PAINTSQUARE.COM
JPCL
VOLUME 37, NUMBER 11 THE VOICE OF SSPC NOVEMBER 2020

COVER PHOTO: EDMNA / GETTY IMAGES

The Society for Protective Coatings

FEATURES

While the process of applying coatings to ships and the surface preparation and inspection activities have hardly changed over the last 50 years, regulations have resulted in changes to paint formulation and increased pressure on ship owners to consider more environmentally friendly solutions. This article highlights the areas where developments will be required to meet the challenges of building, repairing and operating ships in the future, and to identify technologies that may offer solutions to some of these problems.

Traditional zinc-rich primers are the primer of choice during new construction of offshore oil and gas production assets. However, during maintenance, zinc-rich primers are often not used because of difficulties in achieving desired surface preparation and controlling the applied dry-film thickness to prevent cracking. This article will examine the performance of new, activated zinc-rich epoxy primers compared to conventional zinc-rich epoxy primers on steel prepared to different surface profiles using standard techniques of today.

Using dehumidification in shipyards during abrasive blast-cleaning operations has been a widely accepted practice for three decades, and while techniques have become much more sophisticated, the basic goal of preserving the blasted steel and creating the right conditions for coatings application remains the same. This article discusses how various combinations of desiccant dehumidification, heating and cooling equipment and other components have been utilized properly and also provides some examples of when things did not work out so well.

PAINTSQUARE.COM

JPCL

THE VOICE OF SSPC

DEPARTMENTS

ALSO IN THIS ISSUE

STAFF

Editorial

Editor-in-Chief: Charles Lange / clange@technologypub.com

Managing Editor (JPCL/PaintSquare): Brandy Hadden / bhadden@technologypub.com

Technical Editor: Brian Goldie / bgoldie@jpcleurope.com

Associate Editor, Publications & Social Media:
Destiny Johnson / djohnson@technologypub.com

Contributing Editors

J. Peter Ault, Peter Bock, Warren Brand, Robert Ikenberry,
Alison Kaelin, Alan Kehr, Robert Kogler, E. Bud Senkowski

Production / Circulation

Production Design Manager: Daniel Yauger / dyauger@paintsquare.com

Circulation: subscriptions@paintsquare.com

Ad Sales Account Representatives

Group Publisher: Marian Welsh / mwelsh@paintsquare.com

Business Development Manager:
Tracy Dunglinson / tdunglinson@technologypub.com

Classified Sales: sales@technologypub.com

Technology Publishing Co.

Chief Executive Officer: Brion D. Palmer / bpalmer@technologypub.com

Vice President, Operations: Andy Folmer / afolmer@technologypub.com

Vice President, Creative & Custom Media:
Ashley Pound / apound@technologypub.com

Controller: Andrew Thomas / athomas@technologypub.com

Marketing Manager: Jake Landon / jlandon@technologypub.com

Business Administration Manager: Nichole Altieri / naltieri@technologypub.com

SSPC

SSPC Member Development Specialist: Cara Blyzwick / blyzwick@sspc.org

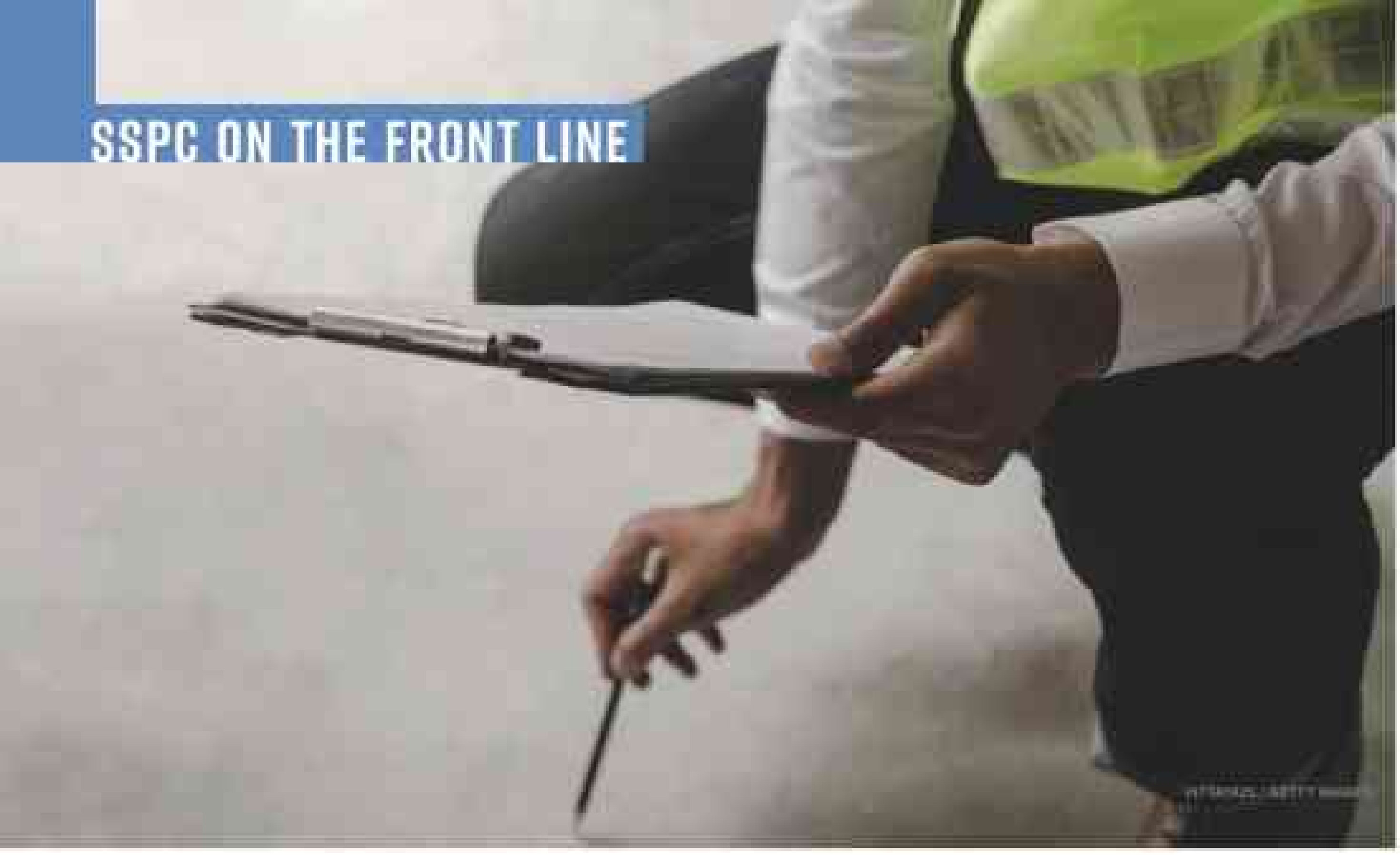
SSPC Member Engagement Specialist: Phil Hall / hall@sspc.org

Telephone: 1-877-281-7772 (toll free); 412-281-2331 (direct)

Periodical class postage at Pittsburgh, PA and additional mailing offices. The Journal of Protective Coatings & Linings [ISSN 2688-741X (online) ISSN 8755-1985 (print)] is published monthly by Technology Publishing Company in cooperation with the SSPC (877-281-7772). Copies of articles are available from the UMI Article Clearinghouse, University Microfilms International, 300 North Zeeb Road, box 91, Ann Arbor, MI 48106. FOR SUBSCRIPTIONS CONTACT US AT: Journal of Protective Coatings and Linings, 1501 Reedsdale St., Ste. 2008, Pittsburgh PA 15233-2341; Tel: 1-800-837-8303 (toll free); 412-431-8300 (direct); Fax: 412-431-5428; email: subscriptions@paintsquare.com. Subscription Rates: North America $90 per year; Rest of World $120 per year. Single issue $10.00. POSTMASTER: send address changes to Journal of Protective Coatings and Linings, 1501 Reedsdale St., Ste. 2008, Pittsburgh PA 15233-2341.

PAINT SQUARE

Printed in the USA / www.paintsquare.com



Continuous Improvement

THE UPSWING IN STANDARDIZATION FOR THE CONCRETE COATINGS INDUSTRY

BY DUSTIN YOUNG, PRODUCT DEVELOPMENT MANAGER, SSPC

Standardization is a key driver for the industrial coatings industry. If there is no current standard for a certain task, how will we know if everyone is doing it correctly—or if this is the task we should be doing in the first place? Ongoing standards development is critical for continuous improvement. A common goal for most worldwide in this industry is to work from the same set of criteria toward the same outcome.

How can we promote this? With facility owner buy-in, that's how. As facility owners develop specifications, they should add relevant standards. This will not only provide the contractor with the correct instructions, but also improve the consistency of asset protection for years to come.

