A unique, high-performance & cost-effective solution for system wide corrosion protection of steam boilers
Polyamine Technology Review

- A novel approach to boiler corrosion control
- Program benefits
- Polyamine performance review
- Applications
GE Polyamine Technology
Combining the Strengths of Neutralizing & State-of-the-Art Surface Adsorption Corrosion Inhibitor Technology

• A unique, volatile surface adsorption inhibitor – the **Polyamine** - combined with …

• … organic amines or ammonia alkalizing chemistry
What is the **key difference** between Polyamine & traditional Neutralizing amine technology?

In a system with a thermal (or pressure) deaerator, Polyamine is designed to provide **total** system corrosion protection against –

- Acidic Corrosion (CO₂)
- Dissolved Oxygen Attack
- Erosion/Flow Assisted Corrosion
- Downtime/Storage Problems
What are the potential benefits of this approach?

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
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<tr>
<td>Low viscosity</td>
<td>Easy to feed</td>
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<td>Volatile filming agent</td>
<td>Full system coverage</td>
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<td>Single product/single feed point</td>
<td>System wide corrosion protection</td>
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<td>Dual corrosion protection mechanisms of adsorption &amp; neutralization</td>
<td>Reduced potential for both dissolved oxygen and carbonic acid failures, as well as flow-assisted and downtime/outage corrosion</td>
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<td>Effective distribution &amp; tenacious adsorption</td>
<td>Off-line protection</td>
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<td>Efficient recycle</td>
<td>Better cost effectiveness</td>
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Polyamine Performance Review
Polyamine Performance Evaluations
Three years of intensive performance evaluations in GE Boiler Research facility

- Corrosion performance versus traditional oxygen scavenger/neutralizing amine benchmarks
- Dissolved oxygen tolerance limits
- Volatility/Re-cycle of Polyamine inhibitor
- Steam purity/carryover effects
Polyamine Corrosion Performance

Excellent corrosion protection versus traditional O₂ scavenger/amine treatment

• Performance comparisons to amine/scavenger treatment were very favorable

• Carbon steel corrosion rates lower with Polyamine

• No oxygen pitting without feed of a traditional oxygen scavenger in systems with an effective thermal deaerator (typically <30 ppb O₂)
Condensate simulation. DI water, 110° C, 5 – 10 ppb O₂

Benchmark: Neutralizing amines and organic oxygen scavenger.

Treatment: 10 ppm Polyamine product

Feedwater simulation, DI water, 110° C, 20 ppb O₂

Benchmark pH 9 with neutralizing amines* and organic oxygen scavenger

Treatment: 10 ppm Polyamine product

With Polyamine treatment for carbon steel there is a slight reduction in corrosion rate versus the Benchmark treatment and no change in yellow metals

* Same ratio as in product
Water beads on low carbon steel test coupons exposed for seven days to 10 ppm of polyamine product, **100 ppb of dissolved O₂** and 110°C (230°F) in deionized water. The average corrosion rate measured for them was 0.23 mpy (0.0060 mm/y).
Polyamine Volatility & Distribution

Unlike traditional filming inhibitors, Polyamine is **significantly volatile & enters the steam phase readily**

- Complete system coverage from BFW feed point
- Minimal loss of Polyamine to Blowdown
- Parallels Neutralizing amine coverage & enhances corrosion protection
Polyamine Volatility & Distribution

• The volatility of Polyamine insures **effective distribution and system coverage** when fed to the feedwater
  – Steam/Liquid Distribution Ratio Range is approx. 5 to 9

• Polyamine re-cycles **efficiently** through the system with returned condensate, much like a neutralizing amine
  – Enhanced cost-performance versus non-volatile oxygen scavengers

• **No negative impact on carryover of steam purity** based on extensive steam sodium testing in GE Research & Operating Boiler
Oxygen Scavenger Compatibility

- Polyamine chemistry is physically compatible with both sulfite and organic oxygen scavengers at use concentrations in boiler feedwater, boiler water & steam condensate.

- In systems with an efficient operational deaerator, oxygen scavenger feed is not required if Polyamine treatment is applied, but may be continued if desired.

- In systems with a poorly operating deaerator or where the customer desires, a complementary oxygen scavenger can be fed into the system with the Polyamine
Applications
Applications – Case Study

• PA woods products facility

• 600 psig boiler system installed a non-condensing steam turbine for power generation prior to sending ex-haust steam to their process.

• Online and offline corrosion protection, without the need for special layup treatments or programs to protect the condenser and steam-condensate piping during idle periods.

• Provided the plant the flexibility to shut down the turbine and condenser/condensate system, while still running individual steam-driven line processes in the plant, and not be concerned about downtime corrosion in the turbine and air-cooled condenser.
Applications

- Plants with an efficient mechanical deaerator (<20 ppb O\(_2\))
- Plants with a history of pitting in steam condensate
- Plants using large volumes of neutralizing amines
- Plants having idle systems and cycling, intermittent & seasonal operation patterns. Cycling plants, seasonable operations, frequent start-ups, turbine and steam path storage protection, etc.
- Plants with FAC issues (with or without oxygen scavenger)
- Plants going into layup (wet and dry)
- Plants currently using filmers. Polyamine could provide a benefit in plants with high CO\(_2\) in steam (economics of films vs. neutralizing carbonic acid) (Polyamine protects the condensate system, injection at feedwater vs. steam header as in standard non-volatile filmers)
Thank you