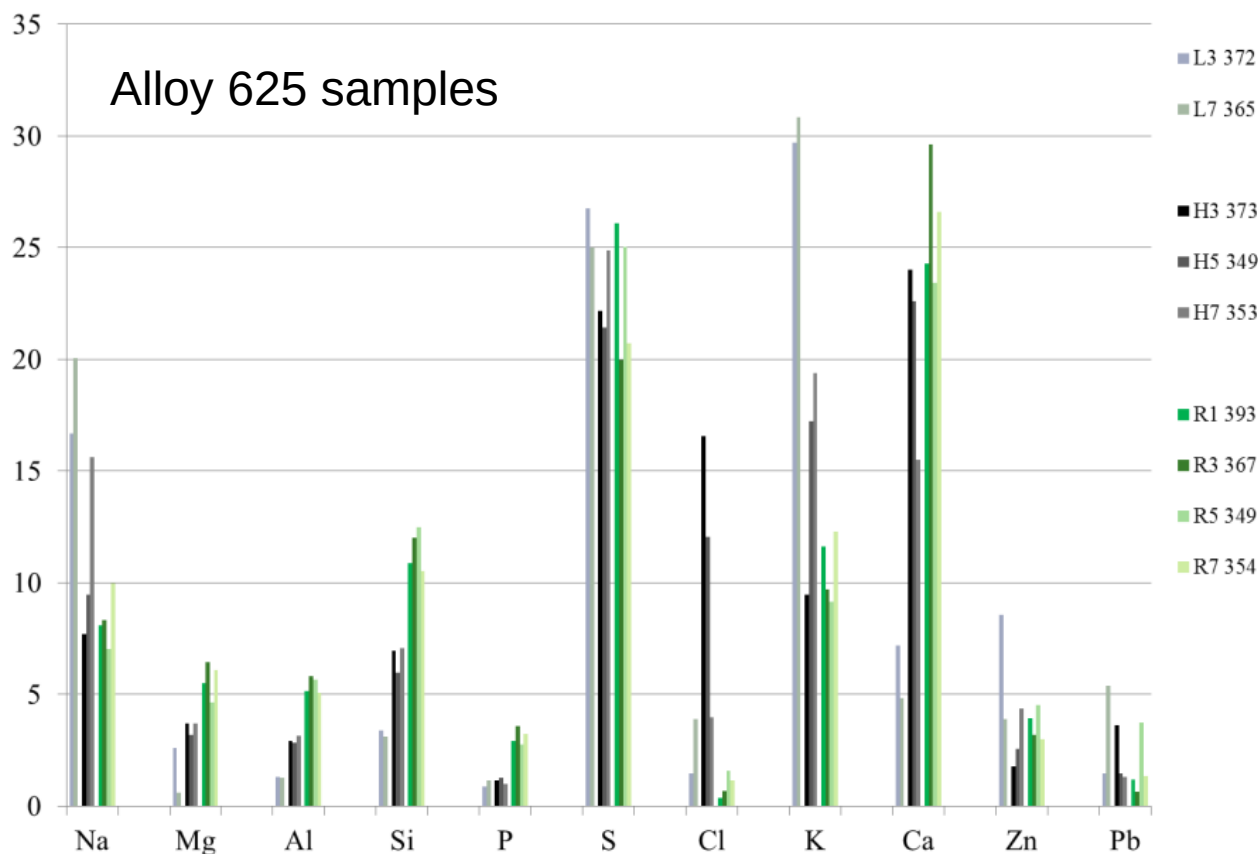


Preliminary results – deposit analysis EDS

Furnace wall corrosion-probes

L-samples = UW 1
H-samples = UW 2
R-samples = UW2 + sewage sludge

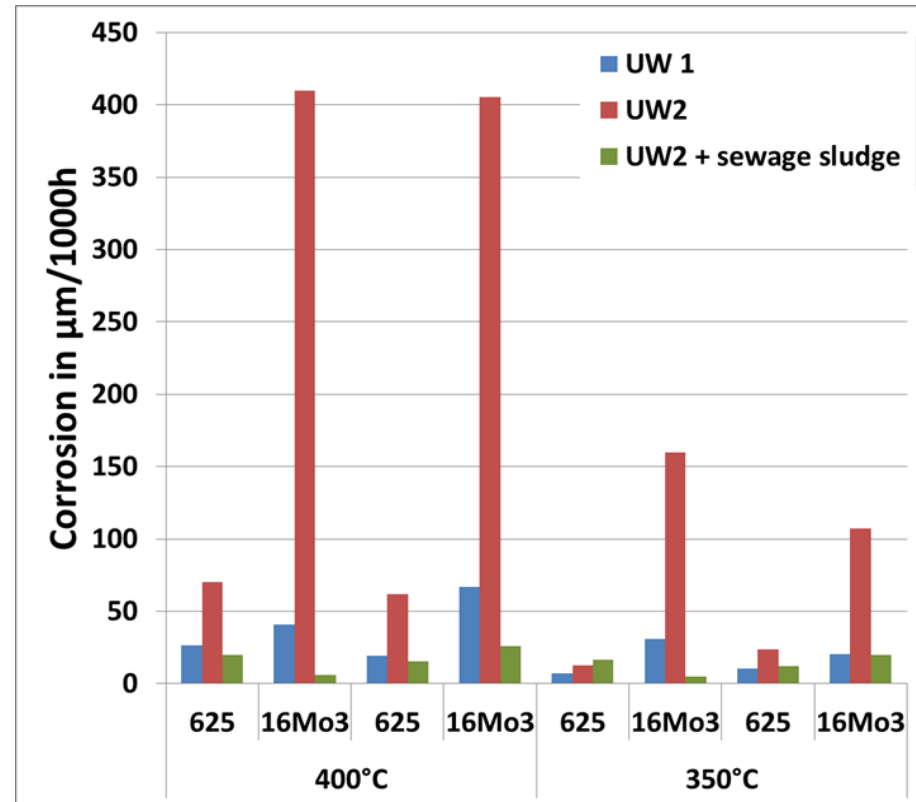
- Less Cl in deposits when sewage sludge are co-fired
- K is fairly similar for all samples except UW1.
→ Indicating that K is in other form than KCl when sludge is co-fired



Preliminary results – corrosion measurements

Furnace wall corrosion-probes

- Less corrosion for both materials when sewage sludge is co-fired.
- Greatest effect at metal temperatures of around 400 °C.
- Greatest effect for low alloyed steel 16Mo3.



