Finnish Recovery Boiler Committee

SKYREC STEERING COMMITTEE MEETING 2/2012

TIME December 19th, 2012 10.00 – 14.00

PLACE Pöyry Finland Oy, Vantaa

PARTICIPANTS

Keijo Salmenoja	Andritz Oy, Helsinki
Timo-Pekka Veijonen	Chairman of Finnish Recovery Boiler Association

Group members without a right to vote:

Markus Nieminen	Finnish Recovery Boiler Association, secretary

Other:

Pekka Pohjanne	VTT (part time)
Emil Vainio	Äbo Akademi (part time)

APPENDICES

1 Project budget and schedule 14.12.2012
2 ÅA, Probe Study of Corrosion in the Economizers of a Kraft Recovery Boiler Corrosion – presentation 19.12.2012
3 ÅA, Probe Study of Corrosion in the Economizers of a Kraft Recovery Boiler Corrosion – draft report 16.12.2012
4 VTT, Analysis of the furnace material test samples – presentation 19.12.2012
5 VTT, Analysis of the furnace material test samples – draft report 26.11.2012
6 Summary report 19.12.2012

DISTRIBUTION
Steering committee and their substitutes
Durability Sub Committee, Black Liquor Sub Committee
Board of the FRBC
MNN, PLA

1 CALLING MEETING TO ORDER

1.1 Absences

Kalle Salmi	Metso Power Oy, Tampere
Reijo Hukkanen	Stora Enso Oyj
Matti Tikka	UPM-Kymmene Oyj, Kymi, chairman
Lasse Koivisto	Andritz Oy, Varkaus
Hidenori Ogawa	Sumitomometal Industries,Ltd.
Timo Peltola	Sandvik, Helsinki
Mika Paju	Metsä Fibre Oy, Joutseno
Esa Vakkilainen	LUT, project coordinator

1.2 Agenda

Agenda was accepted without changes.

1.3 MEMO of the previous meeting (1/2012)

The memo of the previous meeting was accepted.

2 MEETING DECISIONS

PROJECTS:

ÅA, Probe Study of Corrosion in the Economizers of a Kraft Recovery Boiler Corrosion

- Report was accepted with comments.

VTT, Analysis of the furnace material test samples

- Report was accepted with comments.

Summary report:

- Secretary will update report with given comments and send the report to the steering group.

3 BUDGET

Budget (situation 14.12.2012) is presented in APPENDIX 1

Ordered work sum is currently 803 071 €, from which 788 171 € is already paid. Project budget is 805 000 € so we have ~2 000 € left which is enough for the writing the final report.

TEKES refund is complete (350 000 eur), last part was paid in February.

4 FINISHED PROJECTS

You can download all the memos, reports, presentations, videos that has been published so far from the download system: http://www.soodakattilayhdistys.fi/apps/soodakattilayhdistys/download.nsf/ListOfDownloadableFiles?Openview

4.1 Åbo Akademi, Dew point measurements

4.2 Åbo Akademi, Corrosion tests in reducing conditions – PART II

4.3 Boildec Oy, Field testing of furnace materials

4.4 Cewic, TOC removal methods – field tests of activated carbon, UV-treatment and RO-treatment

5 ONGOING PROJECTS

5.1 ÅA, Probe Study of Corrosion in the Economizers of a Kraft Recovery Boiler Corrosion

Background:
The SKYREC dew point corrosion study indicated that little to no corrosion of carbon steel will occur in flue gas heat recuperators until the material temperature was below the water dew point in the flue gases from Kraft recovery boiler. No acid dew point was observed, even when there was significant SO_2 present in the flue gas. This is most likely because any H_2SO_4 formed in the flue gas reacts with Na_2SO_4 to form $NaHSO_4$.

Objective:
The objective of this work was to better understand the cause of corrosion on the flue gas side of heat transfer tubes in the economizer section of a recovery boiler. In particular this work was to clarify the conclusion of the dew point measurements at Rauma and Heinola in a previous study that indicated that there is no H_2SO_4 acid dew point.

Status:
Emil Vainio, Åbo Akademi presented the results and conclusions from the project, APPENDIX 2. Draft report was also received, APPENDIX 3.

