CORTEC Laboratories
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The LEADING Edge

Corrosion Inhibition of Stress Corrosion Cracking and Localized Corrosion of Turbo-Expander and Steam/Gas Turbines Materials

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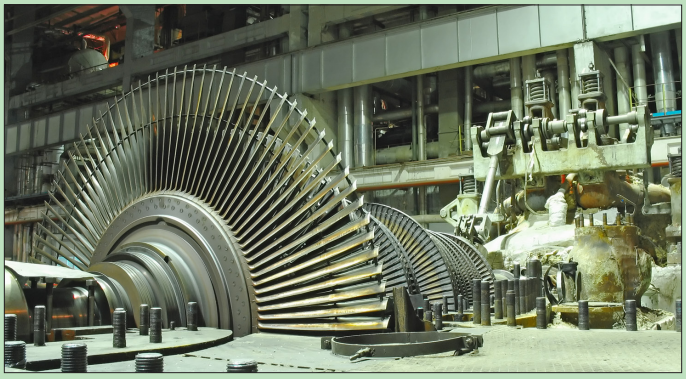
ABSTRACT: Stress corrosion cracking of 7050 aluminum alloys and ASTM A470 steel in the turbo expander and steam/gas turbine industry can cause expensive catastrophic failures, especially for turbo machinery systems performing in hostile, corrosive environments. Commercially available inhibitors were investigated for their effectiveness in reducing and controlling the corrosion susceptibility. Inhibitor effectiveness was confirmed with electrochemical corrosion techniques in different solutions. Polarization resistance increased with concentration of corrosion inhibitor due to film formation and displacement of water molecules. Cyclic polarization behavior for samples in the 1.0% and 5.0% inhibitors showed a shift in the passive film breakdown potential. The substantial increase in the passive range has positive consequences for neutralizing pitting and crevice corrosion cell chemistry. The strain to failure and tensile strength obtained from the slow strain rate studies for both alloys showed pronounced improvement due to corrosion inhibitor ability to mitigate SCC; the fractographic analysis showed a changed morphology with ductile overload as the primary failure mode instead of transgranular or intergranular cracking.

INTRODUCTION: The accumulation of damage due to localized corrosion (pitting, stress corrosion cracking [SCC] and corrosion fatigue [CF]) in low pressure steam turbine components, such as blades, discs and rotors, has consistently been identified as a main cause of turbine failure. Accordingly, the development of effective localized corrosion inhibitors is essential for the successful avoidance of unscheduled downtime in steam turbines or other complex industrial and infrastructural systems and for the successful implementation of the life extension strategies. Most damage occurs during the shutdown period due to chemistry changes and localized stagnant conditions. The environmental changes during the shutdown period significantly influence the probability of failure for the blades and discs in low pressure steam turbines [O_2], [Cl.], temperatures, pH, and time spent in shutdown under aerated conditions increase the probability of localized corrosion attacks. Increase in [Cl.] concentration and pH changes affect the stability of the protective oxides and eventually its breakdown pitting, stress corrosion cracking and corrosion fatigue.



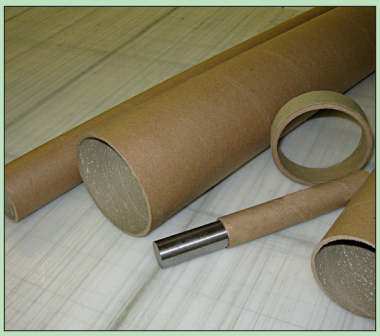
Vapor phase corrosion inhibitors are often a complex mixture of amine salts and aromatic sulfonic acids that provide direct contact inhibition and incorporate volatile carboxilic acid salts as a vapor phase inhibitor for metal surfaces not sufficiently coated. A surface active inhibitor component will be strongly adsorbed at active sites having energy levels complimentary to the energy levels of the polar group, thereby forming a tighter, more uniform protective layer over the metal surface.

CONCLUSIONS: A comprehensive investigation was undertaken to characterize the corrosion behavior of turbo-machinery systems in vapor phase corrosion inhibitor. Effectiveness of the inhibitor was confirmed with electrochemical impedance spectroscopy and cyclic polarization in room temperature and elevated temperature studies. As well, identification of the adsorption mechanism and corrosion activation energy was explored.