Preliminary results – cross section analyses

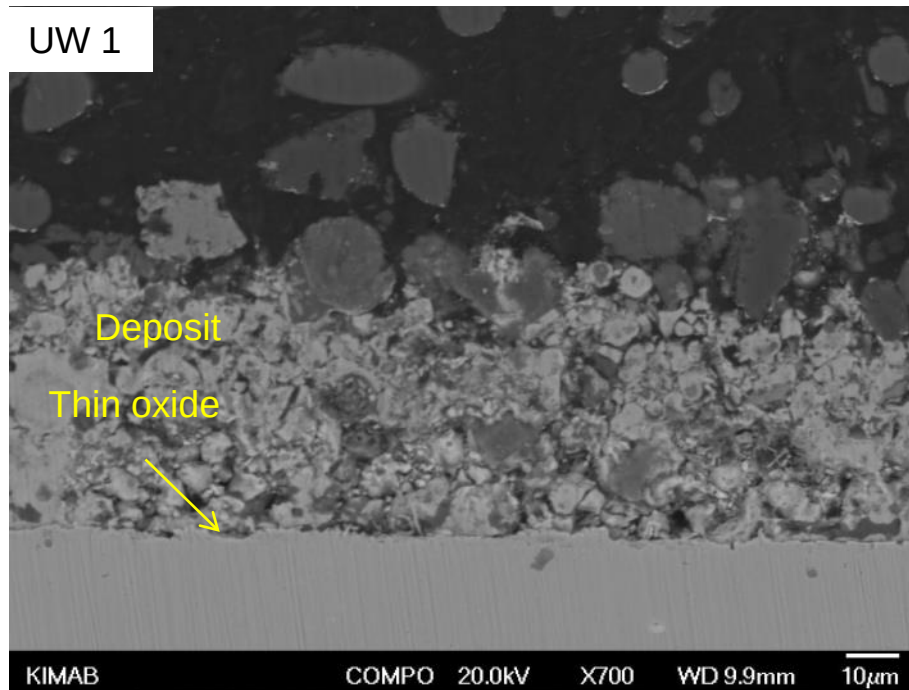
Furnace wall corrosion-probes

Alloy 625

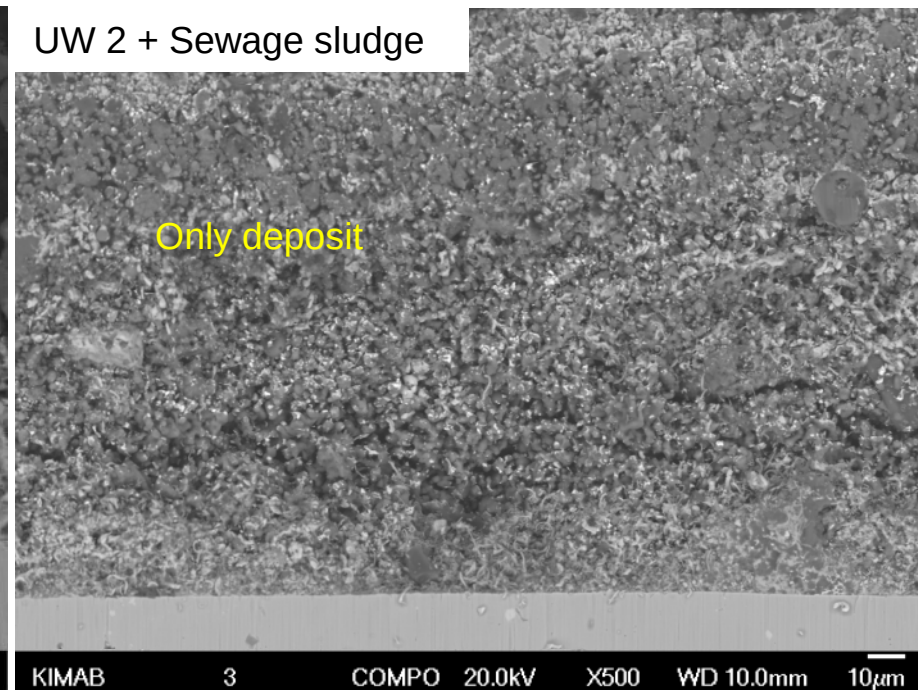
350 °C

In general more corrosion with oxide formation for Alloy 625 sample with no sludge

