

Questions & Answers

POWERFILM™ 10000 FILMING CORROSION INHIBITOR FOR UTILITY BOILER SYSTEMS

When a boiler system shuts down, it cools, drawing a vacuum. Air and non-condensable gases enter the steam cycle. The combination of heat, moisture and oxygen drive a powerful corrosion mechanism. POWERFILM 10000 was designed to protect these systems. It shields the base metal of the boiler system from oxygen attack, resulting in significant improvement in corrosion protection during cyclic operations and unit outages. This helps reduce startup time from unit outages, protects boiler system assets and improves system availability.

What is POWERFILM 10000?

POWERFILM 10000 is filming corrosion inhibitor formulated with a surface active chemistry, which means it has an affinity for metallic surfaces. It does not contain any neutralizing or filming amine. It does not contribute cation conductivity at normal use concentrations.

The major component of the POWERFILM 10000 formulation is based on work done by Nalco Water in the 1940's. This compound, patented back then as a boiler defoamer, has physical and chemical properties that make it ideal to meet today's steam system treatment needs.

- A homogenous product that requires no in-situ mixing
- Twelve-month shelf life
- Fully freeze/thaw recoverable, requiring no agitation
- No viscosity change with temperature
- Does not require formulation with neutralizing amines
- Contains no US EPA priority pollutants
- LD₅₀ >89,500 mg
- Volatile
- No cation conductivity increase at typical use dosage
- NFPA rating of 0/0/0
- Manufactured in accordance with the Toxic Substances Control Act of 1976, The Frank R. Lautenberg Chemical Safety for the 21st Century Act, and included in the TSCA Inventory
- Detectable at use concentrations by an accurate analytical method

There has been a lot of talk about filming amines in the power industry. You say POWERFILM 10000 is not a filming amine. What makes this product different?

Filming and neutralizing amines are commonly and effectively applied in many steam system applications. POWERFILM 10000 was developed for applications – like power plant systems – where an amine is either inappropriate or would not be effective.

Filming amines are *hydrophobic*. Formulating these compounds into aqueous products requires an alkalinizing agent – commonly cyclohexylamine – to bring the filming amine into solution. When fed to the steam system, cyclohexylamine adds cation conductivity which is not acceptable to most power industry customers.

It is possible to keep the cation conductivity low using some filming amine formulations, but very tight chemical control is required. POWERFILM 10000 delivers better corrosion inhibition without adding cation conductivity at normal use concentrations.

We're cycling more and going into short-term outages more frequently than in the past. Can POWERFILM 10000 reduce the amount of corrosion product generated under these operational conditions?

The trend in the power industry toward more cyclic operation drove the development of POWERFILM 10000. Compliance with EPRI guidelines, good chemical control and effective monitoring techniques will deliver outstanding results under steady-state conditions. Cyclical operation makes compliance with best practices more difficult.

POWERFILM 10000 forms a persistent film that protects steam system components during outages. The result: lower corrosion product concentrations upon start-up.

Is POWERFILM 10000 volatile? How does it distribute through the system?

The surface active corrosion inhibitor in POWERFILM 10000 is volatile. Once in the boiler, it vaporizes and leaves with the steam. Once condensed, it forms a protective film on metallic surfaces. The film is persistent, meaning it remains in place during off-line periods, protecting surfaces during cyclic operations and outages.

Is POWERFILM 10000 thermally stable? Will it break down at high temperatures? What are the breakdown products?

Potential breakdown products would be short chain organic acids (such as acetic and formic and/or carbon dioxide).

The maximum CO₂ loading from full decomposition of POWERFILM 10000 would be:

13.2 ppb of CO₂ per 1.0 ppm of POWERFILM 1000 fed (assuming 100% product break down)

In addition to the surface active corrosion inhibitor, what else is contained in POWERFILM 10000?

POWERFILM 10000 contains ammonia. The maximum contribution of ammonia expected with the product is:

1.46 ppb of NH₃ per 1.0 ppm of POWERFILM 10000

Will POWERFILM 10000 coat probes and sensors in the steam system?

During field evaluations of POWERFILM 10000, no evidence of probe or sensor fouling was found.

Some have suggested that we discontinue use of our reductant in our mixed metallurgy system, relying on a filming amine to protect the system. What is Nalco Water's opinion of that approach?

Nalco Water recommends compliance with the EPRI cycle chemistry guidelines.

Reductants render condensate less corrosive. It is Nalco Water's view that relying entirely on the uniform application of a protective film is unwise. It is impossible to determine the extent of the film and, if certain areas have not been treated (or are inadequately treated) those areas are likely to experience higher-than-normal corrosion rates if exposed to corrosive condensate.

