Executive Summary - Understanding Low Temperature Corrosion in BL Combustion – Phase 2

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In our earlier studies for SKY we have established that there is no H_2SO_4 in Kraft Recovery boilers firing black liquor. Instead SO_3 and H_2SO_4 react with fume to form Na_2SO_4 and/or $NaHSO_4$. Dew point and corrosion probe measurements after the ESP in a Kraft recovery boiler (Rauma) and a sulfite recovery boiler (Heinola) indicated that the dew point is determined by hygroscopic salts and it is this that sets the lowest temperature steel surfaces can be held at to avoid low temperature corrosion. In phase one of this study, a method was established for testing steel coupons under salts in a flowing gas atmosphere containing steam, Figure 1. One important aspect to note about these tests is that they are isothermal (steel and gases are at the same temperature).

In this phase a larger matrix was tested by a diploma student (Henri Holmblad). The minimum temperature tested at which no corrosion was visually detected for a given salt and vol-% H_2O tested is given in Table 1. The full matrix tested is given in Table 2. The main findings of this work are:

- The minimum temperature for no corrosion to be detected for the precipitator ashes from a Kraft recovery boiler was between 100 and 110 °C up to 60 vol-% H_2O and between 110 and 120 °C at 80% H_2O.
- The salts only need to absorb a little bit of water. This phenomena appears to be less sensitive to the vol-% of H_2O than the temperature of deliquescence which is the point where the salt absorbs enough water to fully dissolve.
- Absorption of water by $NaHSO_4$ was seen still at 150 C, which was the highest temperature tested.
- Salt mixtures do not necessarily behave in predictable ways given the behavior of the individual salts. Precipitator ashes from older mills with SO_2 emissions are needed as the ash from these mills likely contains some $NaHSO_4$ which may necessitate higher temperatures due to the extremely hygroscopic nature of $NaHSO_4$.

Additional work is needed and a phase 3 study is being proposed.

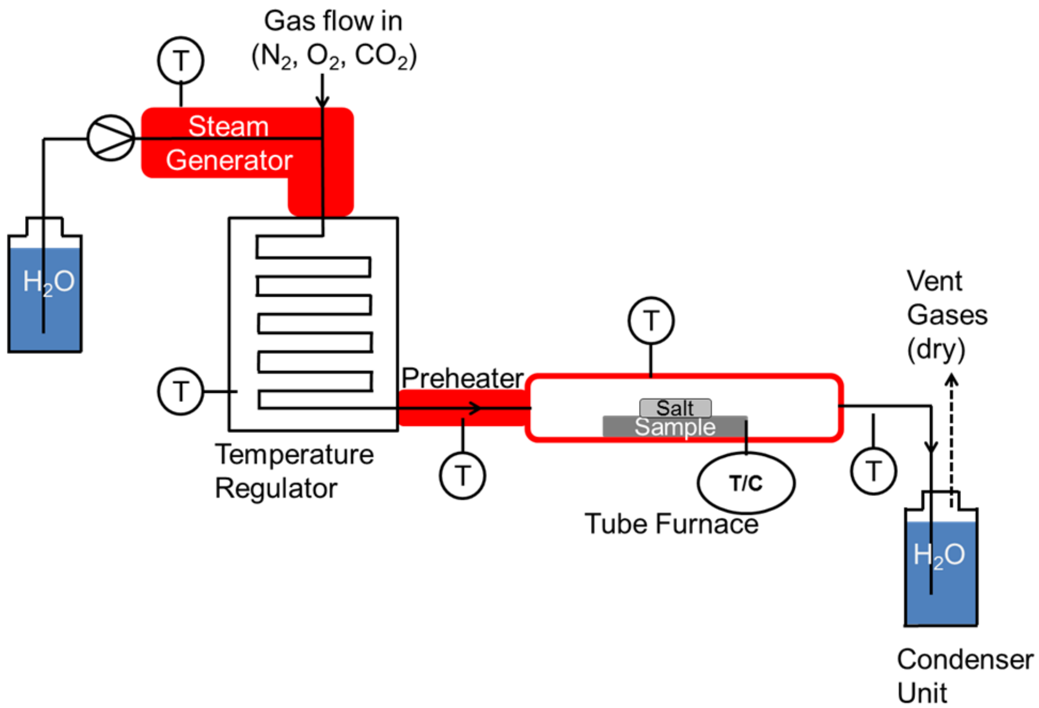

Figure 1. Diagram of the experimental set-up used in this work.

Table 1. Temperatures at which no corrosion was visually present on carbon steel coupons after 4 or 24h under the salt at the given temperature and vol-% H_2O

	27% H_2O	60% H_2O	80% H_2O
Na_2SO_4	90 °C	110 °C	
Na_2CO_3			-[a]
NaCl			120 °C
KCl			120 °C
$NaHSO_4$		>150 °C	
PA1	110 °C	110 °C	120 °C[b] (?)
PA2	100 °C	110 °C	

Table 1. Conditions for corrosion tests in phase 2. All tests carried out with carbon steel coupons under a gas atmosphere containing O_2, CO_2 H_2O and N_2.

Salt	H_2O (vol%)	Temp (°C)	Time (h)
Na_2SO_4	27	80	4
		90	4
	60	100	4
		100	24
		110	24
Na_2CO_3	80	90	4
		100	4
		110	24
		120	24
Na_2SO_4 - Na_2CO_3 (90:10)	27	80	24
NaCl	80	110	24
		120	24
KCl	80	110	24
		110	4
		120	24
PA1	27	70	24
		80	24
		90	24
		100	24
		110	24
	60	100	4
		110	4
		120	4
	80	110	24
PA2	27	100	4
		110	4
	60	100	4
		110	4
$NaHSO_4$	0	150	4
	27	80	4
		90	4
	60	120	4
		130	4
		140	4
		150	4