UW 1



UW 2 + Sewage sludge



Preliminary results – cross section analyses

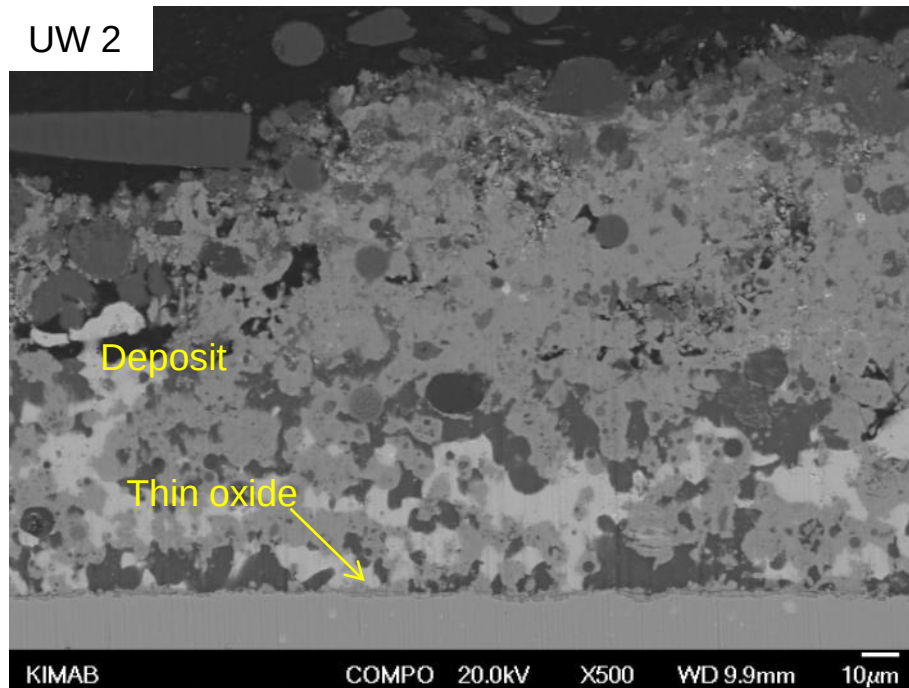
Furnace wall corrosion-probes

Alloy 625

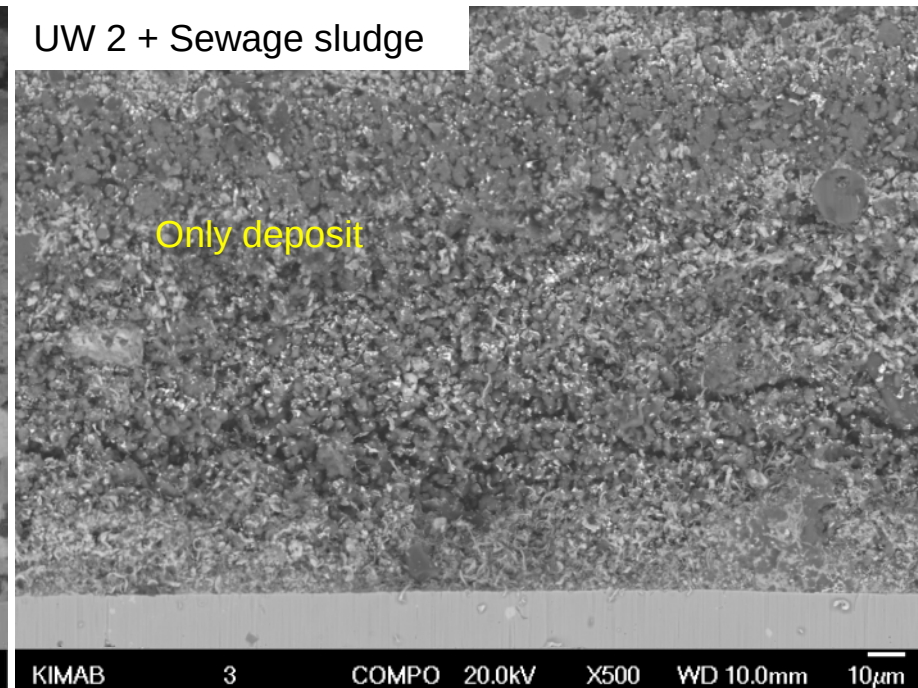
350 °C

In general more corrosion with oxide formation for Alloy 625 sample with no sludge