Summary:
Long term probe studies (~1000h) were carried out at the Rauma mill in the economizers to study corrosion in the economizers. The air cooled probes were kept at 90 °C, above the water dew point, but well below an H_2SO_4 dew point. One was pulled out after 811h of normal operation and the second was pulled out after 1124h of normal operation plus shut down. Negligible corrosion was seen in both cases, Figure 5-1.

Exposure time	Operation	Ring temperature	Ring Weight Loss (mg)	Avg. Corrosion Layer Thickness (µm)	Calculated Avg. Corrosion (mm/yr)
2 h	Normal	80 °C	0	0	
2 h	Normal	75 °C	0	0	
811 h	Normal	90 °C	22	2*	0.02
1124 h	Normal + water wash	90 °C	72	6**	0.05

*Pit corrosion, pits ~10 µm deep
**Pit corrosion, pits ~20 µm deep

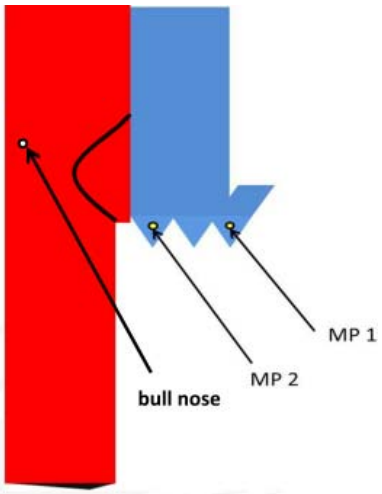
FIGURE 5-1. Corrosion layer thicknesses for the rings in the different probe studies.

No acid dew point corrosion was seen indicating that modern mills can recover more heat from flue gases. In addition, the dew point, SO_3 and corrosion (2h probe study) were measured during oil burning, Figure 5-2.

Conditions during oil burning were special in that a very high air-to-fuel ratio was used. While up to 4 ppm of SO_3 was measured, no acid dew point or corrosion was seen. Further work has been proposed to see if corrosion would be seen during start-up of a Kraft recovery boiler on oil.

Date	Time	MP	SO_3 /H_2SO_4(ppm)	Temp (°C)	Oil burners
18.10	19:20-19:50	b.n.	1	240	2
19.10	10:05-10:35	1	1	150	2
	12:15-12:35	1	1	165	4
	16:27-16:37	2	3	240	4
	16:53-17:13	2	2	240	4

b.n.: bull nose



• No acid dewpoint was found in the dewpoint measurement

FIGURE 5-2. Sampling positions during 2h dew point measurement and SO_3 results

Comments:

- There shouldn't be chloride induced corrosion in those temperatures, it would require chloride water
- Flue gas temperature (figure 4, Tfg) should be checked, flue gas temperature inside economizers should be higher than 150 °C
- Where exactly were the corrosion probes during 811 hour and 1124 hours tests?
- What is the dew point measurement range and accuracy?

- Next measurements should be done after ESP, where heat recovery equipment are located and where there is ~1000 times less ash
- Is ash more reactive to form H_2SO_4 after ESP?
- Could probe measurements with ESP ash done in laboratory furnace?
  - flue gas mixed with SO_3 is led to the furnace
  - SO_3 content, moisture content and temperature could be varied

Decision:
Report was accepted with above comments.

5.2 VTT, Analysis of the furnace material test samples

Objective:
Preparation and analyses (corrosion rate, surface characterisation) of Boildec Oy furnace test materials.

Status:
Pekka Pohjanne, VTT presented the results and conclusions from all five furnace material tests, APPENDIX 4. Draft report is also received, APPENDIX 5.

Summary:
- Corrosion resistance in lower furnace conditions is improved by alloying, especially by chromium.
- According to the wall thickness measurements the test materials can be put in following order based on increased resistance:
  - C-steel << 3R12 < HR11N ~Sanicro 38 (~ Sanicro 28 ~ 3RE28/3XRE28) < Super 625 < Sanicro 67
- Carbon steel corroded at extremely high rate (>4 mm/a) at the temperature of 440 °C.
- 3R12 (AISI 304L) corrodes in such high rate (>0.6 mm/a) at 440 °C that it can't be safely used in the lower furnace in the future high pressure recovery boilers
- Performance of the Sanicro 38 and HR11N was satisfactory in long term test at 440 °C (CR_{max} ~ 0.1...0.2 mm/a), but it is recommended to verify their performance also at lower temperature (400 °C).
- The new material group which looks promising is the high chromium alloys 3RE28/3XRE28 and Sanicro 28, but their long term performance should be verified in the future.
- If the corrosion resistance is the determining factor, the Sanicro 67 seems to be a good material for future boilers, since its corrosion rate was lowest from the studied alloys.
- Based on the long term test the Super 625 is the second best choice for the future high pressure boiler, but because of its relatively high corrosion rate in short term test more and longer tests are needed to verify its performance.

