Introducing Performance Boiler & Cooling Water Metal Passivation Technologies
Anodamine

ANODIC SURFACE ACTIVE POLYAMINE BARRIER PROTECTION

ทุกๆสูตรของ Anodamine ถูกผลิตและส่งออกโดย Anodamine Inc.
Texas USA
Anodamine

Chemical Characterization

The formation of a highly tenacious, hydrophobic, magnetite containing protective barrier film on all exposed metal surfaces.

A Perfect Partnership Between Metal & Water
Purpose of Water Treatment

- ป้องกันการเกิดสนิมใน ติด แฉะ น้ำ ที่อยู่ในระบบของโรงงาน
- ป้องกันไม่ให้เกิดการก่อตัวของตะกัวบนผิวเหล็ก
- ใช้งานง่าย
- Technical support and service
• **Key Performance Indicators**
  • It is the goal of the Anodamine treatment program to achieve significant amounts of savings in following areas;
  • Reduced use of fuel
  • Reduction in maintenance
  • Reduction of down-time
  • Improved lifetime of plant
  • **The KPI’s leading to above goals are:**
    • Reduction / termination of corrosion by keeping the ratio of Fe2+ to Fe3+ at 1:2
    • Reduction of conductivity in boiler water leading to decreased requirement of blow-down volume
    • Improved temperature profile at stack reflecting overall increase of efficiency
    • Reduced blow down volume through setting adjustment of blow down intervals
    • Reduced scaling evidenced through visual inspection and reduced man hours required for cleaning during maintenance cycle.
    • Extended life of pipe-work, particularly in the boiler section evidenced through amount of tube replacement.
The Anodamine focus is based on terminating corrosion and in so doing terminating the source of the corrosion products known to foul boilers & exchangers.
Mechanism of Corrosion

Fe $\rightarrow$ Fe$^{2+}$ + 2 e$^-$ (anodic reaction)

$\frac{1}{2}$ O$_2$ + H$_2$O + 2 e$^-$ $\rightarrow$ 2 OH$^-$ (cathodic reaction)

Fe$^{2+}$ + 2 OH$^-$ $\rightarrow$ Fe(OH)$_2$ (formation rust)
For corrosion of metal to take place, there must be:

1. An **anode** (เหล็ก)
2. A **cathode** (สารเคมี/สารสกปรกต่างๆในน้ำ)

- สนิมเหล็กแท้จริงแล้วคือสารประกอบระหว่างเหล็กกับออกซิเจน
  เมื่อมีเหล็กสัมผัสกับน้ำและความชื้น โดยจะค่อย ๆ สึกกร่อนกลายเป็นเหล็กออกไซด์ หรือที่เรารู้จักกันว่า สนิมเหล็ก

- วิธีการป้องกันเหล็กไม่ให้เกิดสนิมมีอยู่หลายวิธีซึ่งยังใช้กันอยู่ทุกวันนี้ คือการแยกออกซิเจนไม่ให้สัมพะพันกับเหล็กโดยตรง
Phosphate treatment deviations

 Boiler operational at 29 bar

ภอสเฟต + การกัดกร่อนของผิวเหล็ก
ฟอสเฟต + แมกนีเซียม
เคลือบผิวหนังเหล็ก Anode
ป้องกันเหล็กจากปฏิกิริยาออกซิเดชัน
ไม่สัมพะทธ์กับออกซิเจน
ไม่มีการกัดกร่อน
เข้ากับสิ่งแวดล้อมไม่อันตรายต่อสิ่งแวดล้อม
- **Reduced** blow down of energy contained water up to 80% by no phosphate contained treatment
- **Reduced** fuel consumption up to 4% by removing scale and corrosion buildup in the boiler tubes.
- **Reduced** corrosion and erosion in the water, steam and condensate reticulation system up to 95% by polyamine filming and pH buffering
- **Reduced** make up water consumption by reduced blowdown
- **Better** heat transfer capability of condenser & heat exchanger units by scale and corrosion build up removal
- **Better** steam turbine efficiency by preventing mineral carry over
- **Better** environment and working conditions by utilizing non poisonous chemical
Any Chemical Programs Effectiveness CAN ONLY Be Determined by COMPLIANCE OR NON COMPLIANCE WITH INTERNATIONAL CONTROLS
# ASME Compliance