UW 2



UW 2 + Sewage sludge



Preliminary results – cross section analyses

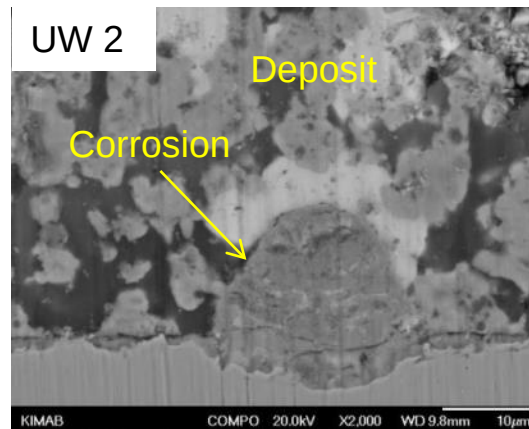
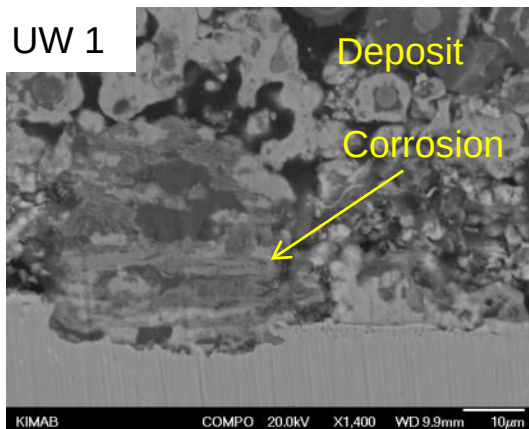
Furnace wall corrosion-probes