While SSPC-SP 13/NACE No. 6, "Surface Preparation of Concrete" and ICRI 310.2R, "Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair" are extremely critical, new standards have been released for concrete surface preparation and concrete inspection. SSPC's Concrete Abrasive Blast-Cleaning standards define three levels of blast cleaning on concrete substrates.

CONCRETE SURFACE PREPARATION STANDARDS

SSPC-CAB 1, "Thorough Blast Cleaning" describes a concrete substrate that, when viewed without magnification, shall be free of all visible deposits of coatings, oil, grease, mildew, curing compounds, form release agents, dust, efflorescence, laitance, concrete splatter, other visible contaminants and poorly bonded or weak surface layers capable of being removed by abrasive blast-cleaning. Surface air voids (bugholes) shall be abrasive blast-cleaned to remove shelled-over cement paste. The blasting must open the full surface dimensions of the voids.

SSPC-CAB 2, "Intermediate Blast Cleaning" describes a concrete substrate that, when viewed without magnification, is free of all visible deposits of oil, grease, mildew, curing compounds, form release agents, dust, efflorescence, laitance, concrete splatter, other visible contaminants and poorly bonded or weak surface layers capable of being removed by abrasive blast-cleaning. Bugholes do not need to be opened, and any existing coating should be removed except for that remaining in surface air voids and pores.

SSPC-CAB 3, "Brush Blast Cleaning" describes a concrete substrate that, when viewed without magnification, is free of all visible deposits of oil, grease, mildew, form release agents, dust, efflorescence, laitance, concrete splatter and other visible contaminants capable of being removed by abrasive blasting. Bugholes do not need to be opened. Loose curing compounds, loose coating and surface layers shall be removed by abrasive blasting and are considered loose if they can be removed by a dull putty knife.

CONCRETE COATING INSPECTION STANDARDS

ASTM D8271-19, "Standard Test Method for the Direct Measurement of Surface Profile of

Prepared Concrete" describes a test method suitable for both field and laboratory use to quantify the depth of surface profile of prepared concrete.

SSPC-PA 19, "Standard for Visual Evaluation of Pinholes in a Concrete or Masonry Coating" details a procedure for use when examining the final coat of a coating system applied to concrete or masonry surfaces to determine the number of visible pinholes. It also contains a pinhole frequency classification scheme that is used to determine the acceptability of the applied protective coating.

CONCLUSION

While these new standards are vital additions to the concrete coating industry, the job is certainly not done yet. Multiple concrete coatings standards are in development. It is great to see such a large community of professionals who work with concrete coatings every day involved in standards development. This will not only improve craftworker skills, but allow facility owners to specify procedures with confidence that the work performed will be completed to the highest industry standard. JPCL

SSPC NEWS

Updates to SSPC-NACE Merger

Since members of SSPC and NACE approved combining associations in May of this year, efforts have continued apace via member-led teams to determine the best ways to bring programs, products and services together under one organization.

Over the summer months, 14 ad-hoc integration teams were created to sort through the vast array of details that need to be considered to enable programs to operate in the new organization. These teams consist of members of both SSPC and NACE as well as staff from each organization.

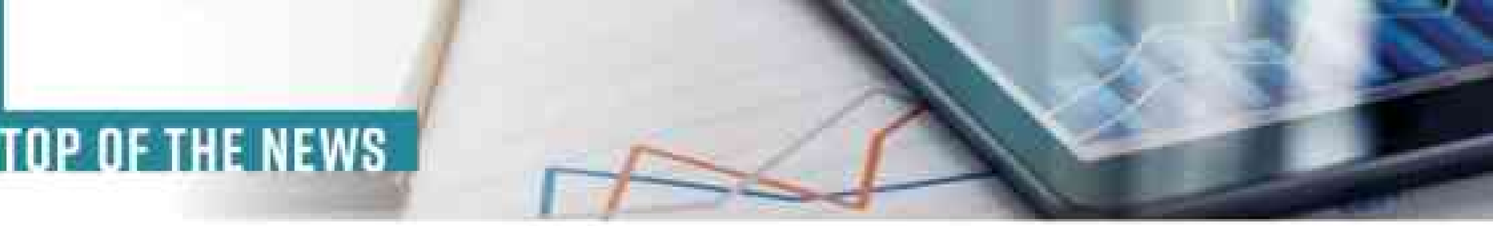
The teams include:

- Transition Team;
- Accreditation Team;
- Brand Team;
- Certification Team;
- Chapters/Sections Team;
- Conferences & Events Team;
- Education Team;
- Finance and Accounting Team;
- Governance Team;
- IT Infrastructure Team;
- Membership Team;
- Pre-Professional Activities Team;
- Publications Team; and
- Standards Team.

Depending on the projects and deadlines, teams meet as often as necessary to facilitate the decision-making process so that members of both organizations can realize the benefit of the combined association as quickly as possible once the combination becomes official in 2021.

Through September and October, much progress was made by all of the teams, and updates have been given at a series of town hall meetings held each month to accommodate members in various global time zones. The October meetings provided updates on the work of the Standards Team and revealed the governance structure for the combined SSPC-NACE organization.

Recordings of each meeting have been made available and can be found at sspc.org/sspc-nace-updates or nace.org/about/nace-sspc-news. In addition, members can find the dates and register to attend future meetings at both sites, including the town halls on Monday, Dec. 14, at 10:30 a.m., Central and on Thursday, Dec. 17, at 6 a.m., Central. Members are also urged to subscribe to the weekly email updates from SSPC and NACE, which offer more timely updates on ongoing activities. JPCL



IPOPBA / GETTY IMAGES

2020 Q3 Financials

SHERWIN-WILLIAMS REPORTS INCREASES

Global coatings firm The Sherwin-Williams Company announced its financial earnings report for the 2020 third quarter on Oct. 27, reporting a year-over-year net sales increase of 5.2% to $5.12 billion. Diluted net income per share; earnings before interest, taxes, depreciation and amortization; and net operating cash also all increased.

The company says that the increase in the quarter was primarily due to higher sales in most of the Consumer Brand Group in all regions as well as continued strong sales in residential and DIY markets in the Americas Group and a return to growth in the Performance Coatings Group.

"Continued and unprecedented strength in our DIY business, solid demand across our residential repaint and new residential segments, and improving demand in our industrial coatings businesses and regions drove our strong third quarter results," said Chairman and Chief Executive Officer, John G. Morikis.

"I am extremely proud of our 61,000 employees, who continue to demonstrate resiliency and determination while providing our customers with differentiated solutions," he added.

In the Americas Group, net sales increased 2.8% to $2.98 billion in the quarter, which was primarily due to higher residential repaint, DIY and new residential paint sales in the U.S. and Canada, partially offsetting the impacts of the COVID-19 pandemic. Segment profit increased $83.8 million to $747.4 million in the quarter.

In the Consumer Brands Group, net sales increased 23.5% to $838.1 million in the quarter, which the company attributes to higher volume sales to most of the group's retail customers in all regions. Segment profit increased to $198.3 million in the quarter from $114.9 million last year.

The Performance Coatings Group also increased marginally with a 1.2% bump to $1.31 billion in the quarter (though it decreased 5.6% to $3.62 billion for the first nine months year over year). The modest increase was due to improving demand in most business and regions, the company said, led by the Packaging and Industrial Wood divisions. Segment profit increased in the third quarter to $155.3 million from $137.5 million.

In all the company generated $2.56 billion in net operating cash during the first nine months of the year, a 54% increase year-over-year.

"For the fourth quarter, we anticipate our consolidated net sales will increase by 3% to 7% compared to last year's fourth quarter. For the full year 2020, we expect our consolidated net sales will increase by a low-single-digit percentage compared to the full year 2019," Morikis said.

PPG REPORTS SALES DECREASE

Worldwide coatings company PPG released its third-quarter 2020 earnings report on Oct. 19, announcing lower net sales at $3.7 billion, or 4% lower than in 2019. However, third-quarter 2020 reported net income from continuing operations was $442 million, up from $366 million last year, while adjusted net income from continuing operations was $458 million, up from $396 million last year.

"As reported earlier this month, we delivered record operating results in the third quarter, with both of our reportable business segments delivering higher segment income than the prior year, despite continued, negative pandemic-related economic effects," said Michael H. McGarry, PPG Chairman and Chief Executive Officer.

The company's Performance Coatings segment third-quarter net sales were about $2.3 billion, roughly 3% lower than the prior year. Segment income for the third quarter was $426 million, up about $45 million, or about 12%, year-over-year. Segment income was aided by higher selling prices, cost-mitigation efforts and restructuring initiatives; partially offset by the unfavorable earnings impact from lower sales volumes stemming from the pandemic.