Cyclic polarization behavior for samples in the vapor phase inhibitor showed a shift in the passive film breakdown potential by roughly +500 mV. This increase in the passive film range will improve localized corrosion resistance. Crevice corrosion test results showed improved corrosion inhibition behavior compared with unprotected samples. The SCC susceptibility degree from the stress corrosion cracking studies showed significant reduction in SCC susceptibility in environments with added VpCI. Furthermore, ductile overload failure mode was observed for the alloys tested in the 5% inhibitor solution. In summary, vapor phase corrosion inhibitors provide an effective corrosion protection for both ASTM A470 and 7050 alloys during the shutdown period for the blades and discs in low pressure steam turbines

New Products

Cortec® CorrTube™



Cortec® CorrTube™ is the premium corrosion inhibiting packaging and shipping tube in the industry. It provides superior corrosion protection for both ferrous and non-ferrous metals. In addition, CorrTube™ is fully recyclable/repulpable. After use, it can be recycled into other types of paper products such as boxes, cardboard and other corrugated materials. CorrTube™ is environmentally safe, non-toxic, biodegradable, and doesn't contain any nitrites, phosphates, silicates, or other hazardous compounds.

CorrTube™ is easy to use, simply match the appropriate diameter tube to the size of your part. The VpCI® coating on the inside of the tube vaporizes, reaching all metal surfaces to provide complete corrosion protection. It has the unique inhibiting action of Cortec VpCI® that forms a thin effective protective layer and does not alter the appearance of products or require removal before further finishing or use.

Eco-Line® CLP

Cortec's laboratory is continuously working on environmentally friendly, biobased, biodegradable products. One of these products is Eco-Line CLP (Clean, Lubricate, Protect), which is a canola oil based version of our VpCI® Super Penetrant.

The major functions of this product:

- Lubrication
- Rust protection in humid and harsh environments
- Penetration of rust on nuts and bolts
- Excellent cleaning properties

Biodegradable and 90% biobased, freeze-thaw stable and easily removable with common detergents.

MCI® POWR (Penetrant, Oil, and Water Repellant)

This new product combines many functions needed today in construction industries. This one component, VOC compliant, penetrating, breathable water-based silane sealer, containing migratory corrosion inhibitor (MCI®) provides water repellency and resistivity to concrete from oil and water staining. The combination of all these functions makes this product superior for the industry.

M-531

M-531 is an oil-based anticorrosion additive recommended for use in naphthenic, paraffinic, and synthetic oils. An alternative to widely used Cortec® additives M-529 and M-530, this product is recommended for situations when the first two have compatibility problems with the base oil to which they are being added.

CorroLogic™ VpCI® Filler

CorroLogic™ VpCI® Filler is a unique product designed to fill and provide protection for interstitial spaces inside pipelines, tower support structures and other tubular objects. The filler provides excellent contact, vapor and inter-phase protection; and also prevents the ingress of air and water inside filled structures.

CorroLogic™ VpCI® Filler is a two part system consisting of an aqueous corrosion inhibitor (Part A) and powder gelling agent (Part B). When combined, the two components form a gel-like consistency within a predetermined period of time. The absorbance or gelation can be controlled based on the exact mix-ratio. The tunability of this system makes it suitable for a number of different applications.

EcoDevice™- Now Available!

Cortec® is pleased to announce the availability of EcoDevice™, our newest corrosion inhibiting emitter. EcoDevice™ is constructed from biobased, renewable materials providing a sustainable option for corrosion protection.

Each EcoDevice™ will protect up to 42 L (1.5 ft^3) of enclosed space and has a profile of less than 1 mm (0.03 in) making it ideal for applications where space is limited. The low profile and increased protective ability results in a material reduction of approximately 92% in comparison to traditional foam-based devices, truly making EcoDevice™ an environmentally conscious alternative!

EcoDevice™ is available in cartons of 50 individually wrapped devices.