Application of a reductant, in accordance with EPRI guidelines, controlled with Nalco Water's Corrosion Stress Monitor, in conjunction with a filming inhibitor like POWERFILM 10000 is the best way to control steam system corrosion throughout the system, regardless of

metallurgy and under every operating condition.

We recently turned off our reductant, let the ORP rise and haven't seen any increase in copper. Have we been wasting money on reductant all these years?

No. A reductant doesn't reduce copper corrosion rates *per se*. Copper oxides, formed under reduced conditions, provide corrosion resistance. When ORP increases (becomes less negative or more oxidative), the copper oxides dissolve. This dissolution occurs slowly at first and then accelerates. Although copper concentrations may remain low initially, once the protective copper oxide layer has been compromised, copper corrosion rates and metal wastage increase rapidly.

For cycling plants with mixed metallurgy systems, Nalco Water recommends a three-part approach: reductant, control using Nalco Water's Corrosion Stress Monitor and POWERFILM 10000.

We've gotten along for years without a filming inhibitor. Why would I want to consider one now?

As noted above, power plant operations are much different today. Plants that were designed to operate base loaded now cycle frequently and frequently go into short-term outages. Those operational stresses require different chemical approaches.

The following are some of the ways our customers have told us these changing operational requirements have impacted their plants and how a filming inhibitor like POWERFILM 10000 helps them meet these new needs.

Frequently out-of-spec chemistry

As a 2004 EPRI Technical Report pointed out, "[d]uring cycling operation, cycle chemistry and corrosion are difficult to control." Some plant chemists, knowing their chemistry will likely be out-of-spec during cyclical operation, become less concerned about it. When the root cause of the out-of-spec condition does not obtain from cycling, it remains unaddressed for longer than necessary.

There's more to worry about than the main condenser.

The main condenser is always the paramount concern, but plant and corporate chemists know that other components – reheaters, feedwater system components, etc. – can take the plant offline just as easily as a condenser leak. Particularly with older plants, operators are concerned about expensive or untimely failures in these auxiliary systems, the repair of which might require expenditures greater than a parent company is willing to make.

Additionally, downtime during periods of peak demand can mean a failure to generate when the potential for profit is highest, something most power plants can ill afford.

Chemical cleanings aren't free or without risk.

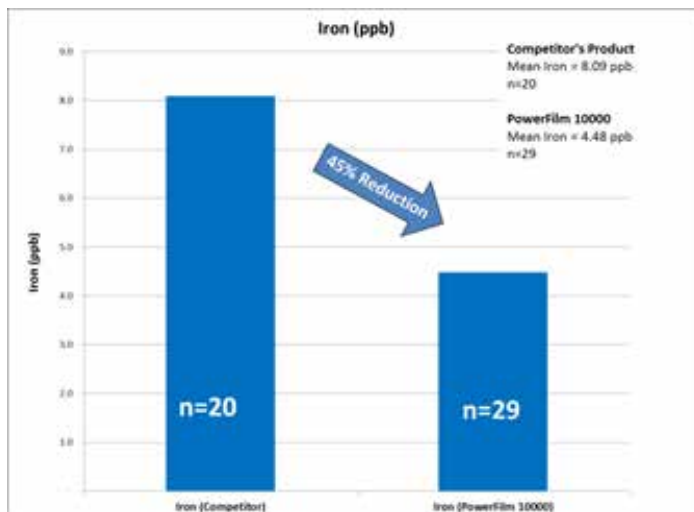
Even moderate corrosion product generation results in waterside deposition that can be removed only through chemical cleanings. These costly evolutions, performed frequently enough, increase a plant's operating costs unnecessarily.

Plants are operating well beyond their intended life spans.

Longevity is a key business imperative, particularly with older coal-fired units. A relatively modest expenditure on a filming corrosion inhibitor reduces wear-and-tear on older components, potentially keeping them in service longer and minimizing routine maintenance costs.

What results have you achieved with POWERFILM 10000?

Field trial results have shown superior results when compared to competitive filming inhibitors, as measured using a corrosion product sampler.



For more information about how POWERFILM 10000 has helped customers achieve their goals, contact your local Nalco Water sales representative.

We follow EPRI guidelines. Was POWERFILM 10000 included in the EPRI filming amine evaluation?

Yes. Nalco Water routinely participates in EPRI studies, including the filming amine evaluation.

We need to submit the components of any product we bring into the plant to the state EPA for approval. Will Nalco Water disclose the components of POWERFILM 10000?

Yes. While we do not publically disclose the components of our products generally, customers will be provided with a full disclosure of the components of POWERFILM 10000 to satisfy any regulatory compliance or local plant safety requirements.

Where do I go to learn more about the physical properties of POWERFILM 10000?