The Industrial Coatings segment third-quarter net sales were $1.4 billion, down about $80 million, or 5%, versus the prior-year period. Segment income was about $253 million, up nearly $45 million, or approximately 23%, year-over-year.

The company ended the third quarter with net debt of $3.5 billion, approximately $600 million lower than the second quarter. The company prepaid $1 billion of a $1.5 billion term loan maturing in April 2021. The company's $2.2 billion revolving credit facility is currently undrawn.

"Looking ahead, we are likely to experience normal seasonal trends in the fourth quarter, especially in our European and North American architectural coatings businesses. Even with the continued uncertainty from the pandemic we expect overall economic activity to continue to recover, but in an uneven manner," said McGarry.

"The pandemic is still significantly impacting the demand for certain coatings products—most notably, global commercial aerospace, marine and protective coatings that support the oil and gas industry. In addition, we expect that automotive refinish coatings demand in the U.S. and Europe will remain below 2019 levels until there is a return to more normal commuting patterns."

"We will continue to prioritize the health and safety of our employees, while providing excellent support to our customers with our technology-advantaged products. I am very proud of the entire global PPG team, and I want to thank everyone for their continued focus and diligence during these challenging times. As I said last quarter, I remain confident that we are on the path to emerge from this crisis as an even stronger company, and these record quarterly results lay the foundation for delivering on this commitment," McGarry concluded. JPCL

COMMENTS IN RESPONSE TO:

"Field Testing for Soluble Salts: A Problem to Be Aware Of"

From JPCL September 2020

Author Simon Hope's article on the pros and cons of different testing methods for soluble salts got coating experts talking about their experiences with testing in the field.

T_KIMURA / GETTY IMAGES

Regis Doucette:

"Thank you for providing solid wisdom here about an infrequent topic of non-visible contaminants that make very frequent appearances in the field ... Your presentation is spot-on about the various methods. Extraction of surface ionic contaminants using distilled water, documented in numerous studies, will solubilize ... but half the samples are inadequate. Thus, at the analysis stage, investigators/field tests will be starting off with half the tests not able to identify the problem. This condition or problem is akin to having someone who lies to you half the time, but you cannot discern which half of the time he/she is telling the truth.

The second part of testing is the analysis, which you presented so very well ... Keep up the great work."

Simon Hope:

"Thanks for the positive comments, Regis. The taking of high-risk testing from the lab and into the field and being given to people who don't fully understand what is actually being done is a great worry."

Gavin Bowman:

"Excellent article, Simon. Certain aspects have backed my thoughts up from when I became a 'salt nerd' a good while ago!"

Peter Bock:

"The biggest problem with all the salt (and ion) testing is that it tests only very small spots, and the type and amount of contaminants on the surface can vary widely. In the early 2000s, when I worked for a very large industrial coatings company that was willing to spend money on lab work, we did dozens of Bresle tests on different spots of the same 300-square-foot section of contaminated tank wall. The test results varied widely, even between adjacent test areas. What we need is a test instrument like a paint roller or a low-voltage holiday detector, which can sweep large surface areas and do large numbers of salt or ion tests, producing a map, or at least an average, for the whole tested surface. Until then, we are really still just guessing and hoping."

EDITOR'S NOTE

The award-winning Mario Cuomo Bridge repainting project was covered in the October JPCL feature, "2020 SSPC Structure Awards Series: The Mario Cuomo Bridge and the Bayonne Bridge." Carboline Company also provided coatings for the project, including zinc-epoxy-urethane systems and intumescent fireproofing application to some portions of the bridge. JPCL apologizes for this omission.

PAINTSQUARE DAILY NEWS TOP 10

From paintsquare.com/news, Oct. 5–Nov. 8

1. Trump Pushes to Paint Border Wall
2. PPG Reports Sales Decrease in 2020 Q3
3. Tnemec Announces 2020 Tank of the Year
4. Sherwin-Williams Reports 2020 Q3 Increases
5. NY Exec Pleads Guilty in Bid-Rigging Scheme
6. OSHA Issues FAQ on N95 Masks
7. Survey: Highest-Paying Jobs Without Degrees
8. EPA Proposes Tank Inspection Alternative
9. FDOT Requests Skanska to Cover Toll Loss
10. NTSB Attributes Corrosion in Fatal Crash

THE FUTURE OF SHIP PAINTING

Part 1: Identifying Problems, Exploring Solutions

BY ANDY HOPKINSON, RALITSA MIHAYLOVA AND RAOUF KATTAN, SAFINAH GROUP LTD.

The process of applying coatings to ships, the associated surface preparation and inspection activities for new construction, dry-dock repair, and maintenance has hardly changed over the last 50 years. However, regulations have resulted in changes to paint formulation, and increased pressure on ship owners and shipyards to consider more environmentally friendly solutions that would reduce waste and impact on health, safety and the environment. Inspection regimes have gradually become stricter, resulting in additional work to rectify unsatisfactory workmanship.

While limited attempts were made in the 1970s[1] to consider how vessels may be painted in the future, little has since been done to look at the future possibilities. Currently, the industry is exploring the concepts of the unmanned ship operation and increased automation in shipbuilding and repair. This article aims to highlight the areas where significant changes and technology developments will be required to meet the challenges of building, repairing and operating ships in the future, and to identify technologies that may offer solutions to some of these problems against the background of increased regulatory and environmental concerns.

THE CURRENT VIEWPOINT

In any gathering of coatings experts, one of the regular laments is that coatings fail because of poor surface preparation and/or poor application. However, data from the authors' work over 20 years has indicated that this is not necessarily always the case, and that while these may be symptoms of failure, they are not, in most cases, the root cause of the failure. The implication of this conclusion is that given the required inspections needed for certification, certified coating inspectors are not carrying out their task properly.

An analysis of the failures investigated by the authors is summarized by root cause in Figure 1, which shows how important factors such as design, specification and product selection could affect a coating's performance. While the authors accept that there may be considerable variability in the experience of coating inspectors and technical service personnel, factors that determine a coating's performance are decided well before any coating inspection takes place. The determination of the suitability of a surface preparation for coating is usually based on visual standards (for example, surface cleanliness), which can make an objective determination very difficult. This raises a cause for concern and a need for a change in approach.

For newbuilding work, it is clearly in the interest of the shipyard to "get it right the first time," as this minimizes the overall cost and time of a project. In dry-dock, contractors are usually rewarded based on man-hours, and so potentially the incentive to improve the process is lower, with time and competitor pressures tending to drive quality down to ensure profits. Onboard maintenance by the crew has huge variability in terms of quality and quantity of work carried out; however, it is a relatively low proportion of the overall operating budget and this tends to relegate it well down the list of operational priorities for most ship owners.

Standards are readily referred to within specifications or on technical data sheets but without understanding the implications for specific tasks.[2] It is a common misconception that all standards were written with ships in mind rather than for a broad range of coating activities covering a range of structures (from buildings to railcars).

Therefore, standards must be subject to scrutiny and discussion before any project starts to agree how they should, and will be, applied. There is thus an urgent need to make these standards more relevant to the shipping industry and improve the technical integrity of some (such as IMO PSPC).

THE DECISION-MAKING PROCESS

The Ship Owner

There are different kinds of owners, and ownership patterns, which can impact coating selection, expenditure, and ultimately performance, irrespective of the quality of the work at new build or during repair, or the level of experience of the inspectors. Owners can be broadly divided into four categories: private, public, state and financial.[3]

The period of ownership of individual vessels differs on average by company type. For example, financial companies (banks, funds, etc.) tend to keep assets for significantly shorter periods of time, whereas state-owned companies tend to hold on to them for much longer. Also, different companies have different investment horizons, and the timeframes to realize the return on their investment could be significantly different—and hence, the willingness to invest in the longevity of the vessel can also vary considerably.

Vessels can have as many as five to eight owners over their lifetimes, depending on type. Bulk carriers tend to have more owners on average than both tankers and container vessels. It was also found that the first owner tends to keep the asset the longest, which usually covers the first and second special surveys.[3]

However, ships' economic lives are finite, and on average last about 25 years. When strict regulations are enforced that require costly retrofits, many owners tend to scrap older tonnage, so the average economic life of a vessel shortens. For vessels with multiple owners, this results in frequent changes of ownership and very short periods of ownership. For ship owners whose main priority is to generate profit based on the market fluctuations, and who tend to buy and sell vessels speculatively, there is little incentive to spend on the coating process and general maintenance.

All these factors make the management of coatings problematic, as every change of owner can result in a change in coating specification and coating manufacturer, making the coating process unique among the various engineering systems on board the ship, which otherwise generally last the life of the ship, or rarely see a change in supplier.

