Typical damages to Boilers & Economizers

A guide how to discover and prevent ......
Most commonly seen damages

Boiler water side - Damages caused by:
- Contamination with oil
- Scales and Sludge
- Oxygen Corrosion

Boiler fire side – Damages caused by:
- Soot fire (economizers)
- Sulphur corrosion
- Lack of maintenance
- Failure to understand boiler safeties
Contamination with oil

- Contamination with oil is the most dangerous form of contamination.

- Contamination with oil creates an insulating effect, preventing the heat transfer in tubes and plates.

- Contamination with oil typically comes from leaking heating coils / heat exchangers in cargo system or fuel tanks etc.
Contamination with oil

- Contamination with oil will always lead to boiler failure if not cleaned out.

- Contamination with oil will cause the metal temperature to raise above the critical temperature even with limited oil film thickness.

- Contamination with oil of only 0.5 mm thickness reduces heat transfer rate with 40% - compared to limestone (carbonate) which needs a layer of ~7.0 mm for same reduction.

<table>
<thead>
<tr>
<th>T 0</th>
<th>T 1</th>
<th>T 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>No sediment</td>
<td>178</td>
<td>590</td>
</tr>
<tr>
<td>Oil-film 0.5 mm</td>
<td>184</td>
<td>256</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Heat transfer</th>
<th>kW / m²</th>
</tr>
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<tbody>
<tr>
<td>137</td>
<td>82</td>
</tr>
</tbody>
</table>

Water: 170°C @ 7 bar
Furnace: 1200°C
Contamination with oil

Damages caused by oil contamination

- Deformation of materials (tube – plate)
- Cracks in materials
- Repeated damages if not 100% cleaned in time
- Extensive expenses to repair correct and safely
Contamination with oil

How to discover / avoid damages caused by oil contamination

➢ Check hot-well frequently – install filter material even with small traces of oil

➢ Install equipment for continuous monitoring of boiler water

➢ Install automatic blow down if contamination is frequent
Scales and Sludge

- Primarily originates from hardness in untreated boiler water (calcium / magnesium / sulphate)

- Secondly due to external contamination, e.g. leaking sea water equipment (condenser etc.)
Scales and Sludge

Damages caused by Scales and Sludge

- Build up of scales and sludge will lead to reduced heat transfer on boiler surfaces
- Similar to oil contamination – but not as severe
Scales and Sludge

How to discover / avoid damages caused by Scales and Sludge

➢ Always use a good quality distilled water

➢ Chemical treatment according to makers recommendations

➢ Frequent surface and bottom blow down to remove sediments – before settling into scale and sludge

➢ Install conductivity monitoring equipment.....
Boiler water hardness

We Know Your Boiler......
## Boiler water hardness

### RELATIVE HARDNESS SCALE

<table>
<thead>
<tr>
<th>TERM</th>
<th>Parts per Million (ppm)</th>
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<tr>
<td>Soft</td>
<td>&lt;17.0</td>
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**Hardness test strips**

Range:
0, 40, 80, 120, 180, 250, 425, 1000 ppm (mg/L)

**Total Test Time: 3 Seconds.**

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We Know Your Boiler......
# Boiler water hardness

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<tr>
<td>Slightly Hard</td>
<td>17.1 - 60</td>
</tr>
<tr>
<td>Moderately Hard</td>
<td>61 - 120</td>
</tr>
<tr>
<td>Hard</td>
<td>121 - 180</td>
</tr>
<tr>
<td>Very Hard</td>
<td>&gt;180</td>
</tr>
</tbody>
</table>

**Take sample 10 ml. Add one drop.**

- If turns blue - then your water is soft.
- If color is purple or plum - the water is hard.
- Add more drops to the sample until it turns blue.
- Keep count of the total number of drops.
- Each drop is 20 ppm so you can calculate your total hardness in seconds.
A variety of electronic test instruments are also available – even combined with oxygen measuring ........
Boiler water hardness

Dry powder treatment

Water filter (Dolomite / RO)

We Know Your Boiler......
Oxygen Corrosion

........ is the most common form of corrosion in steam boilers

➢ Reaction between the dissolved oxygen and the iron – caused by a “galvanic process”
Oxygen Corrosion