Alloy 625

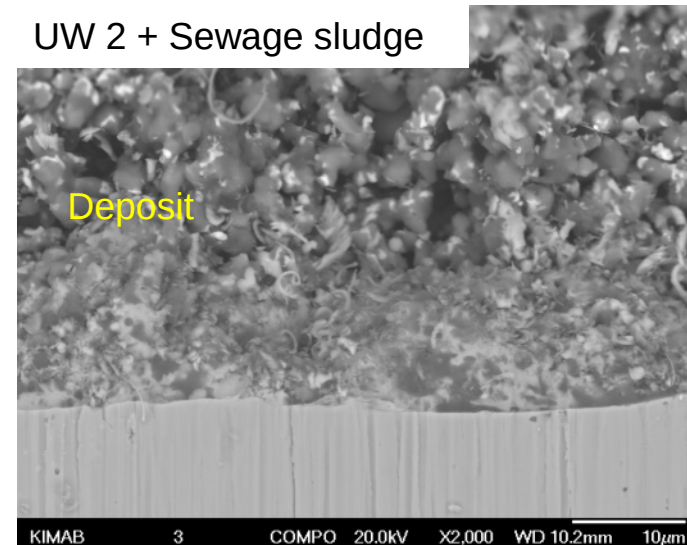
350 °C

Local corrosion with Ni, Cr- oxide as corrosion products

No clear signs of local corrosion



UW 2 + Sewage sludge



Preliminary results – cross section analyses

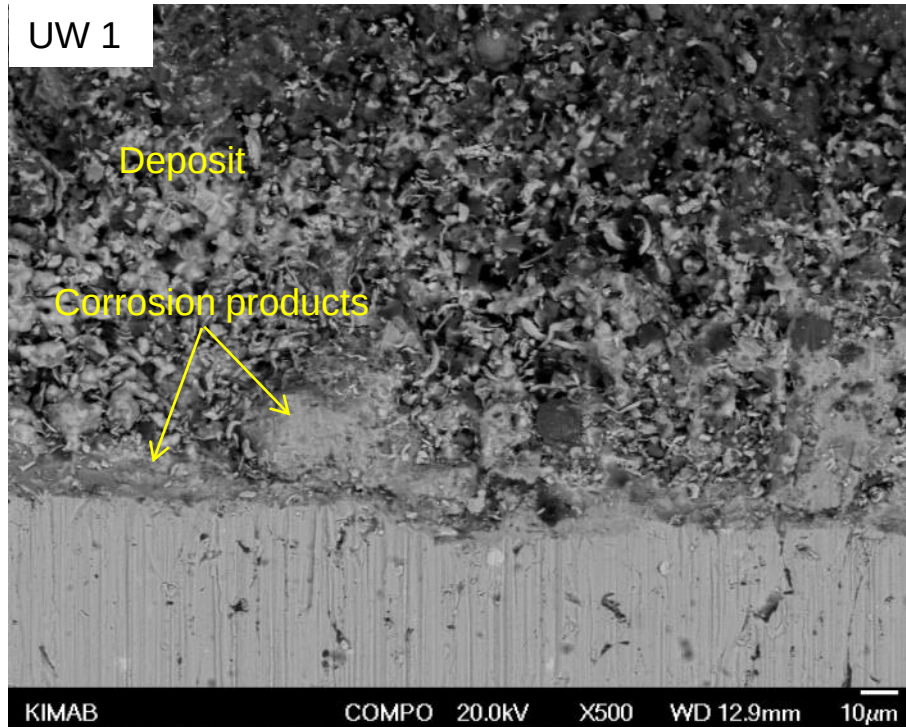
Furnace wall corrosion-probes

Alloy 625

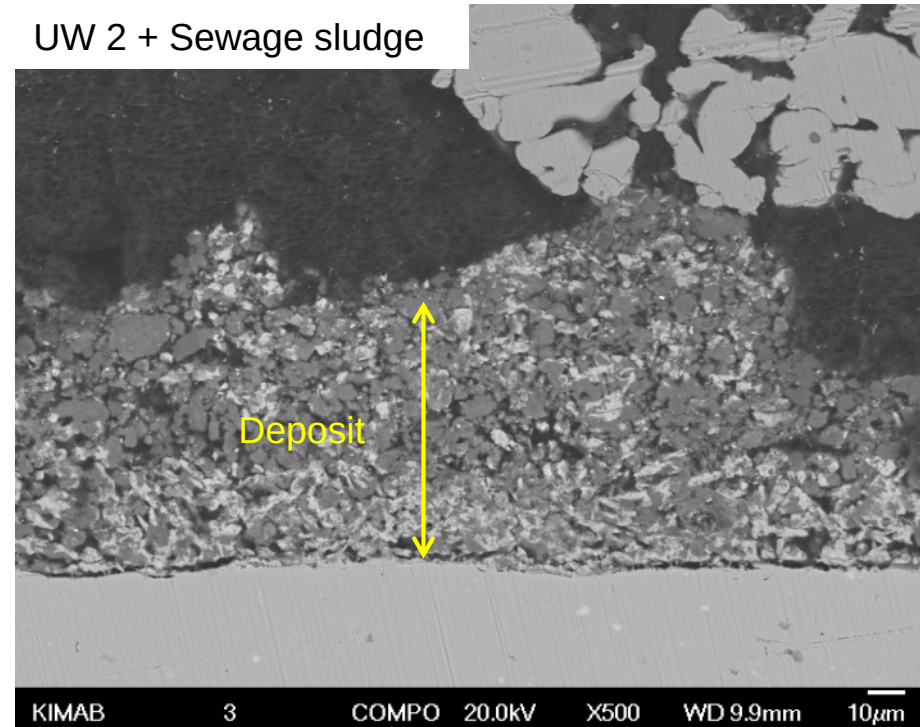
400 °C

In general more corrosion with oxide formation for Alloy 625 sample with no sludge