In terms of vessel integrity, the Classification Societies have a key role as they are often the recognized authority to assess coatings in ballast and crude oil cargo tanks. Ship owners also change Classification Societies for a variety of reasons (for example, when a ship is sold). The change of ownership and Classification Society can lead to a lack of continuity in terms of an intimate knowledge of how the coatings perform in service, and similarly when a change of paint supplier occurs, this also limits the extent to which any lessons learned about performance can be put into practice. This has generally limited attempts to draw meaningful data about coating performance across different manufacturers and coating types.

The Equipment Supplier

The marine market for surface preparation and coating application equipment is limited, and small compared to the needs of other manufacturing industries that have more customers and can generate greater sales than the marine market. Consequently, development of surface preparation and application technology tends to dominate in these markets where mass production readily justifies investment in automation.

The coating process technology used in the shipping industry is very mature and is at the phase where every possible benefit is being squeezed out of the existing technology to keep pace.

The Coating Contractor

Because of the mature level of technology used in coating application, there are very low barriers to entry for a new company, and this has led to the existence

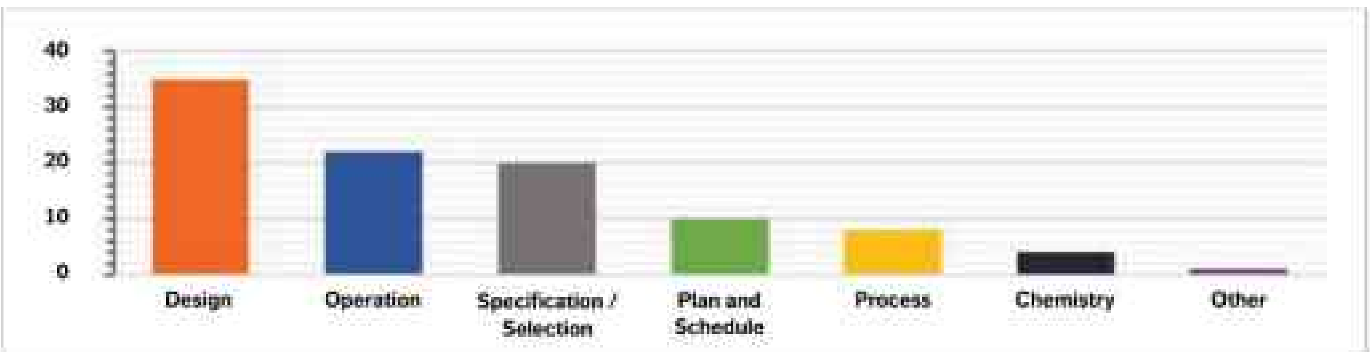


Figure 1: Causes of coating failure (%) based on the authors' investigations. FIGURES COURTESY OF THE AUTHORS UNLESS OTHERWISE NOTED

of numerous small coating contractor companies that are often used by shipyards and by ship repair companies as a way of balancing the labor demand during the build or repair process. The market is therefore competitive; for example, more than 40 coating contractor companies are present in Singapore alone. A few companies have tried to establish themselves as international players, but they generally suffer from a cost disadvantage, and the market does not offer much scope for them to increase prices to reflect the "superior" service or technology they may be able to provide.

The coating department is often under the supervision of a coating "manager," who in most cases does not have a university education, but has usually risen through the ranks based on experience and craft skills. The likely qualification held will be that of a coating inspector, such as SSPC, FROSIO, ICorr, NACE or equivalent. In many of the leading shipyards there are a growing number of qualified chemists and corrosion engineers who either undertake this role or support the manager.

For surface preparation and coating work, the type of training available is generally "on-the-job" and traditionally the requirements are informal. However, there is a growing trend for formal training and certification, within the industry. This serves to indicate the challenges that the coating process must overcome to increase productivity and provide cost savings through life of the vessel.

The Shipyard

In the same way that there are different types of owners, there are also different types of shipyards: those that are high-volume producers of a range of vessels, and those that are specialist builders of fewer vessels (for example, cruise ship or naval ship builders). Some build in the open air and some build in enclosed facilities. The production needs of these yards vary in terms of speed of build and throughput, which are important factors in coating selection as they affect drying times, overcoating intervals and key features of shop primers such as weathering, cutting and welding.

Coating product development is often driven by the needs of the major shipbuilders, where most of the marine coatings are sold, and hence these markets become key targets for the coating company product development programs. This tends to result in performance solutions for these major facilities, requiring that the many smaller facilities or specialist builders have to adapt products to their specific needs.

Local regulations and environmental concerns are increasingly playing a key role in this area. For example, the use of abrasive blasting in some shipyards can be restricted, or the need to limit volatile organic compound emissions can adversely affect the production performance of a facility.

CHALLENGES—AND POSSIBLE SOLUTIONS

One of the key problems is the lack of coordination between the new build and in-service requirements. At new build, the team is mainly focused on the delivery of the vessel on time and on budget, and in many cases, little thought or concern is given to the in-service operational costs and needs.

In terms of the paint supplier, the ability to follow a vessel throughout its life is hampered by the varying patterns of ownership, often resulting in new owners switching paint suppliers, and in short-term interests that tend to lead to lower cost rather than best practice.

The shipyard's interest in a vessel is only over the 12-month warranty period. The paint company has the shipyard as the client initially, and then the owner, who may only keep the vessel with the same paint company until the next drydock. Thus, there is often little consideration of through-life performance and how best to measure it.

It is often said today that the major new build yards wield too much influence, and the price pressure on owners to accept standard designs can often result in an increase in through-life operating costs. Until this is resolved by proper feedback mechanisms, new build designs and the selected coating schemes will compromise future operating costs.

The situation is being compounded by the fact that few ship owners employ coatings experts directly, and when this happens, they are often recruited to be part of the site team for a new build. Meanwhile, in the technical departments at the head office or in company management, there are very few companies that can claim to have genuine in-house expertise with respect to corrosion and coatings.

Vessels being managed suffer even more because of the competitive nature of the industry and natural owner resistance to pay for "enhanced" services when they are considered to be the responsibility of the ship manager. As an extreme example, a ship management company could be dis-incentivized from adopting novel solutions that could save the client money but increase their own costs, which they may not be able to recoup.

This implies that there is a need in the market for a "total coating management" service, which can consider the through-life engineering requirements of the coating system, tied to the ship itself rather than the owner, and provide each owner with around-the-clock support for the coating needs, including longer-term behavior analysis, and provide the specialist support to owners, managers, charterers and others.

Process Variability

One of the key challenges facing the coating process is that of variability or predictability. When coating a complex space such as a ballast tank using the IMO PSPC regulation and good practice guides as provided by many paint companies, a manual surface preparation process is required to provide a Sa 2.5 cleanliness finish. The profile of this finish is in the range of 30–75 microns, whereas the coating to be applied is in the range of 280–640 microns—typically two coats of paint in areas of complex geometry. Thus, the manual application process must deliver a tolerance of 360 microns (the difference between the minimum and maximum thickness).

Variability of the application performance has been assessed[4] and current processes are not capable of meeting these tight tolerances, resulting in elevated paint thickness and/or inadequately prepared surfaces.

Design Problems

The way in which ships are designed, including their structural configuration, has been optimized over many years to ensure efficiency and consider key parameters such as cargo carrying capacity and speed. Very little consideration has been given to the concept of design for coating, and rarely (if ever) have the authors seen reference to ISO 12944-3 in any paint specification with its emphasis of design for coating detailed features like scallops and welding configurations.

Standard access holes in tanks are generally too small for workers to easily access with the required equipment and lighting, and make the process of ventilation and curing much harder. Work with a Dutch yard[3] showed that where additional effort is made, then designs can be modified to reduce the number of edges (a regular source of coating breakdown and corrosion), improve access with bigger holes and reduce total surface area for coating that could lead to considerable cost savings for the ship yard.

Yet, it is still common today to see designs that, while they may provide productivity savings in steel work or weight, create significant problems in service by using dissimilar metals, complex geometrical design or provide tight spaces which make it impossible to properly prepare and coat with the technology that is available today.

Design today has its limitations; classification rules require key structural inspections to be carried out at arm's length and hence result in considerable expense in the provision of temporary means of access.

Future Design Solutions

The use of mild steel will likely prevail for the immediate future, but the potential use of graphene to allow different structural configurations to replace the stiffened flat panel, as has been often envisaged with corrugated core laser welded panels, could be realized.[4] Such a change would allow increased structural efficiency and offer different options for corrosion protection and smooth flat surfaces for functional coatings to be applied.

Design improvements can be also made by upgrades to standards such as ISO 12944-3 to address specific issues related to marine structures. Furthermore, such standards should be referenced in design and coating specifications.

Access for work and inspection is critical to the through-life performance of the coatings and the operating cost of the vessel. A considerable amount of effort has been placed in the development of drone technology to carry out surveys, which the authors believe will have a considerable impact on vessel design in the future. In addition, technologies for underwater hull cleaning/surveying and coating removal will also evolve and need designs to be developed to take their requirements into account.