Your local Nalco Water sales engineer can provide a product bulletin listing physical properties. He or she also has access to additional detailed information.

How do you measure the concentration of POWERFILM 10000?

Nalco Water has developed a lab analytical method for POWERFILM 10000. The procedure reports concentrations as POWERFILM 10000. For customers with the necessary analytical capabilities and the desire to perform the method in their own labs, Nalco Water will provide the procedure. We have no plans to develop a field test method.

How is the POWERFILM 10000 dosage determined?

POWERFILM 10000 is generally applied through a stainless steel injector to the discharge of the condensate pump at a rate determined by your Nalco Water representative. Chemical dosage control is determined by pump drawdown and adjustment.

How is a POWERFILM 10000 program monitored?

We recommend measuring corrosion product using a corrosion product sampler or routine iron and copper testing to measure efficacy.

What health and safety information do I need to safely apply POWERFILM 10000?

Section 12 of the POWERFILM 10000 SDS contains the NFP and HMIS health and safety information for the product. POWERFILM 10000 is rated as non-hazardous, with a 0 0 0 rating for both systems.

What are the consequences of overfeeding POWERFILM 10000?

- Increase in cation conductivity at concentrations over 2.0 ppm as product
- Potentially higher condensate/feedwater pH and ammonia concentrations

Above 2.0 ppm we have seen a 0.1 µs/cm increase in cation conductivity in field evaluations.

Can POWERFILM 10000 be diluted or should it be fed as a neat product?

POWERFILM 10000 is best applied neat (as delivered). If treatment pumps are oversized for the low dosage rate required, the product can be diluted with DI makeup water and/or condensate if required.

POWERFILM 10000 has EPA clearance. What does that mean?

In 2016, Congress passed The Frank R. Lautenberg Chemical Safety for the 21st Century Act, a major update to the 1976 Toxic Substance Control Act (TSCA). The Act increases public transparency for chemical information and POWERFILM 10000 is registered in accordance with these new, more stringent standards.

The EPA now reviews new chemistries, their uses, handling and exposure routes and their eventual environmental fate. They may also make recommendations into specific HAZCOM or other notifications required to use any new chemical component. This registration process is an important step we take to ensure Nalco Water provides the best guidance to our customers for use of our products.

Proactive management of human health and environmental safety of our chemical product, and ingredient portfolios is a very high priority for Nalco. Our strategy is supported by significant investments in development and maintenance of a state-of-the-art global chemical management database which houses detailed

human health, environmental safety and regulatory data on all substances, ingredients, and products related to our commercial enterprise. Ecolab's health and safety procedures for controlling the formulation of our products start at the raw material level. All raw materials are screened by our Product Safety team for chemicals of concern, including CMRs (carcinogens, mutagens, and reproductive toxins) and SVHCs (substances of very high concern). Additionally, we review each raw material for compliance with the US Toxic Substances Control Act (TSCA), global chemical inventory compliance, and EPA/FDA compliance (where applicable). The chemical composition of our raw materials is stored in our global enterprise EHS (Environment Health and Safety) system. Our development teams take a system approach to product development considering human and environmental exposures in the context of the application, product packaging and delivery systems. As a result, sustainability factors are proactively included early in the development process to reduce impacts related to our product portfolio. This strategy has positioned Ecolab/Nalco to stay ahead of both our customers' expectations and emerging global regulation.

How will POWERFILM 10000 impact my condensate polisher resin?

Purolite conducted a detailed evaluation of the impact of POWERFILM 10000 on condensate polisher resin. (This report is available upon request.) POWERFILM 10000 had no effect on the Strong Acid Cation (SAC) component of mixed bed resins. POWERFILM 10000 will load onto the Strong Base Anion (SBA) component of mixed bed resins. This loading is likely due to the SBA interaction with the POWERFILM 10000 active. No capacity was lost after proper mixed bed regeneration, using 4% acid for the SAC and 4% caustic for the SBA. POWERFILM 10000 will not cause any irreversible fouling and no long-term damage will occur to mixed bed ion exchange resins.

Nalco Water, an Ecolab Company

North America: 1601 West Diehl Road • Naperville, Illinois 60563 • USA

Europe: Richtstrasse 7 • 8304 Wallisellen • Switzerland

Asia Pacific: 2 International Business Park • #02-20 The Strategy Tower 2 • Singapore 609930

Greater China: 18G • Lane 168 • Da Du He Road • Shanghai China • 200062

Latin America: Av. Francisco Matarazzo • nº 1350 • Sao Paulo – SP Brazil • CEP: 05001-100

Middle East and Africa: Street 1010, Near Container Terminal 3, Jebel Ali Free Zone, PO BOX 262015, Dubai UAE

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