Recovery boiler superheater corrosion – Impact of amount of melt at T_0

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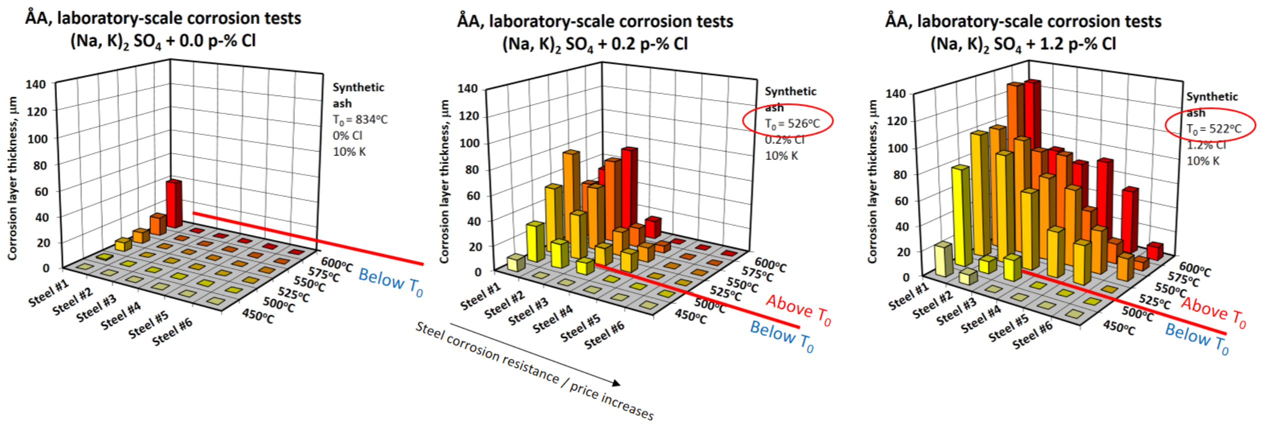
Introduction and objectives

The objective of this work is to obtain a better understanding of the role of amount of melt on superheater corrosion in recovery boilers. Earlier work (Figure 1) has shown deposit first melting temperature T_0 to be an important parameter for superheater corrosion in Kraft recovery boilers. This has led to the rule-of-thumb to maintain the superheater steel temperature below T_0 in order to avoid melt in contact with the steel and uncontrolled corrosion. The first melting temperature T_0 provides a good first overall indication for deposit corrosivity.

However, as can be seen in Figure 1, not all steel grades show equal propensity for corrosion at T_0. Some grades corrode already below T_0, while others seem to withstand corrosion or show less corrosion even above T_0. Clearly, corrosion in general nor the corrosivity of a deposit cannot be simplified to a single parameter T_0. There is a need for deeper understanding of corrosion in recovery boilers. For example, it is not clear if small amounts of melt at T_0 are equally corrosive as high amounts of melt are.

Melt, and the amount of it, in contact with the superheater steel can be argued to be a physico-chemically more relevant parameter for corrosion than the first melting temperature. *The objective of this work is to obtain a better understanding of the impact of amount of melt on superheater corrosion.*The work is expected to result in a refinement of the T_0 corrosion rule-of-thumb, and provide new fundamental understanding that will help boiler manufacturers, material designers, and boiler operators better address corrosion issues in recovery boilers.



/Skrifvars et al, Corr. Sci. 2008/

Figure 1. *Results from earlier work showing importance of T_0 for corrosion*

Deposit chemical composition and T_0

Figure 2 presents melting curves of alkali salts representative of recovery boiler ESP ash. The chemical composition of the salts are given in Table I. The first melting temperatures of the salts are practically the same, whereas the amount of melt at T_0 increases with increasing chlorine content. In general, the T_0 of alkali salts is mainly determined by the potassium content; whereas, the amount of melt at T_0 is mainly determined by the chlorine content. The purpose of the work described here is to understand better at which melt fraction different steel grades start to corrode.