Other key areas are, naturally, cargo tanks, holds and chemical cargo tanks. For cargo holds, issues of abrasion and cargo handling damage need to be investigated and new design configurations considered. Attempts to use stainless steel for chemical cargo tanks have found some success, but this in turn raises the issue of dissimilar metals being used in the adjacent ballast tanks, and in addition, stainless steel is not without its maintenance needs in the form of repassivation.

Any design should thus aim to minimize the coating challenge over the life of the vessel, with the desired outcome a coating-friendly design, which can be defined as one that is not only well suited to enhance the productivity of the new build yard by having simpler structural configuration that minimizes complexity and hence access and ease of coating, but also is both optimized for the operational requirements and the likely adopted maintenance regime, and provide asset integrity through-life.

One of the most significant issues for coatings over the last 30 years in terms of structural design of vessels has been the rise in the number of designs that are provided directly by a shipyard which tend to focus on optimizing production time and efficiency during the build cycle, rather than the through-life needs of the asset/owner.

COATING STRATEGY

Every world-class shipyard has a well-defined build strategy that is often very detailed for steel and outfit work but can be lacking in how the coating activity can best be integrated into it. The lack of application of any coating strategy is often reflected by the relatively high levels of rework that are required in coating activities because of poor integration of the coating process with other activities.

A key issue has been the increased levels of productivity in shipbuilding in general against a set of technologies (surface preparation and coating application) that have not progressed in terms of productivity, and struggle to provide consistent/predictable performance in terms of surface cleanliness and application (a fully automated shop primer line being a general exception to this rule).

Current Coating Strategy

The building strategy of today generally affords little space for the coating activities despite them often being a bottleneck process.[7] Many shipyard designs and developments often create imbalanced processes by underestimating the needs of the coating process either in the form of too few workshops, insufficient transport capability or (as in most shipyards), the subsequent need to repair the freshly applied coating. More effort has to be put into developing coating strategies that accept the limitations of current technologies.

Future Coating Strategy

If technology does not change then coating strategies will have to be better integrated into the production process and even simple things such as allowing more cycle time for coating work in winter compared to summer will be required. However, technology opportunities continue to emerge in the form of coatings that are more resistant to hot work damage, or hot work technology that is more forgiving to existing coating systems. Low heat input technologies for cutting and welding such as using high-power lasers could provide such solutions, while current technology limits the "self-healing" capability of high build coatings often used on ships.

The second part of this article will cover in detail the coating specifications and standards used today, and what will be necessary in the future. It will also consider the needs of coating technologies in the future. JPCL

ABOUT THE AUTHORS

Andy Hopkinson is the Managing Director for Safinah Group Ltd. He joined the coating industry in 1993; prior to joining Safinah, he held business development, technical service and sales management positions with one of the world's largest coating companies.

Ralitsa Mihaylova is the Head of Special Projects for Safinah Group Ltd. She is qualified as a Marine Engineer and has experience working in ports administration, ship management and maritime administration, including a research placement at the IMO.

Raouf Kattan is the Principal Consultant and founder of Safinah Group Ltd. He has a background in seafaring, academia, shipping, shipbuilding and naval architecture and protective coatings, and he has worked on a wide range of marine, offshore and industrial projects, including catastrophic coating failure investigation and failure analysis relating to coatings.

REFERENCES

1. Dr. Kiyoshi Terai, Tatsumi Kurioka. "Future Shipbuilding Methods." Shipbuilders Association of Japan, 20th Anniversary Commemoration Prize Essay; August 1969; BSRA Reference 30,593.
2. Kattan M.R. "Cure or Curse – Marine Coating Standards and Specifications." *Marine Technology* (SNAME), July 2017.
3. Mihaylova R.; "Periods of Ownership in Shipping: Patterns and Influences." Ph.D. Thesis, University of Newcastle upon Tyne, April 2017.
4. Kattan, R., Fletcher, J. "The Problem with Meeting Paint Specifications." SPPC Annual Conference, USA, 2015.
5. Dr. Broderick D. "A Structural Design Methodology to Reduce Structural Complexity to Improve Coating Application and Performance In Water Ballast Tanks." Ph.d. Thesis; University of Newcastle upon Tyne; 2015.
6. Hoare. J, Kattan M.R. "Laser Welding and Steel Sandwich Construction for Merchant Ships." NEWBUILD 2000 Conference, Royal Inst of Naval Architects, London 1995.
7. Baldwin L., Kattan M.R., Townsin R. "Painting and Ship Production – Interference or Integration?" RINA Corrosion Conference, London Oct 1994.

[illegible] / GETTY IMAGES

CAN YOU USE A ZINC-RICH PRIMER WHEN PAINTING OFFSHORE?

BY RAQUEL MORALES, ANTONI PRIETO, JOAQUIN FERREIRO AND DAVID MORTON, HEMPEL A/S

Traditional zinc-rich primers are the primer of choice during new construction of assets placed offshore for oil and gas production. However, during maintenance, zinc-rich primers are often not used because of difficulties of achieving desired surface preparation and controlling the applied dry film thickness to prevent cracking.

This article will examine the performance of new, activated zinc-rich epoxy primers compared to conventional zinc-rich epoxy primers on steel prepared to different surface profiles using standard techniques of today.

Surface preparation is a crucial factor to ensure good performance of a coating system in an offshore environment. Both substrate cleanliness and surface profile—influenced by the shape of abrasive—will impact the adhesion of the primer, which has a direct influence on the performance of the coating system.

Testing performed will show the importance of surface preparation on the ability of the coating system to provide long-term corrosion resistance in an offshore environment, and on how the choice of zinc-rich primer can improve tolerance to unsatisfactory surface preparation and thus enhance the lifetime of the coating system. Testing completed includes cyclic ageing according to ISO12944-9 (2018), blister box testing according to ISO 6270-1 and the impact test according to ISO 6272-1.

BACKGROUND

The beneficial effect of zinc-rich primers, both organic and inorganic, on the longevity of protective coatings is primarily assumed to be due to a cathodic protection mechanism.[1]

Zinc coatings are protective in two different ways: they serve as barriers and also as galvanic protectors of steel surfaces, regardless of the type of zinc coating involved. Metallic zinc protects steel from corrosive attack in most atmospheres by acting as a continuous and long-lasting barrier between the steel and the atmosphere. Zinc has a much lower corrosion rate than steel, so that in all except very polluted (acid or alkaline) atmospheres, the zinc will provide protection against rust for long periods of time. Historical data to prove this point have been released in reports by ASTM International and by the Zinc Institute as a result of actual service and field tests of zinc coatings.

The primary objective of surface preparation is to provide maximum adhesion of a coating over a substrate. Adhesion is the key to coating effectiveness, and it determines whether the coating is merely a thin sheet of material lying on the substrate or whether it becomes an actual part of the substrate. Adhesion becomes an even more critical condition for coatings applied in corrosive areas. Thus, proper surface preparation is vital to the long life and effectiveness of a coating applied in corrosive service.[1]

The actual mechanism of surface preparation has a twofold purpose. The first purpose is to remove any extraneous, loose materials from the surface of the substrate, as well as to eliminate chemically bonded scales, oxide films and similar surface reaction products that cover active adhesion sites on the metal surface. The removal of such materials exposes the reactive sites so that the primers can have contact with them and develop the maximum adhesion possible.

The second purpose of surface preparation is to increase the surface area by increasing the roughness and anchor pattern of the surface. By this means, the actual exposed surface area per unit of actual area is greatly increased. By increasing this effective surface, many additional reactive sites on the metal surface are exposed, allowing for additional polar or chemical adhesion of the primer to the surface. This is extremely important, because increasing the opportunity for either primary or secondary valence bonding with the coating system is the key to the best possible adhesion of any coating.

Historically, zinc epoxies have been specified only when surface preparation could be prepared by methods such as abrasive blast-cleaning. Abrasive blasting ideally creates maximum adhesion between the coating and the surface—good enough to promote long durability of the asset given that proper techniques are followed and specified standards are met. However, the need for this level of surface preparation makes the application of zinc-rich coatings during maintenance periods more complex, and as a result, these coatings are mainly used for new building and application on workshops.

In offshore maintenance jobs, the surface usually is not abrasive blasted, as there can be both logistical and environmental issues related to this task related to containing, collecting and disposing of spent abrasive material from miles offshore. As a result, power-tool cleaning and hand-tool cleaning are more often used for maintenance, which means that the surface area will not be increased as it is when abrasive blasting is used.

The increasing demands on the performance of zinc-rich primers—for example, low rust creep—has generated even more focus on maximizing the utilization of the zinc dust in the coating and optimizing the rust creep resistance. This has not been possible without adequate surface preparation (such as abrasive blasting) of the substrate.