"Consensus on Operating Practices for the Control of Feed Water & Boiler Water Chemistry in Modern Industrial Boilers"

<table>
<thead>
<tr>
<th>Compliance</th>
<th>Non Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protection against corrosion &amp; increased reliability of utilities</td>
<td>Failures and frequent installation downtime.</td>
</tr>
<tr>
<td>High purity steam and condensate.</td>
<td>Contaminated steam and condensate waters decrease plant efficiency, damage and foul turbines by deposition and erosion.</td>
</tr>
<tr>
<td>Optimization of resources - fired fuel and water.</td>
<td>Contaminated feed waters (condensate &amp; softened) increases blowdown and fired fuel consumptions.</td>
</tr>
<tr>
<td>Lower cost of steam production.</td>
<td>Increased costs to produce steam.</td>
</tr>
</tbody>
</table>

All treatment and operational tasks involving water treatment and its critical role toward ensuring protection and reliability of capital plant assets MUST be at all times "benchmarked" against ASME controls and compared to achievements in other similar industrial installations. A water treatment program that does not enjoy management and operational support, understanding and commitment is one that is doomed to fail.

The daily multi-disciplined engineering, chemical and operational challenging of the status quo and desire to continuously strive for improvement should be our common goal ensuring our customers set the pace and remain leaders in its field.

The anodamine™ technologies boiler, steam and condensate program is unequalled in its ability to passivate metal. Our analytical data and weekly consultancy service reports have been redesigned to offer a score card type format for showing areas of non compliance, with clickable links on areas of deviation to allow for a brief discussion on non compliance issues, root cause and recommendations for remedial action.

The accumulative and professional knowledge and experiences of the well respected regulatory and controlling authorities and the contaminant and management guidelines they offer to industry, should be embraced. It is the responsibility of every operator & professional engineer in any market or industry sector to respect and with dedicated effort, work toward achieving these contaminant guidelines.
# Steam & Condensate Analytical Review

- **Red**: Please click on red sections for Remedial Actions. (Red Sections Show Non Compliance With ASME)
- **Green**: Sections Show Compliance with ASME: No Additional Response Required
- **Orange**: Sections Show Excessive Blowdown
- **Purple**: Procedures for Boilers & Cooling Circuits

<table>
<thead>
<tr>
<th>Report No.</th>
<th>234</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date:</td>
<td>11-Dec-08 Glenn Magee</td>
</tr>
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## Condensates

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>Conductivity</th>
<th>Silica</th>
<th>Total Iron</th>
<th>Cycles</th>
<th>Zone</th>
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<tbody>
<tr>
<td>Boiler 4 Sat. Steam</td>
<td>8.59</td>
<td>6.76</td>
<td>0.02</td>
<td>0.013</td>
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<td></td>
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<tr>
<td>Boiler 6 Sat. Steam</td>
<td>8.59</td>
<td>8.08</td>
<td>0.009</td>
<td>0.017</td>
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<tr>
<td>Fe 63 Turbine Condensate</td>
<td>8.75</td>
<td>6.78</td>
<td>0.011</td>
<td>0.006</td>
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<tr>
<td>Reformer 3 Turbine Condensate</td>
<td>8.83</td>
<td>10.12</td>
<td>0.017</td>
<td>0.019</td>
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<tr>
<td>Hot Condensate</td>
<td>8.81</td>
<td>112.00</td>
<td>0.041</td>
<td>0.032</td>
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<td>LPG Condensate</td>
<td>8.78</td>
<td>14.80</td>
<td>0.023</td>
<td>0.029</td>
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<tr>
<td>Fe 4 Condensate</td>
<td>8.78</td>
<td>14.80</td>
<td>0.023</td>
<td>0.029</td>
<td>3</td>
<td></td>
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<tr>
<td>Fe 8 Condensate</td>
<td>8.78</td>
<td>14.80</td>
<td>0.023</td>
<td>0.029</td>
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<td>Fe9 Condensate</td>
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<td>14.80</td>
<td>0.023</td>
<td>0.029</td>
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<tr>
<td>Coker Condensate</td>
<td>8.78</td>
<td>13.90</td>
<td>0.028</td>
<td>0.030</td>
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<tr>
<td>Corner 150 psig Condensate</td>
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<td>13.90</td>
<td>0.028</td>
<td>0.030</td>
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</table>

