High efficiency Waste Fired Power Plant of AEB
- experiences with material

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Main conclusions

• Material performance of Inconel 625 Water walls at high steam parameters (438°C/130 Bar) is good
• No signs of deterioration in the superheater sections
• A material performance programme has been set up to monitor progressing performance at this more extreme environment to gain systematic understanding. This will further support maintenance strategy and decisions on further increasing steam parameters
City of Amsterdam Waste and Energy Company

• One of the largest Energy from Waste (EfW) facilities in the world on a single location

• Two plants:
  – Waste to Energy plant
    • Operated since 1993, 4 lines
    • 850,000 tons MSW, 100,000 tons sewage sludge
  – Waste Fired Power Plant
    • Operated since 2007, 2 lines (line 35 and 36)
    • 530,000 tons of commercial waste / ISW
    • Highest P/T operating conditions worldwide!
Waste Fired Power Plant – efficiency improvement measures

• SNCR and Low excess air ratio
• High steam pressure and temperature: 130 bar / 438°C
  – Intended upgrade to 160 bar / 480°C
• Intermediate reheating: 14 bar / 320°C (patent)
• Reduced condensation pressure: 30 mbar/ 30°C

22% net electrical (1993 plant)

30% net electrical (WFPP)
34% gross electrical
Considerations of material deterioration susceptibility

• At 130 bar steam pressure, the steam saturation temperature is 330°C instead of 250°C (40 Bar) At 160 Bar this will be 350°C.
• This will lead to a higher surface temperature of the water wall pipes in the evaporation zone and higher susceptibility to corrosion.
• Since commercial waste has higher Cl-levels, corrosion risks should be considered.
• Because of this AEB decided to implement after one year of operations a thorough materials testing program, to learn further lessons on durable waste incineration.
Design considerations

• Water walls: up to third pass: design for long lifetime
  – Use Inconel 625 cladding to cover the water wall sections of the boiler up till the third pass
  – This will effectively protect for corrosion and increase the evaporation surface and thus the steam production
• Super heater sections and economizer sections: design for fast replacement
  – Made from normal steel (15/16Mo3 and 13CrMo44), design such that complete SH sections can be taken out and replaced in a fast way
First experiences (after 1 year of operation)

• No wall thickness measurements yet at line 35.
• Welding quality in line 35 is less than in line 36.
• At line 36, at transition from ceramic tiles into inconel 625, locally, very limited material deterioration has been found.
• No signs of corrosion or deterioration higher in the waterwall / second / third pass and superheater sections.
Test Cladding

Corrosion probes (KEMCOM)
Material testing program

- Field material tests (including ash sampling)
- Process optimization
- Cost effective maintenance strategy
Challenges

- Organising all international contractors, less than two months prior to the outage
- Combine all the additional work with the planned activities during the outage with a duration of only 2½ weeks
- Creating/controlling the boundary conditions for each application
- Latest NDT techniques and monitoring tools were applied to conduct activities in parallel, e.g. scaffolding and NDT wall thickness measurements with KEMBUS
- Limited time window to conduct measurements
- No plans/options for destructive analyses of test areas after exposure (no cutting of tubes)
Lay-out test panels

- **Blue**: Hauser
- **Orange**: Armat 889C
- **Pink**: Armat 888Z
- **Green**: Sulzer Metco
- **Yellow**: VSH Alloy 686
- **Red striped**: VSH Alloy 622
- **Gray**: VSH Alloy 686 CMT

**FRONTWALL**

**ROOF**

**INTERMEDIATE WALL**
Test panels in 1st pass
KEMBUS

- Measuring wall thickness on the fire side from the outside
SH-tubes before cleaning
Results SH-tubes
Roof section 1st pass
Front wall 1st pass (intermediate row)
Process optimisation

- Two-step approach for optimising firing conditions:
  - Total freedom of control room engineers to optimise the conditions based on their experience
  - Prescribed measurement matrix of conditions

The influence of the process/combustion parameters on the corrosion rate will be measured by multiple on-line electrochemical corrosion monitors
Approach process optimisation

- Determination of the influences of process/combustion conditions:
  - \( \text{O}_2 \)
  - Recigas
  - Primary Air
  - Tertiary Air
  - Flame position

- Determining the influences on the corrosion rate $\rightarrow$ Fine tuning of the automated combustion control!
Online electrochemical corrosion monitor

- Radiant Probes

- Superheater Probes
Process optimisation: phase 1

• First approach was to measure the corrosion on the frontwall in the first pass at different levels.
• The SH-probe type was selected because the elements are more easy to dismantle for analyses purposes.
• During the first measurement campaign, evidence raised that the selected probe type was unfortunate due to the influence of the probe geometry and it’s positioning in the radiant section ➔ high corrosion rate (up to 10mm/yr).
• The sensors were machined from 13CrMo4.4 (tube material).
Process optimisation: phase 2

- In July 2009 two new SH-probes with alloy 625 sensors and two new radiant probes with alloy 625 (W)/15Mo3 sensors were installed.
- A measurement campaign was started with 4 probes simultaneously on the frontwall and the side walls of the 1st pass.
- The aims of the extended measurement campaign are:
  - Comparison of the results of the radiant probe design and the SH-probe design.
  - Measuring corrosion rates in areas selected during inspections conducted during the outage of June 2009.
SH versus Radiant probes

![Graph showing SH versus Radiant probes with markers for 6e L SH2 and 6e R R2]
Conclusions

• Welding procedures influence the quality of Inconel 625 at most severe corrosion conditions
• Promising results of test panels in areas with potentially severe corrosive conditions
• Hardly visible deterioration of test panels in roof section
• Hardly visible deterioration at the SH-tubes
• Influence visible of process parameters on corrosion rate
• The Radiant electrochemical corrosion monitoring probes are showing corrosion rates (0,1 - 0,2 mm/yr), which have been confirmed by wall thickness measurements and visual inspections.
Future perspective

- Although additional testing is still required, extrapolating the present trends with respect to material performance, quality control and the potential to optimise the firing conditions are indicating that high efficiency Waste to Energy conversion can be combined with a cost-effective maintenance strategy.
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