In zinc-rich primers, zinc is used as a pigment to produce an anodically active coating. Zinc will sacrifice itself and protect the steel substrate, which becomes the cathode. The resistance to corrosion is dependent on the transfer of galvanic current by the zinc primer. As long as the conductivity in the system is preserved and as long there is sufficient zinc to act as an anode, the steel will be protected galvanically. Therefore, zinc pigment particles in zinc primers are packed closely together and are typically formulated with very high loadings of zinc dust. Zinc loadings of 80–85%, by weight, have been used. This huge amount of zinc dust—close to the Critical Pigment Volume Concentration—means that there is less binder than in other types of primers, where the amount of pigment is much lower. This could directly affect the adhesion of the coating to the steel, as the binder is the main driver for adhesion.

NEW TECHNOLOGIES

The demands on protective coatings used in offshore environments are very high, and modern paint systems are generally so durable that upon exposure to natural weathering, they may show little signs of deterioration. However, maintenance jobs offshore are occurring more often, and having to stop production to complete these jobs means loss of productivity. If these durable modern-day coating systems, which are mainly used for new building, could be used for maintenance jobs, then the time between maintenance jobs could be extended.

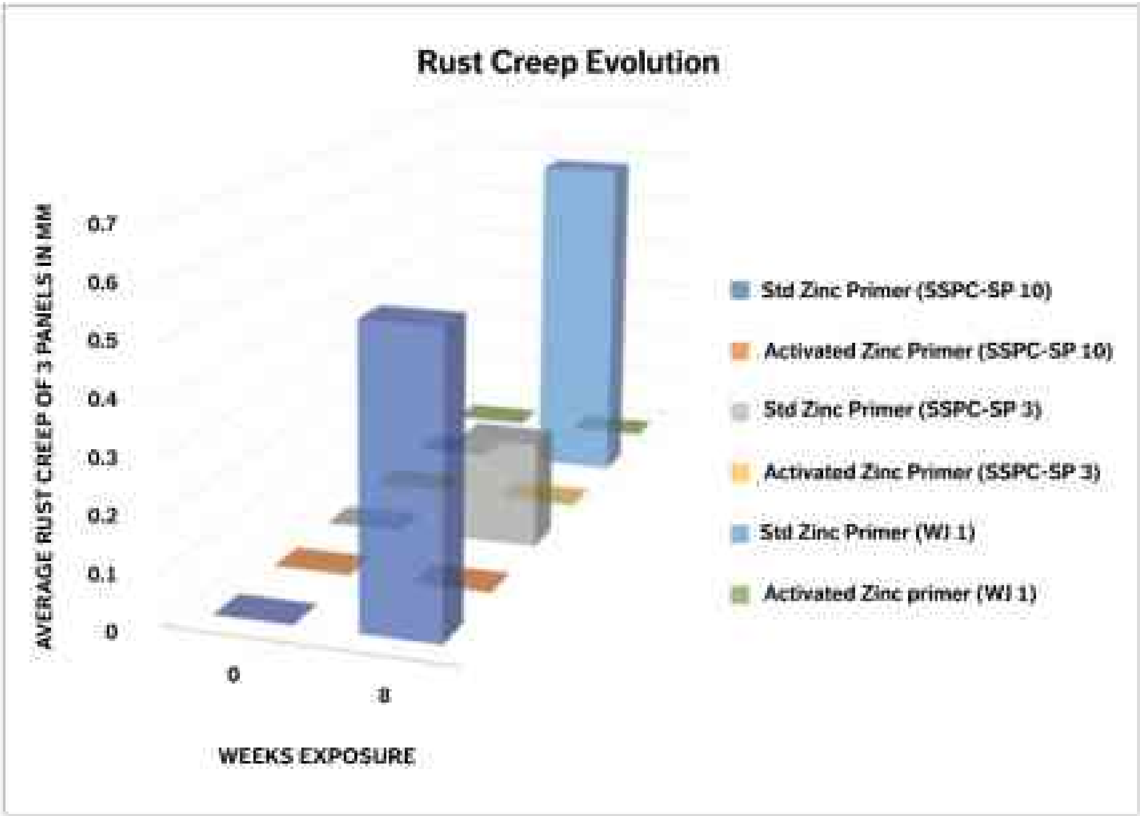


Fig. 1: Rust creep evolution results for tests done on steel panels coated with 60 µm (2.4 mils) of primer. The panels (7.5 cm x 15 cm x 5 mm; 2.96 in. x 5.91 in. x 0.197 in.) were composed of hot-rolled mild steel.

FIGURES COURTESY OF THE AUTHORS UNLESS OTHERWISE NOTED

The use of new technologies and paint formulations implies that new coatings are used with little or no previous track record. This has resulted in more emphasis being placed on accelerated laboratory testing to evaluate coating performance. Many of these accelerated exposure tests will not, within their exposure time, visually show the negative effects on intact coated surfaces.

Therefore, behavior of these coatings around artificially made damages, such as scores made in the laboratory, are given significant considerations, and many prequalification tests are based among others on rust creep and blistering, as well as detachment from scores (including NORSOK M-501, ISO 12944-9, NACE TM0104, TM020412, TM0304 and TM0404). One of the requirements for prequalification of zinc primers according to ISO 20340 is rust creep below 3 mm (0.118 inch).

The industry is looking to use the latest technologies available in order to reduce the associated maintenance and repairs cost, as well as systems that increase application productivity. Recent testing results suggest that all these benefits can potentially be achieved with a new anti-corrosion technology, based on activated zinc.

This new technology combines barrier and inhibition mechanisms to achieve a high level of steel protection, significantly reduced effects of corrosion stress and increased durability, productivity and mechanical performance compared with standard zinc primers. This technology is based on the combination of the elements used in traditional zinc epoxies with two new substances—hollow glass spheres and proprietary activators.

In addition, activated zinc coatings can potentially offer one more advantage when it comes to anticorrosive protection: an increased scavenger—or inhibitor—effect. Over time, chloride ions penetrate protective coatings and cause corrosion, especially in aggressive saltwater environments. Zinc-activated coatings capture chloride ions by forming chloride-containing salts around the glass spheres. This significantly delays the corrosive process as the chloride ions are trapped in the coating and cannot reach the surface of the steel.

Zinc-rich epoxies are often used in applications that expose the steel to severe mechanical stress, such as the extreme temperature fluctuations found in some industries and environments, including offshore. However, in a typical zinc protective system, the zinc primer is the weakest mechanical point. As a result, cracks can form in the coating as the steel expands and contracts. Activated zinc coatings are different due to an added self-healing capability.

Laboratory testing evaluated the performance of this new generation of activated zinc-rich epoxy primers with enhanced protection versus standard zinc-rich epoxy primers on substrates prepared to different standards. Preparation panels were divided in two categories: cleanliness and surface roughness. Cleanliness levels include SSPC-SP 10/NACE No. 2, Near White Metal Blast Cleaning; SSPC-SP 3, Power Tool Cleaning; and simulated SSPC-SP WJ-1/NACE WJ-1, Waterjetting to Bare Substrate, with flash rust levels defined as

Table 1: Exposure Testing Results After 25 Weeks

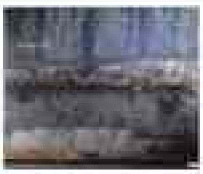
Grit – Medium		Shot – Medium		Shot – Fine	
					
Standard Zinc-Rich Epoxy	Activated Zinc-Rich Epoxy	Standard Zinc-Rich Epoxy	Activated Zinc-Rich Epoxy	Standard Zinc-Rich Epoxy	Activated Zinc-Rich Epoxy
		Not possible to evaluate (N/E)*		Not possible to evaluate (N/E)*	
Rust Creep = 8.5 mm	Rust Creep = 0 mm	Rust Creep = *N/E	Rust Creep = 1 mm	Rust Creep = *N/E	Rust Creep = 1.2 mm

Table 2: Impact Resistance Results After 24 Weeks

Grit – Medium	
	
Standard Zinc-Rich Epoxy	Activated Zinc-Rich Epoxy
Shot – Medium	
Not possible to evaluate	
Standard Zinc-Rich Epoxy	Activated Zinc-Rich Epoxy
Shot – Fine	
Not possible to evaluate	
Standard Zinc-Rich Epoxy	Activated Zinc-Rich Epoxy

moderate according to SSPC-SP 12/NACE No. 5. Surface roughness levels for SSPC-SP 10 are medium grit, medium shot and fine shot according to ISO 8503.

The performance properties of the new-generation primer have been tested according to different standard corrosion tests (ISO 12944-6, Salt Spray Test according to ISO 9227...) and benchmarked against standard organic zinc-rich primers—the results of which follow.