## Feed Waters

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>Conductivity</th>
<th>Silica</th>
<th>Total Iron</th>
<th>Cycles</th>
<th>Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>CWA Raw Water</td>
<td>10.24</td>
<td>292</td>
<td>2.30</td>
<td>0.024</td>
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<tr>
<td>Softened Water</td>
<td>10.20</td>
<td>299</td>
<td>2.30</td>
<td>0.03</td>
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<tr>
<td>Boiler House 2 Feed Water</td>
<td>9.98</td>
<td>294</td>
<td>2.30</td>
<td>0.022</td>
<td>4</td>
<td></td>
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<tr>
<td>Boiler House 3 Feed Water</td>
<td>10.10</td>
<td>164</td>
<td>2.05</td>
<td>0.030</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

## Generators

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>Conductivity</th>
<th>Silica</th>
<th>Total Iron</th>
<th>10 to 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiler 4</td>
<td>10.98</td>
<td>1026</td>
<td>24.50</td>
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<td>Boiler 6</td>
<td>11.11</td>
<td>2872</td>
<td>41.00</td>
<td>0.049</td>
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<td>Boiler 10</td>
<td>11.21</td>
<td>3365</td>
<td>35.80</td>
<td>0.035</td>
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<tr>
<td>Reformer 3 WHB</td>
<td>11.16</td>
<td>3014</td>
<td>28.90</td>
<td>0.054</td>
<td>14</td>
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<tr>
<td>SRU WHB</td>
<td>11.23</td>
<td>3123</td>
<td>31.54</td>
<td>0.09</td>
<td>15</td>
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<tr>
<td>FCC Fe 4</td>
<td>10.90</td>
<td>3012</td>
<td>26.70</td>
<td>0.198</td>
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<td>FCC Fe 8</td>
<td>11.10</td>
<td>2876</td>
<td>19.60</td>
<td>0.0237</td>
<td>10</td>
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<tr>
<td>FCC Fe 9</td>
<td>11.10</td>
<td>2678</td>
<td>27.54</td>
<td>0.232</td>
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<tr>
<td>Coker WHB</td>
<td>11.10</td>
<td>2678</td>
<td>19.60</td>
<td>0.125</td>
<td>10</td>
</tr>
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<td>SRU 1</td>
<td>11.12</td>
<td>3143</td>
<td></td>
<td></td>
<td>3</td>
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<td>SRU 2</td>
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<td>2865</td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>SRU 3</td>
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<td>2940</td>
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<td></td>
<td>3</td>
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<tr>
<td>SRU 4</td>
<td>11.23</td>
<td>2474</td>
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<td></td>
<td>3</td>
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<tr>
<td>Effluent Cooler</td>
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<td></td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>
A Perfect Partnership Between Metal & Water

Linear Polarization Resistance Corrator® Corrosion Data on Raw Water (No Treatment)
Probe ID: RW-001: Probe Type 3 Electrode Anodic