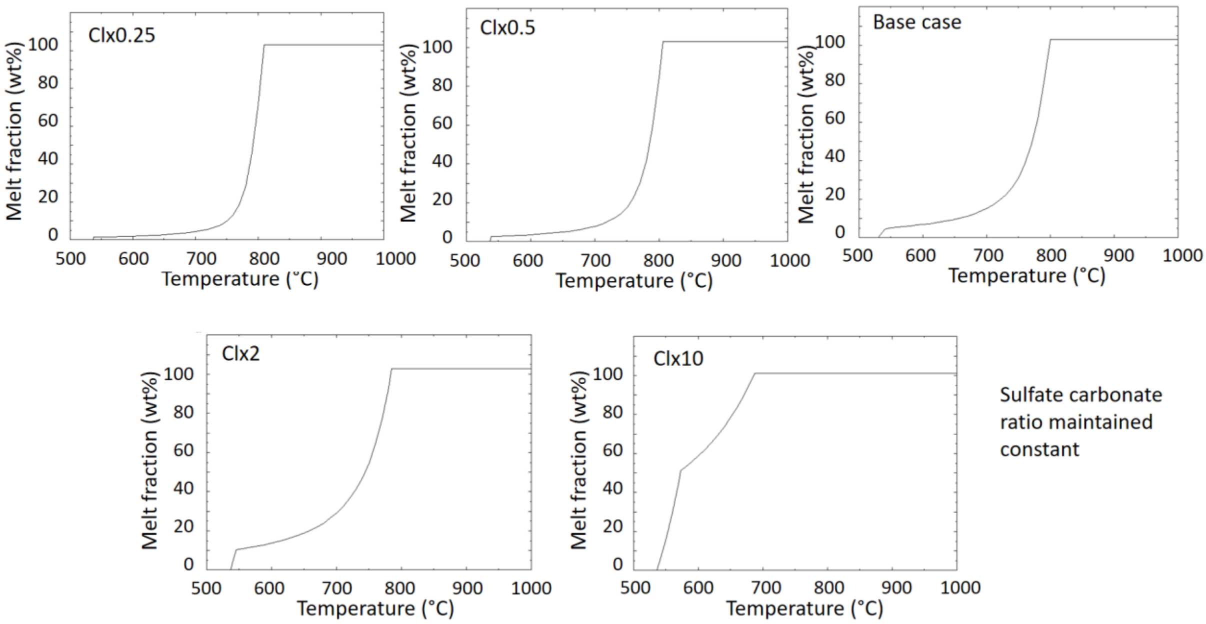


Figure 2. *Melting curves of salts in Table I.*

Table I. *Chemical composition of salts for which melting curves shown in Figure 2.*

	Cl x 0.25	Cl x 0.5	Base Case	Cl x 2	Cl x 10
	Composition (wt-%)				
Na	31.3	31.3	31.4	31.4	32.0
K	5.0	5.0	5.0	5.0	5.0
SO_4	50.6	50.4	50.0	49.1	42.3
Cl	0.25	0.5	1.0	2.0	10.0
CO_3	12.8	12.7	12.7	12.5	10.7
Melt(wt-%) @T_0 540 °C	1.5	3	6	12	~30

Preliminary work on the impact of amount of melt at T_0

Some preliminary work to address the question of impact of melt fraction on corrosion has been done (Figure 3). Two steels and Na-Cl-SO_4 salt mixtures were used. For different mixtures of this salt system, T_0 is 626 °C, independent of amount of Cl content (amount of melt). One-week corrosion tests (ÅA standard tests) were carried out at temperatures right above or right below T_0. For both steels, there is no corrosion at the lowest melt fraction tested. A threshold amount of melt is needed for corrosion to start. This threshold amount is different for the two steels. These results provide first indications that corrosion is not only about the first melting temperature T_0, but depends also on the amount of melt at T_0, with this threshold amount appearing to be steel-specific.

