Proposal: Understanding Low Temperature Corrosion in BL Combustion – Phase 3
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In our work on SKY projects on low temperature corrosion, we have established that there is no sulfuric acid dew point in Kraft recovery boilers and that the lowest temperature flue gases can be lowered to is determined by the hygroscopic nature of salts on the steel surfaces. We have studied the corrosion of carbon steel under hygroscopic salts at isothermal conditions. The conditions used in phase 2 are given in Table 1. The key finding was that for most salts/H_2O concentrations, 110 °C was a temperature where corrosion was not observed except for $NaHSO_4$.

This is a proposal to build on the earlier results through the following measurements:
- 24h corrosion tests with 2-4 precipitator ashes from boilers including one with at least slightly acidic salt (ex. Heinola)
- A 1000h test with a Finnish kraft precipitator ash at two temperatures

<u>Precipitator Ashes from 2 mills (4 runs)</u>

In phase 2 we looked at two precipitator ashes from the same mill, but firing black liquor from different wood species. The compositions of the two precipitator ashes are given in Table 2. In this proposal we will run 2-4 precipitator ashes, at least one will be from Heinola and the others will be from kraft pulp mills.

We will run the tests with some heating elements removed from the back of the tube furnace to create a situation in which the temperature of the samples in the lower temperature zone are about 15 °C lower than in the hotter temperature zone, Figure 1. We will have thermocouples in contact with each of the steel pieces so that we have an accurate temperature for each piece during the run. The object will be to find the border between no visible corrosion and visible corrosion. If we find this border on the first run, we will run another ash. If not, we will adjust the temperature for the same ash. We plan to run at least 2 ashes, but if we find the border for each ash on the first run, we will be able to test 4 ashes.

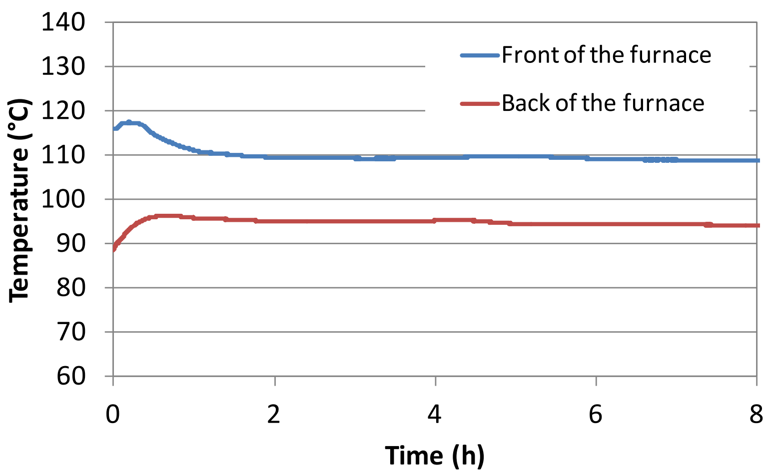

Figure 1. Temperature gradient created in a tube furnace by removing heating elements from the back of the furnace.

<u>1000h test (1 runs, 2 temperatures)</u>

A 1000h test will be carried out with the same Finnish kraft precipitator ash as in the 24h tests, also at 25% H_2O. The runs with the Finnish precipitator ashes will help confirm this is a safe temperature for precipitator ash with at least some Na_2CO_3 in it. We will be able to test 2 temperatures in one test as described above. We will set the temperature in the hotter zone to be the same as the temperature at which we saw no corrosion in the 24h tests.

If corrosion is seen in the 1000h test, the corrosion layer will be analyzed by SEM-EDX.

<u>Steel</u>

We will use 16Mo3 (EN 1.5415) steel coupons provided by one of the companies in tests. We will have 2 coupons in each temperature zone with measurement of the individual coupon temperatures.

Deliverables

A written report will be delivered to SKY within 6 weeks of completion of the 1000h run. The tests will be started within 3 weeks of receiving a sample of 16Mo3 and precipitator ash samples. In addition, the results will be presented at Soodakattilapäivä and reported to the Lipeätyöryhmä and SKY boards as requested.

Cost

The cost for the work planned here is **18 100€** + VAT.

The costs include some margin if a run has to be aborted due to something breaking or a break in power.

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

Table 2. Composition of the precipitator ash.

	Na (wt-%)	K (wt-%)	SO_4 (wt-%)	Cl (wt-%)	CO_3 (bal) (wt-%)
PA1	30.3	4.6	58.4	0.9	5.8
PA2	29.8	4.8	61.0	1.0	3.6