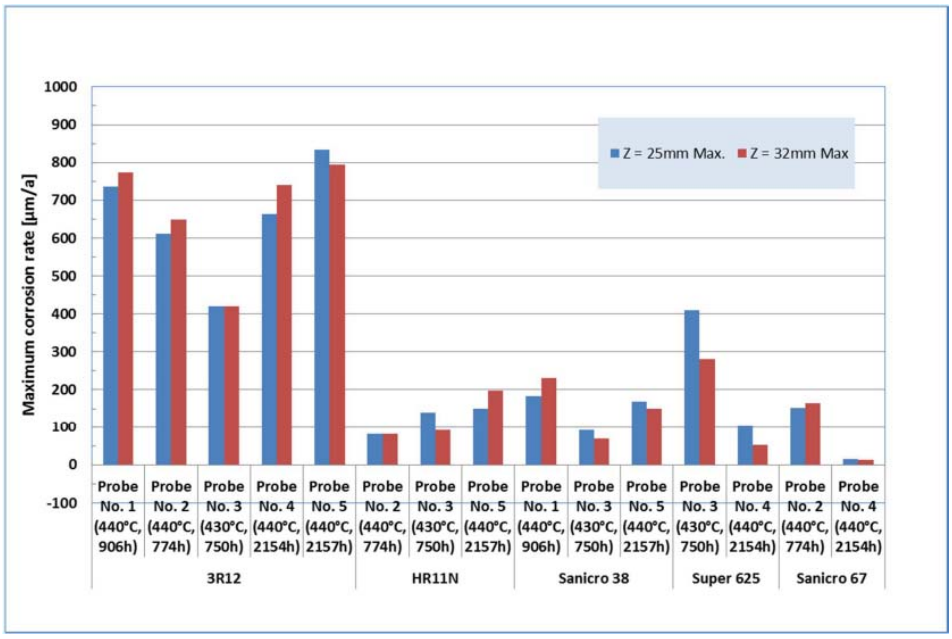


FIGURE 5-3. Calculated maximum corrosion rates for the 3R12, HR11N, Sanicro 38, Super 625 and Sanicro 67 materials from the probe test No. 1 - 5.

- In current samples the biggest problem was the specimen alignment i.e. it was impossible to measure the thickness profiles exactly from the same location before and after the test.
  - Some error to the measurement results; especially to the maximum corrosion rates
  - Most significant when samples had surface scratches and dents
- Another factor that affected to the accuracy was the surface deposits that were not completely removed during washing.
- Tests showed that polishing together with longer exposure time improves the accuracy, both of which are recommended to be used in future tests and especially when evaluating highly alloyed materials.
- The following factors should be considered if future tests are planned:
  - test tubes should be monotubes, made of the outer layer of compound tube
  - thermoelement should be welded carefully to inner side of the test tube (if needed at all)
  - Tube wall thicknesses varied as a function of circumference (in tolerance) -> test tubes should be machined round

Comments to the draft report:

- Corrosion columns should have error bars (min/max)
- Corrosion columns should show oxide layer
- EDS analysis figures in the report doesn't include all components, only the important
- Could corrosion results looked as function of time, short test and longer test, is corrosion linear?

Decision:

Report was accepted with above comments.

6 SUMMARY REPORT

Preliminary summary report was send to steering committee for comments in May 2012. Now secretary has updated the summary report with projects that have ended after May 2012.

Summary report is presented in APPENDIX 6 and can also be downloaded from:
http://www.soodakattilayhdistys.fi/apps/soodakattilayhdistys/download.nsf/11d6a3ccd3209b4cc2257784003c4a58/dbf03daa988e50c4c2257949004dbca3?OpenDocument

Comments:
- What was accomplished –part (page 8) should more detailed
- What where highlights?
- Budget should be included to the report

Decision:
Secretary will update report with given comments and send the report to the steering group.

7 OTHER ISSUES

No other issues.

Markus Nieminen