New Product Developments

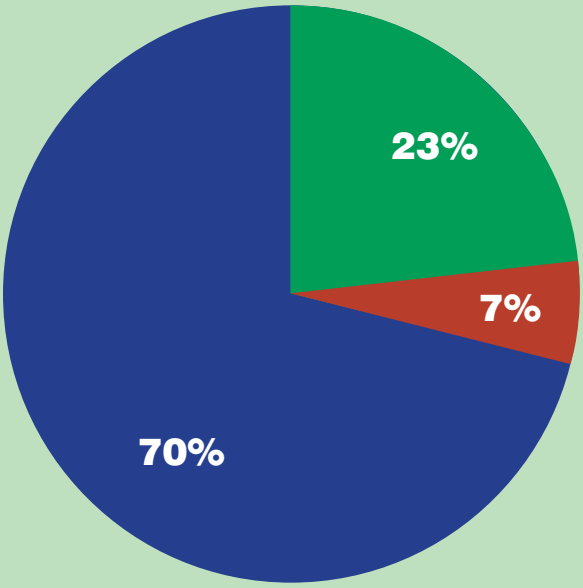
"Successful product development is essential for any business if it hopes to exist for any length of time" **Encyclopedia of Business**

New products, whether in the form of new applications, new innovations, or entirely new goods, are an essential component of business success. "Innovate or die" has become a rally cry at small and large businesses alike. New products are essential to survival.

In today's technologically driven world the importance of product innovation is growing. To stay competitive, companies must develop new products and technologies more efficiently than ever before.

Customers often ask us, "What's new?" Every year you have to raise the ante. If you don't, you will be left in the dust. That's why we, as a team, are committed to making our product development process as efficient as possible in order to deliver new innovative products to our customers. We are proud to be the leader of new product development in the global corrosion inhibitors market.

Cortec® Corporation:
leads in the number of new product developments



Source: MarketsandMartkets, Company Sources

Cortec® Laboratory 2011

Cortec® Laboratory Provides Quality-Testing Service for Internal and External Customers.

Almost a year has passed since Cortec® Laboratory was awarded ISO/IEC 17025 accreditation. This summer the lab will go through the annual audit process. The laboratory together with the quality management team will do their best to make this audit successful. This evaluation should be easier than the initial accreditation as the system is established and we are mindful of the conformance requirements.

We have been sending customer satisfaction questionnaires with each test report completed to get your feedback on how we are doing and what we can do to improve. The analyses of these surveys shows a high level of satisfaction with Cortec® lab services and the feedback has been very positive.

Maintaining ISO/IEC 17025 accreditation requires a continuous effort from the laboratory team to provide a high level of service, keep equipment in excellent working order and deliver on-time results. The fact that our lab is ISO certified has resulted in two major benefits: it attracts paying customers seeking test services and most importantly, it gives Cortec® a real advantage to our sales force in the market place.

Mike Gabor Vice President of Sales/Midwest of Cortec® Corporation sent the laboratory the following letter:

Rita,

" I wanted to thank you for the hard work you and the Cortec® Laboratory group put in to earn your ISO 17025 Certification. I must admit I was unaware of the impact that this would have on our customers. I have noticed on many occasions since how impressed our customers and potential customer are at hearing this news. I share it in every meeting and get sincere "congratulations" from engineers, chemists and other professionals. We always new our lab was world class but it is a great way to let others know too. Thanks for your support and for providing this great sales advantage for us."

The Laboratory is very proud to receive such a positive evaluation and asks Cortec's Sales teams to help attract new customer by promoting the information of available services.

Papers Submitted in 2011

EuroCorr (3)
Corrosion Inhibition of Metals by Corn Derivatives
Evaluation of Corrosion Protection Potential of Agricultural By-Products
Expanding the Use of Compostable Plastics: A Novel Approach to Corrosion Inhibiting Films

NACE (2)
Novel Vapor Phase Corrosion Inhibitors Derived from Agri-Products
By-Products of Ethanol Production in Water Treatment Applications

AWT (1)
By-Products Of Ethanol Production In Water Treatment Applications

European Bioplastics Conference – Abstract submitted
Expanding the Use of Compostable Plastics: A Novel Approach to Corrosion Inhibiting Films

MP Magazine Published March 2011
Corrosion Prevention Using Environmentally Friendly Biodegradable Vapor phase Corrosion Inhibitors

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