EXPERIMENTAL PROCEDURE

All prepared panels were composed of hot-rolled mild steel, exhibiting Rust Grade A according to ISO 8501-1.

The panels to be prepared according to SSPC-SP 10/NACE No. 2, Near White Metal were blasted with three different abrasive media types, including:

- Medium Grit – Panels were blasted with steel grit type G40, according to SAE J444:2012 until the cleanliness and roughness profile medium (Rz=60–100 µm) was obtained;
- Medium Shot – Panels were blasted with steel shot mixture S330/S170 (2/1) according to SAE J444 until cleanliness and roughness profile medium (Rz=40–75 µm) was obtained; and
- Fine Shot – Panels were blasted with steel shot mixture S330/S170 (2/1) according to SAE J444 until cleanliness and roughness profile medium (Rz=25–40 µm) was obtained.

For SSPC-SP 3, Power Tool Cleaning, select panels prepared to SSPC-SP 10 with grit-medium were sprayed with deionized water by air gun and introduced into a condensation chamber for 24 hours at 50 C (122 F). After being removed from the chamber, the panels were cleaned with power tools.

To simulate waterjetting according to SSPC-SP WJ-1/NACE WJ-1, Waterjetting to Bare Metal, select panels prepared to SSPC-SP 10 with medium grit were sprayed with deionized water by air gun and introduced into a condensation chamber for 15 minutes at 50 C (122 F) until they displayed a moderate level of flash rust according to SSPC-SP 12/NACE No. 5.

After preparation, all panels received a single coat of zinc-rich primer, applied by brush with no dilution in the specified thickness of 2.4–3.2 mils.

Exposure Testing

The exposure cycle used in this procedure, according to ISO 12944-9:2018, lasted a full week (168 hours) and included:

- 72 hours of exposure to UV and condensation in accordance with ISO 16474-3 under Method A, cycle 1 of ISO 16474-3, alternating periods of 4 hours exposure to UVA-340 lamps at 60 (±3) C and 4 hours of exposure to condensation at 50 (±3) C;
- 72 hours of exposure to neutral salt spray in accordance with ISO 9227; and
- 24 hours of exposure to low temperature at −20 (±2) C.

Test panels were exposed for 25 cycles, or 4,200 hours. After removing the coating by a suitable method, the width of the corrosion was measured at nine points (the midpoint of the scribe line and four other points, 5 mm apart, on each side of the midpoint). The rust creep (M) was calculated from the equation:

$$M = (C - W)/2$$

where C is the average of the nine width measurements and W is the original width of the scribe.

Table 3: Neutral Salt Spray Testing Results After 8 Weeks

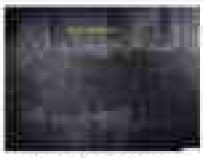
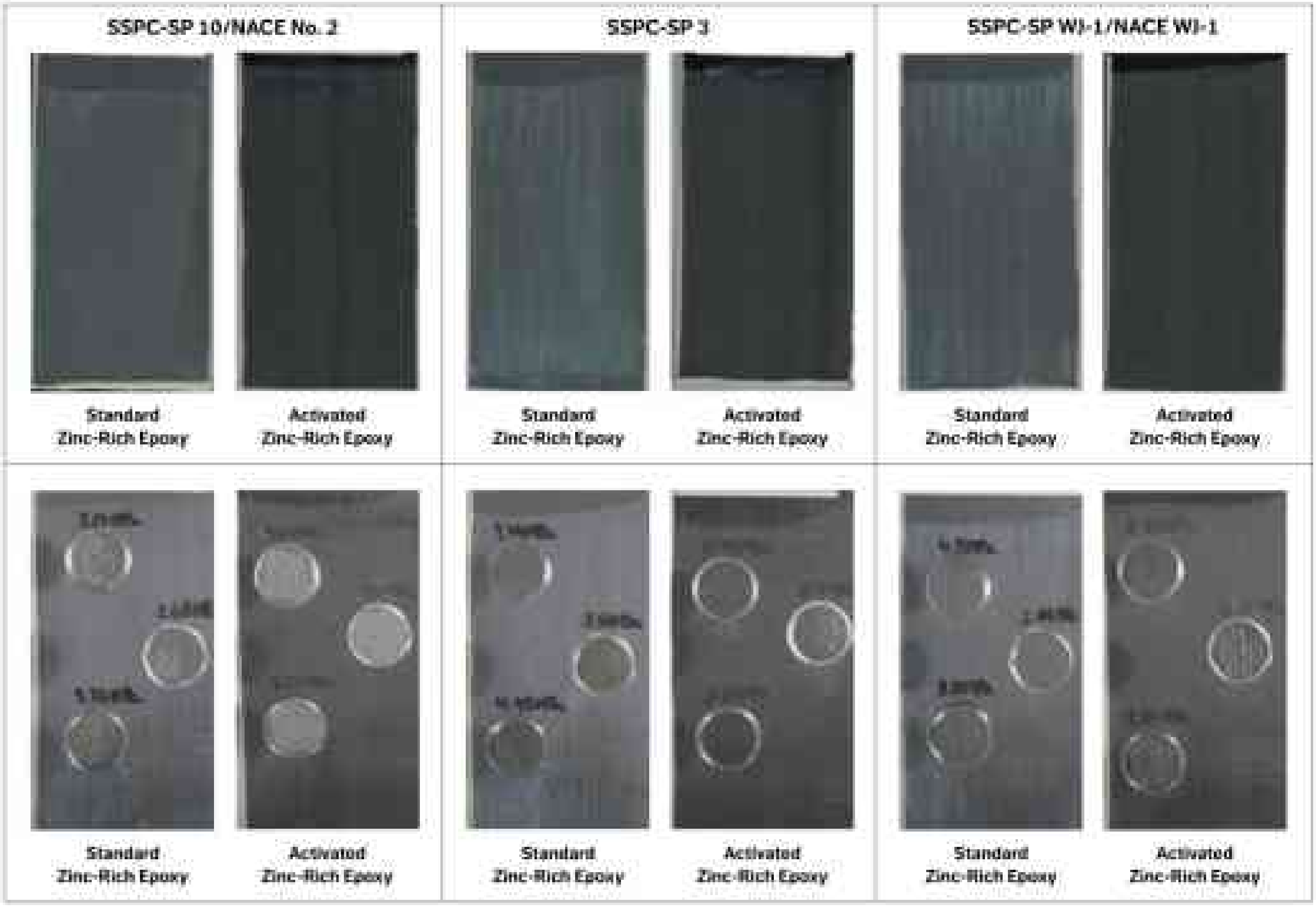
SSPC-SP 10/NACE No. 2		SSPC-SP 3		SSPC-SP WJ-1/NACE WJ-1	
					
Standard Zinc-Rich Epoxy	Activated Zinc-Rich Epoxy	Standard Zinc-Rich Epoxy	Activated Zinc-Rich Epoxy	Standard Zinc-Rich Epoxy	Activated Zinc-Rich Epoxy
					
Rust Creep = 0.6 mm	Rust Creep = 0 mm	Rust Creep = 0.2 mm	Rust Creep = 0 mm	Rust Creep = 0.63 mm	Rust Creep = 0 mm

Table 4: Blister Box Testing Results After 8 Weeks



Neutral Salt Spray Test (SST)

This method was performed according to ISO 9227 in order to evaluate the corrosion resistance of a coating system by reproducing the corrosion that occurs in atmosphere containing salt spray or splash. The operation conditions of the salt spray test are constant spray with 5% NaCl solution at 35 C (95 F).

After exposure, blistering and rust were evaluated on both panel and around the score (in mm from center), according to ISO 4628-2 and ISO 4628-3, respectively. Cracking was evaluated according to ISO 4628-4. Adhesion was evaluated according ISO 4624 (pull-off testing).

After removing the coating at a score by a suitable method (mechanical or chemical cleaning), the width of the corrosion was measured at nine points. The rust creep (M) was calculated from the same equation used for exposure testing.

Impact Resistance Test

This test was performed according ISO 6272-1, a procedure for rapidly deforming, by impact, a coating film and its substrate, and for evaluating the effect of such deformation. The test was performed on 1.5 mm panels. After the coatings had cured, a falling weight of 1 kg, with an indenter-head diameter of 20 mm, was dropped from a distance onto the test panel. The panel was supported by a steel fixture, with a 27-mm-diameter hole, centered under the indenter. When the indenter strikes the panel, it deforms the coating and the substrate. By gradually increasing the weight's distance, the point at which failure usually occurs can be determined. The impact value was reported as the highest impact reproduced five times, which resulted in no visible cracks and no adhesion failure in the paint film. The impact value was stated in kg-cm. A possible rupture was evaluated as cohesive or adhesive.

