Steam System Corrosion Protection Designed for the Refining Industry
A Collaborative effort of GE Refinery Process and Boiler Research and Engineering

A Low-Salt/Polyamine Boiler Treatment Technology
Low-Salt/Polyamine Condensate Treatment Technology

Integrated solution between refinery process and water treatment technology: Lower salting amine technology expanded to include steam condensate treatments
Why Low-Salting Amines for steam treatment?

Condensate treatment tailored for the refining industry

- Developed utilizing state-of-the-art modeling capability developed at GE for both Water and Process operations
- **Low-Salt Neutralizing Amines** - utilizing amines that have less potential for forming corrosive amine chloride salts
- **Polyamine** - Effective protection of “difficult to treat” steam condensate – reboilers, high alkalinity make-up sources, users of flashed steam
- Equal or improved use-cost to the current boiler neutralizing amine products
Amine sources and recycle loops

Amine sources include:
• Overhead neutralizers
• Steam neutralizers
• Crude oil
• Slop oil
• Alkanolamine unit
• Sour water strippers
• H₂S scavengers
• Cold wet reflux

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GE “Low Salt” for steam condensate

- Collaboration between Hydrocarbon Process and Water Technologies Research and Engineering Team

- Designed to reduce amine-chloride salt fouling and subsequent corrosion potential – especially in refinery distillation units operating at lower tower top temperatures (ex. maximizing distillate production)
GE LoSalt™ modeling
Utilized for product design and the current operating impact of treatment chemistries
### Low-Salt/Polyamine Condensate Treatment Technology

**SALT POINT DATA OF AMINE BLENDS IN CRUDE UNIT OVERHEAD, Deg F**

<table>
<thead>
<tr>
<th>Chloride ppm</th>
<th>Steam Amine X</th>
<th>NA0660</th>
<th>Low-Salt/Polyamine</th>
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<tr>
<td>10</td>
<td>227.8</td>
<td>212.1</td>
<td>184.2</td>
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<td>160</td>
<td>296.8</td>
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</table>
GE Polyamine technology
Combining the strengths of neutralizing and state-of-the-art surface adsorption corrosion inhibition

• Four year research effort

• A unique, volatile surface adsorption inhibitor – the Polyamine - combined with ...
  Low salting neutralizing amines designed specifically for refinery steam system protection
GE Polyamine Technology
A novel approach to boiler system corrosion control

What is Polyamine technology?
• A unique, volatile corrosion inhibitor in combination with a high-performance neutralizing amine blend that provides protection against both carbonic acid and dissolved oxygen corrosion

How is it different from a traditional boiler treatment?
• In a system with an effective thermal deaerator, the Polyamine product provides oxygen corrosion protection in the BFW and condensate systems, by filming the metal surfaces. It may augment or replace the existing oxygen scavenger
Polyamine Corrosion Evaluation

Under high corrosion stress → 100 ppb dissolved oxygen

- Minimal pitting
- Minimal general corrosion
- Robust surface film
- 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
Sulfite $O_2$ Scavenger

Both are averages of 3 tests
Each test run - 4 coupons for 14 days

Polyamine

Coupons in same softened feedwater system

MPY 3.1

MPY 0.22, no pits
Key performance differences
Polyamine blends versus traditional amine treatments

Polyamine blends provide enhanced corrosion protection against:

• Dissolved oxygen corrosion and upsets, air in-leakage
• Erosion/flow assisted corrosion
• Downtime/storage corrosion
• Acidic corrosion - CO₂, chloride/sulfate, organic acids
Polyamine program benefits

Why consider Polyamine technology?

Assurance and reliability

• Dual corrosion protection mechanisms of adsorption and neutralization reduces acidic/oxygen/FAC corrosion and iron transport

• Off-line protection - the Polyamine’s effective distribution and tenacious adsorption to metal surfaces provides enhanced protection when the system is off-line
GE Low Salt/Polyamine “Steamate* LSA179x”

Steam System Modeling and Product Comparison

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GE Steam System Computer Modeling
Optimizes product selection and cost optimization for complex steam systems
GE Steam System Computer Modeling

Example: CO$_2$ and amine distribution in flash tank

Flash tank bottoms

17% FLOW

pH = 7.0
81 PPM CO$_2$
147 PPM AMINE

83% FLOW

pH = 10.0
0.3 PPM CO$_2$
27 PPM AMINE

pH = 9.2
14 PPM CO$_2$
47 PPM AMINE

Flashed steam

Condensate
GE “Polyamine”

New Technology in Condensate Treatment Chemistry
Low Salt/Polyamine program goals

Qualification and evaluation

• Cost/performance evaluation – must provide superior feedwater/condensate protection at equal or lower cost – determined by GE steam system modeling and field analytical analysis

• Process units – must be superior in limiting amine chloride salt fouling potential – determined by GE LoSalt modeling and field analytical analysis
Low Salt/Polyamine opportunity

• Opportunity for boiler/steam system and refinery process reliability improvement
• Opportunity for treatment/chemical cost reduction
• Potential opportunity for refinery process operating flexibility/improved profit
Thank you for your time and partnership