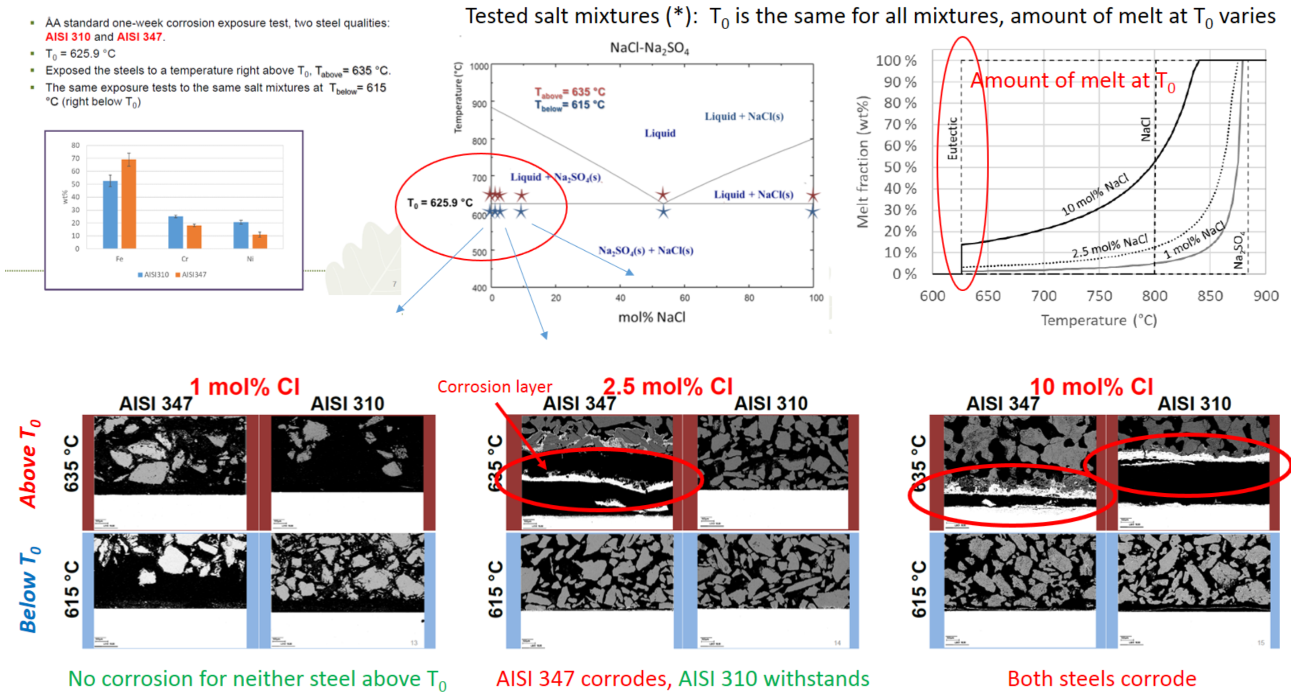


Figure 3. *ÅA standard one-week corrosion test; results from first studies into impact of amount of melt at T_0 on corrosion: bottom left – no corrosion at lowest melt fraction; bottom middle and bottom right – a steel-dependent threshold amount of melt at T_0 is needed for corrosion.*

Objective and scope of this work

The work described here aims to understand better at which melt fractions (amount of melt) different superheater steels start to corrode. Salt compositions in Figure 2 (or similar, could be selected together with SKY) are used in combination with three steel grades. Potential steel candidates could include some of the steels used in Figure 1. It could also be interesting to compare three steel such that two are steels used today (one lower grade, the other higher grade) and the third would be a more exotic, one that is not yet in standard use in recovery boilers. The final selection of steel grades could be done together with SKY.

Schedule, implementation, and cost

The work will be completed during 2020 as MSc thesis work.
ÅA standard one-week corrosion experiments will be carried out using 5 salt compositions (Figure 2, Table I), in combination with three steels. Experiments will be carried out at temperatures below (-20 °C) and above (+20 °C) first melting temperature T_0. Sample cross sections are prepared and analyzed using SEM/EDXA (see Figure 3 for examples). Primarily, one sample is analyzed using SEM/EDXA. However, each experiment will be carried out with duplicate steel samples to ensure that a spare sample is available. In interesting cases or situations of failed sample, the spare samples will be analyzed. The extent of the experimental matrix has been planned to give an about two month experimental part in the MSc thesis work.
Cost: 27 000 euro (+VAT).