GE Power & Water
Water & Process Technologies

GE Polyamine Technology

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

imaginaton at work

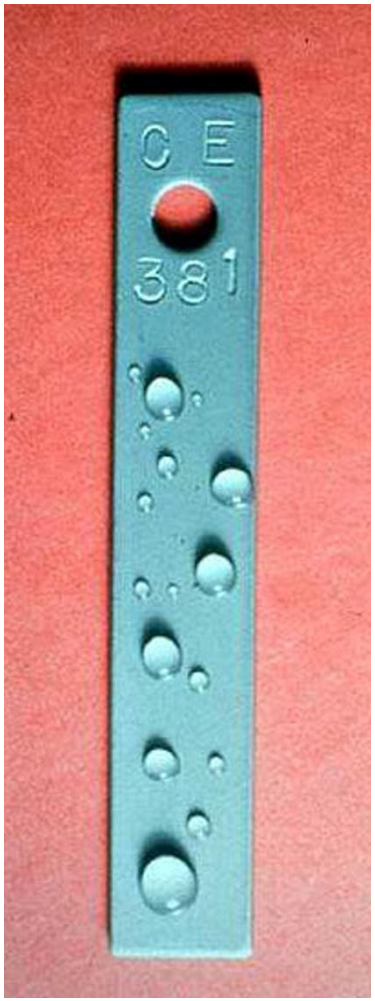
Polyamine Technology Review

- 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 (CO_2)
Dissolved Oxygen Attack
Erosion/Flow Assisted Corrosion
Downtime/Storage Problems

What are the potential benefits of this approach?

Feature	Benefit
Low viscosity	Easy to feed
Volatile filming agent	Full system coverage
Single product/single feed point	System wide corrosion protection
Dual corrosion protection mechanisms of adsorption & neutralization	Reduced potential for both dissolved oxygen and carbonic acid failures, as well as flow-assisted and downtime/outage corrosion
Effective distribution & tenacious adsorption	Off-line protection
Efficient recycle	Better cost effectiveness

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

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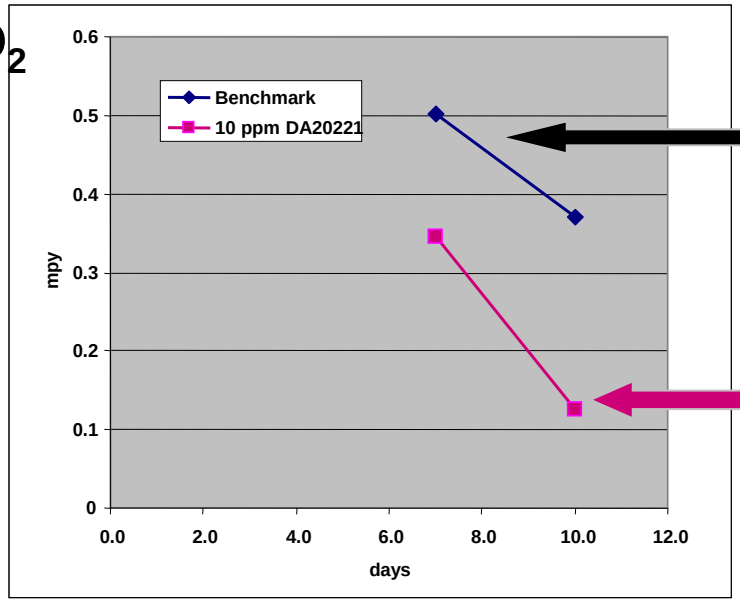
Polyamine Corrosion Performance

Excellent corrosion protection versus traditional O_2 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, 110^0 C, 5 – 10 ppb O_2



Benchmark: Neutralizing amines and organic oxygen scavenger.

Treatment: 10 ppm Polyamine product

Test Coupons treated with GE Polyamine product

Feedwater simulation, DI water, 110^0C, 20 ppb O_2

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

Polyamine Corrosion Evaluation
Under High Corrosion Stress -> 100 ppb Dissolved Oxygen

No pitting

No 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 O_2** and 110^{0}C (230 ^{0}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.

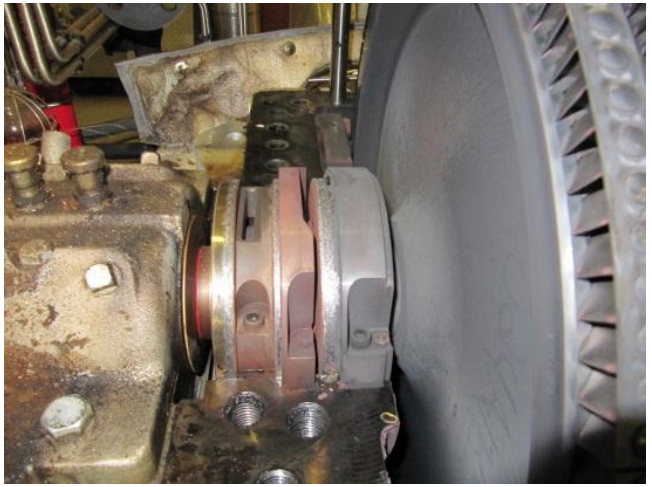
- In systems with an efficient operational deaerator, oxygen scavenger feed is not required if Polyamine treatment is applied, but may be continued if desired.

- 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