Maximum = 10.08 mpy
Minimum = 0.46 mpy
STD Deviation = 2.67 mpy

CWA Raw Water Analysis
- pH = 10.2
- Conductivity = 254 us/cm
- Hardness = 69 ppm
- Silica = 2.52 ppm
- Iron = 0.020 ppm
- Chloride = 36 ppm

Some fouling of the corrosion probes leads to a temporary reduction in corrosion but under deposit pitting corrosion increases.
Corrosion rate increases due to presence of residual brine in softened water

Softened CWA Water Analysis

- pH = 10.2
- Hardness = 0
- Conductivity = 254 us/cm
- Silica = 2.52 ppm
- Iron = 0.020 ppm
- Chloride = 25 ppm

Maximum = 11.77 mpy
Minimum = 0.06 mpy
STD Deviation = 3.60 mpy

A Perfect Partnership Between Metal & Water
A Perfect Partnership Between Metal & Water

Linear Polarization Resistance Corrosion Data on Softened Water + anodamine LP
Probe ID: SW-002: Probe Type 3 Electrode Anodic

- Maximum: 0.14 mpy
- Minimum: 0.01 mpy
- STD Deviation: 0.03 mpy

Best Industry Standard: 0.01–0.02 mpy
A Perfect Partnership Between Metal & Water

Linear Polarization Resistance Comparative Corrosion Data
Probe Type: 3 Electrode Anodic

Corrosion Rate mpy

Time (minutes)

Softened Water

Raw Water

Softened Water + anodamine LP
A Perfect Partnership Between Metal & Water
## Technical Evaluation

### Performance Power Generation System & Refinery Plant

1. Based on a report from operations engineer, Scaling problem on steam chests at steam turbine & steam drive pump have been removed.
2. Based on test corrosion coupon in condensate line, Polyamine completely protects from corrosion with 0 mpy.

<table>
<thead>
<tr>
<th>New Corrosion Coupon</th>
<th>Convention Treatment Technology (1426 hours)</th>
<th>Anodamine Treatment Technology (1420 hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Metal Loss: 0.22 mills</td>
<td>• Metal Loss: nil mills</td>
</tr>
<tr>
<td></td>
<td>• Corrosion Rate: 1.351 mills per year</td>
<td>• Corrosion Rate: nil mills per year</td>
</tr>
<tr>
<td></td>
<td>• Deposit &amp; loss Metal Oxide on metal surface</td>
<td>• Smooth Filming on magnetite surface</td>
</tr>
</tbody>
</table>
Economic Evaluation

In the first three months application

1. Saving blow down ➔ Saving De-mineralized Water: 5313 ton, Fuel Oil: 77.1 ton per month
2. Saving cost due to reduced Blow down ➔ USD 15606 per month
3. Due to shut down operation from dosing pump conventional technology in new plant, existing plant & refinery ➔ Saving power electric USD 7056 per month

Technical Evaluation

<table>
<thead>
<tr>
<th>No.</th>
<th>Parameter</th>
<th>Unit</th>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Conventional</td>
</tr>
<tr>
<td>1</td>
<td>pH</td>
<td></td>
<td>8.05</td>
</tr>
<tr>
<td>2</td>
<td>Specific Conductivity</td>
<td>us/cm</td>
<td>9.4</td>
</tr>
<tr>
<td>3</td>
<td>Silicate</td>
<td>ppm SiO2</td>
<td>0.078</td>
</tr>
</tbody>
</table>

Steam Quality
Hydrazine addition (complete oxygen removal + phosphonate chelant)

START OF ACCELERATED CORROSION TEST
After 10 minutes reaction time
After 4 hours reaction time
anodamine
Accelerated Corrosion Test: START
Duration of Test 1 hour
Duration of Test 3 days
ACCELERATED CORROSION TEST COMPARISON

Hydrazine & chelants with complete oxygen scavenging evidenced by formation of extensive magnitude of magnetic corrosion product oxides = 4 hours

...anodamine with ZERO oxygen scavenging = 3 DAYS