How to avoid damages caused by Oxygen Corrosion

- Chemical treatment according to makers recommendations – incl. oxygen binder
- Ensure that the hot well (cascade tank) temperature is as high as possible: 85 - 95°C
- If necessary then install heating in hot well
- Oxygen content reduced by 50% at 80°C – compared to 40°C ............
Soot fire in Economizers

Mainly occurs to exhaust gas economizers with extended heating surface

- Caused by excessive soot build up on extended surface – loosening and catching fire

- Soot build up mostly originates from poor engine combustion, excess lube oil consumption, ineffective soot blowing

- Contributing factor can be low circulating water temp. causing sulphur condensation (wet soot)

- A “downward spiral” is increased back pressure due to soot build-up, - causing further soot build-up, etc.
Soot fire in Economizers

How to prevent soot fire

➢ Keep the economizer surfaces as clean as possible

➢ Assure soot blowing equipment in good condition and that routines are kept acc. to recommendations

➢ Assure good engine performance / efficiency

➢ Install flow control / monitoring on circ. water line

➢ Install equipment for measuring back pressure on gas side
Sulphur Corrosion

...... occurs due to a reaction between oxygen and sulphur contained in the soot

➢ In economizers often caused by (rain) water entering from funnel

➢ If circulation water temperature is low (< 130°C) then an increased risk of sulphur condensation on tubes will occur

➢ In oil fired boilers typically the affected area is below any refractory lining – where soot builds up
Sulphur Corrosion

How to reduce Sulphur Corrosion

➢ In economizers the heating surfaces shall be kept as clean as possible (no soot – no noticeable corrosion)

➢ Circulation water temperature to be > 130°C – preferably min 140°C. (for the typical evaporating economizer after engine, the water is circulated on oil fired boiler and temp. above 160°C)

➢ In oil fired boilers water washing shall be planned so that boiler can be fired immediately after completion – not waiting days / weeks till next use (cargo boilers)
Inspection and Cleaning

..... will save a lot of problems

➢ Frequently inspect the boiler for any abnormalities in operation and external appearance

➢ Water side inspections should be planned at intervals, every 6 or 12 months depending on operation.

➢ Important to check for deposits at water side or blockage of tubes etc.
We Know Your Boiler ……

**Inspection and Cleaning**

- Gas side inspections / cleaning, shall be conducted when exh gas temp is increasing from normal (OF boiler and economizer)

- ..... and if back pressure increases above normal for economizer

- Check drains before water washing to prevent excess build-up of water / mud at inaccessible locations

- ..... and to protect T/C (economizer)
Inspection and Cleaning

- Frequently inspect the refractory for defects, cracks, debris, or crumbling.
- The burner inlet refractory geometry is important to maintain the correct flame figure.
- If possible then avoid soaking with water during cleaning of boiler – and if unavoidable allow to dry out slowly with very low fire.
- NOTE: do not leave to dry without firing as then increased risk of sulphur corrosion.
Inspection and Cleaning

➢ Daily check and clean the burner / nozzles

➢ Frequently check all drive belts, linkages, etc. for slack – and correct function

➢ A burner unit in good working condition is mandatory to obtain good combustion and minimum soot deposits
Lack of Maintenance

..... or failure to understand boiler safeties?

➢ Unfortunately the boiler safeties are often found in a poor maintenance condition – and even sometimes out of service / by-passed.

➢ Periodical checks are not done by competent person

➢ Boilers and pressure vessels are **DANGEROUS** equipment when not maintained properly
Improve Your Maintenance

...... and save money

➢ Our qualified service engineers and boiler superintendents can help you by pointing out areas for improvement and train the crew.

➢ Pre Docking Inspection may reveal a small defect, or suspect condition before becoming a disaster – and allow to plan for a timely repair.

➢ Performance Test / Burner adjustment and – optimization, very often result in energy savings, lower running costs – and it is good for our environment too.
Learning Points ......

➢ A minor change in awareness can create substantial economical saving as well as avoiding problems.

➢ An insignificant investment in additional equipment will support the above even further.

➢ A straight line in water treatment reports. ?

➢ Simple crew training could be beneficial to prevent boiler failures.
Thank you - for listening