UW 1



UW 2 + Sewage sludge



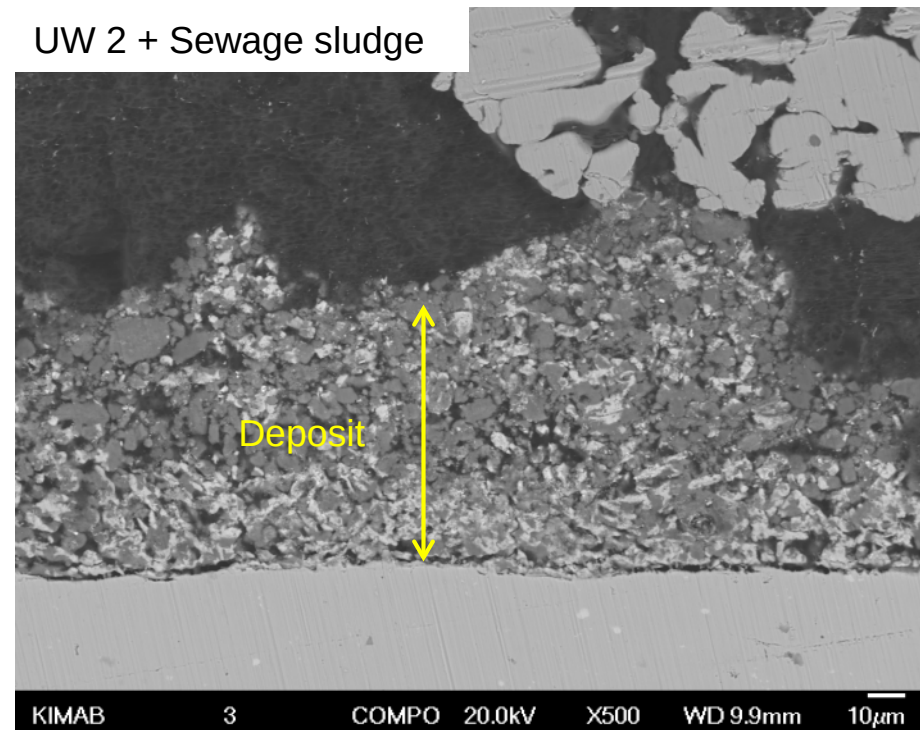
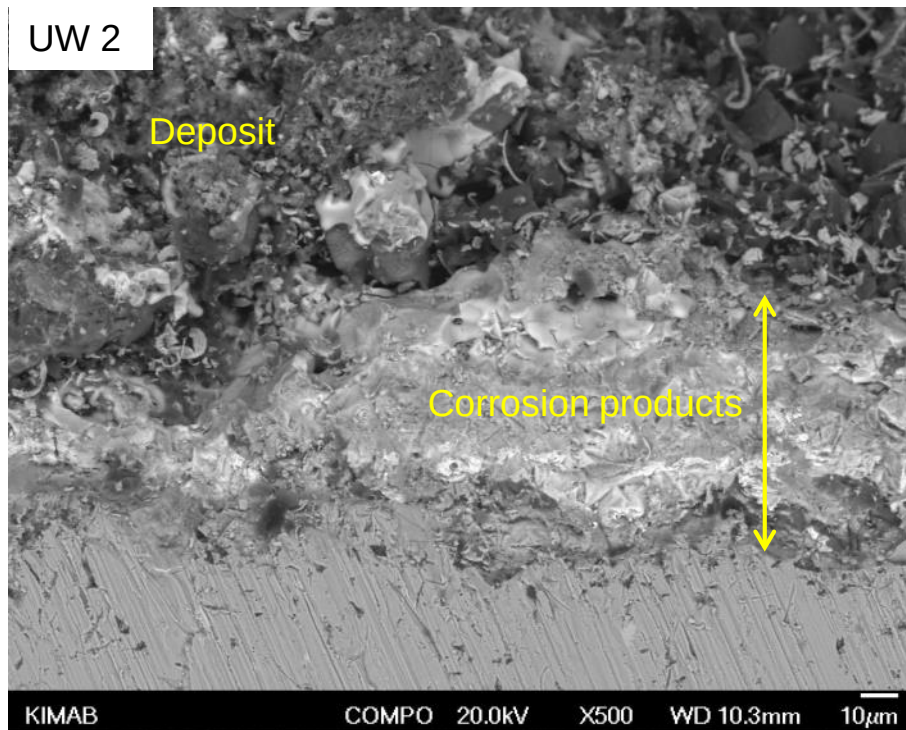
Preliminary results – cross section analyses

Furnace wall corrosion-probes

Alloy 625

400 °C

In general more corrosion with oxide formation for Alloy 625 sample with no sludge



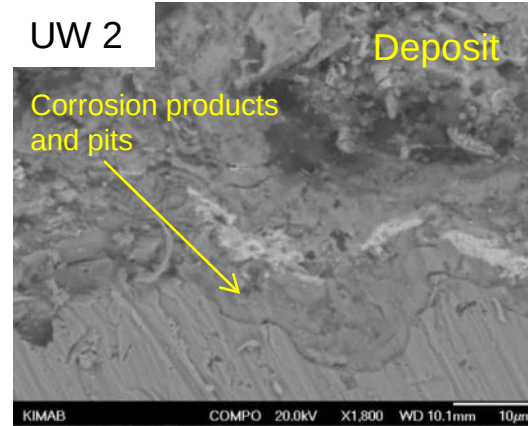
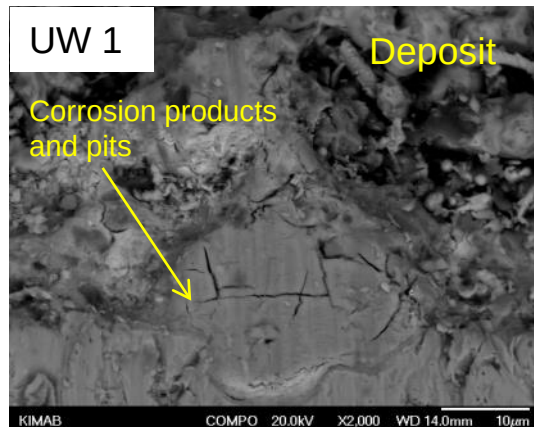
Preliminary results – cross section analyses

Furnace wall corrosion-probes

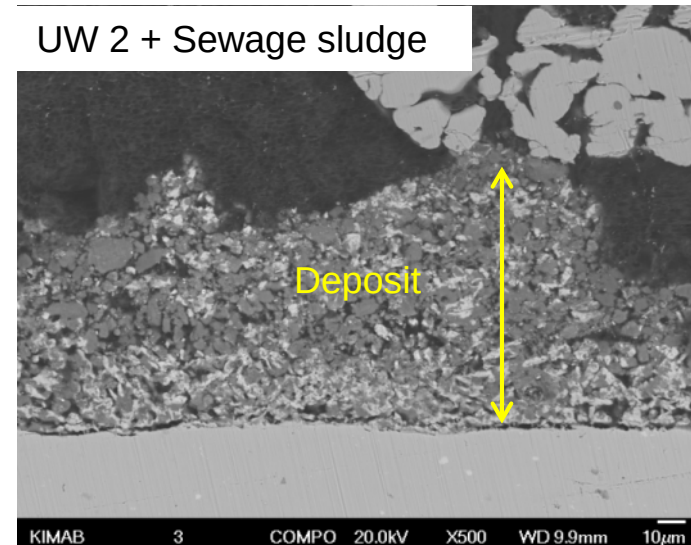
Alloy 625

400 °C

Local corrosion with Ni, Cr- oxide and lead molybdate (UW2) as corrosion products



No clear signs of local corrosion



Preliminary conclusions

- Co-firing of sewage sludge show reduce chlorine in deposit both at super heater position (3h) and at furnace wall position (336 h)
- Co-firing of sewage sludge decrease the corrosion rate of both low alloyed steel and nickel based alloy 625 after 2 weeks exposure
 - For Alloy 625 this is also seen in cross section analysis

What's next in the project?

- All field exposures are performed
- Further evaluation of the samples
 - Sewage sludge, what does the cross section of 16Mo3 tell?
 - Sludge type #2, is there a similar effect?
- Evaluation of samples from the coating campaigns
- Evaluation of coated probe exposed in Blackburn Meadows boiler

Thank you for listening!

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