Blister Box (Condensation) Test

This test was performed according to ISO 6270-1 in order to evaluate the water resistance of a coating system using controlled condensation. The panel surface with the coating system was exposed to 38±2 C, saturated water vapor, at an angle of 15 degrees/60 degrees to the horizontal. The reverse side of the panel was exposed to room temperature. At the selected inspection intervals during and after completion of exposure, blistering, rusting, cracking and flaking were evaluated according to ISO 4628-2, 3, 4 and 5. After completion of the exposure, adhesion was evaluated according

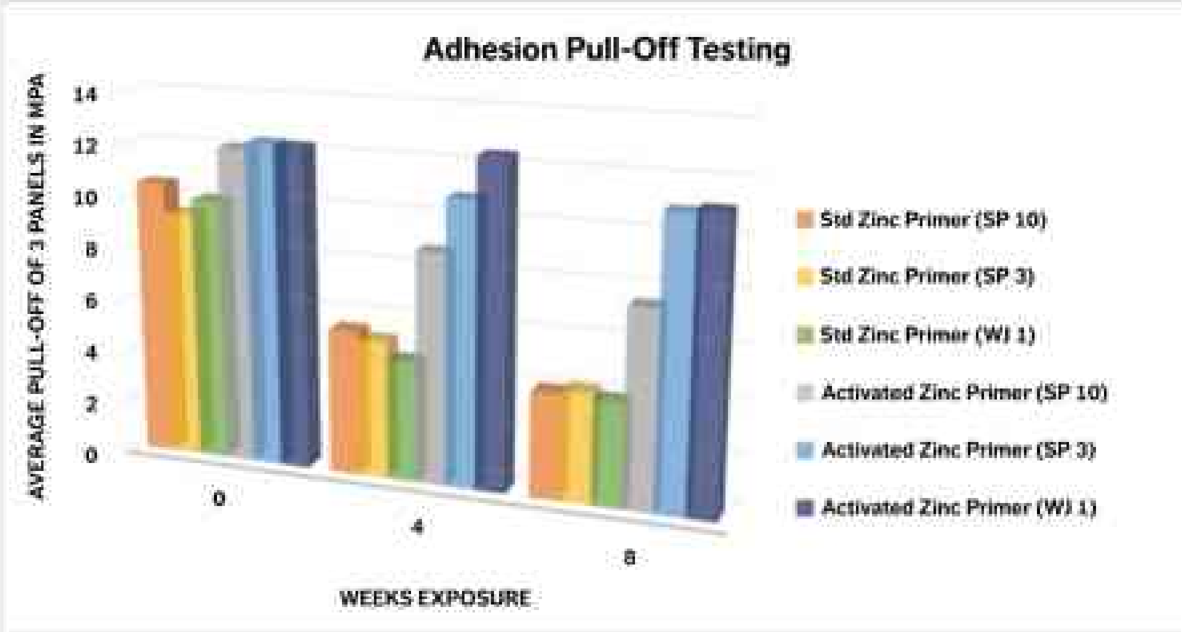


Fig. 2: Adhesion pull-of testing results done on steel panels coated with 60 µm (2.4 mils) of primer.

to ISO 2409 (cross-cut test), knife test or according to ISO 4624 (pull-off test).

Pull-Off Test

Pull-off testing according to ISO 4624 / ASTM D4541 covers the determination of the pull-off strength of a coating or coating system, by determining the greatest perpendicular force (in tension) that a surface area can bear before a plug of material is detached. Failure will occur along the weakest plane within the system, comprising the test fixture, adhesive coating system and substrate.

After curing of the paint, dollies were glued to the panels with a solvent-free epoxy adhesive. After the proper curing of the adhesive (standard is 24 hours at room temperature), the paint film was cut free around the dollies down to the substrate, and the dollies were pulled off at a tensile stress of 0.7 MPa/s. The pull-off strength (commonly referred to as adhesion) was noted and stated in MPa. The type of rupture (cohesive/adhesive) and location was also noted. The standard diameter of the dollies was 20 mm; others (typically 14.2 mm) may also be used.

RESULTS

Roughness Profile Comparison

This first part of this examination focuses on the study of the different roughness profile used in the industry. Cleanliness was SSPC-SP 10 for all the specimens and the change was the roughness profile (Medium Grit, Medium Shot and Fine Shot).

CYCLIC EXPOSURE TESTING

After exposure testing, the adhesion was checked in all cases by pull-off testing, and the break was between the coating and the glue, possibly due to salts on the surface. Adhesion was determined according to the knife test, and the activated zinc-rich coating showed a satisfactory level of adhesion before and after exposure on all different substrates. Meanwhile, for the standard zinc-rich coatings in shot profile panels, the adhesion was lost drastically after exposure. Adhesion was always better with roughness Medium Grit after testing for both technologies.

These results show that the influence of surface preparation is a key to better performance of the coatings. Standard zinc-rich primers worked better when surface preparation was performed SSPC-SP 10 and roughness profile Medium Grit than when the roughness was Medium Shot, and performed the worst with Fine Shot.

This huge difference in performance was not seen when the activated zinc-rich coating was applied. It performed best when the surface was prepared to SSPC-SP 10 with Medium Grit, but in all the cases the activated zinc-rich epoxy performed well.

IMPACT RESISTANCE TESTING

These results again show that the influence of surface preparation is a key to the performance of the coatings. Standard zinc-rich primers had better impact resistance when the surface preparation was done to SSPC-SP 10 with roughness profile Medium Grit than when the roughness was Medium Shot and Fine Shot, where cracking was observed. This difference in performance was not seen when the activated zinc-rich coating was applied. For all panels, there was no cracking when the impact test was done.

Cleanliness Comparison

This second part of the investigation is focused on the study of the different cleanliness used in the industry, both for new building and for maintenance or repair.

NEUTRAL SALT SPRAY TESTING

After the salt spray testing, the adhesion was again measured by pull-off test, and in all cases the break was between the coating and the glue due to salts on the surface. ISO 2409 (Cross-cut test) was performed and the activated zinc-rich coating kept the same value before and after exposure. On the other hand, the standard zinc-rich coating value increased from 0 to 2 after exposure, showing some adhesion lost.

The results show that activated zinc technology had good performance on the different cleanliness methods, but standard zinc-rich coating did not have an acceptable anticorrosive properties.

BLISTER BOX TESTING

The results show that both technologies had good performance on the different cleanliness methods when the coatings were not exposed, but after exposure, the activated zinc-rich coatings had, in all cases, better adhesion than the standard zinc-rich coating. The activated zinc-rich coating did not loose adhesion after exposure on any of the different substrate cleanliness panels.

FINAL CONCLUSIONS

The roughness profile results show that the influence of surface preparation is a key to better performance of coatings. Standard zinc-rich primers work better when surface preparation is performed to SSPC-SP 10 and roughness profile Medium Grit than when the roughness is Medium Shot, and performs worse with Fine Shot than Medium Shot. This difference in performance was not seen when the activated zinc-rich coating was applied.

The cleanliness comparison results show that the activated zinc technology had good performance on the different cleanliness methods, but the standard zinc-rich coating did not have acceptable anticorrosive properties, and loss of adhesion was significant.

Taking all these points into account, it can be seen that the activated zinc technology could be a beneficial coating system when offshore platforms needs to be protected in both new building and in maintenance, with different substrate preparations. JPCL

ABOUT THE AUTHORS

Raquel Morales is a Business Technical Expert with Hempel in Barcelona, Spain. She holds an MSc in Chemical Engineering from UPC University, Barcelona and is FROSIO Level III certified with 22 years of experience in paints, varnishes and polymers in technical R&D positions.

Antoni Prieto is the R&D Protective Manager with Hempel. He holds an MSc in Chemical Engineering from UPC University, Barcelona and a post-graduate degree in Technology of Paints from IQS, Barcelona. He has more than 12 years of industry experience and holds FROSIO Level III certification.

Joaquin Ferriero is an R&D Specialist with Hempel. He holds a Master in Technology degree in Paints from Les Heures University and has more than 40 years of industry experience in different coating companies. Since joining Hempel, he has been involved in development and testing of new products for the protective market.

David Morton is the Chief Scientist with Hempel based in Copenhagen, Denmark. He holds a BSc in chemistry from Liverpool University and a PhD in chemistry from Saint Andrews University in Scotland. Morton joined Hempel in 2013 and has worked in the coatings industry for over 30 years, holding various R&D positions with several companies.

REFERENCES

1. D. Kjernsmo, K. Kleven, and J. Scheie, "Corrosion Protection", 1st Edition (2003), ISBN 87- 989694-0-4, Hempel A/S.
2. Charles G. Munger and Louis D. Vincent, "Corrosion Prevention by Protective Coatings, 3rd Edition (2014).

DEHUMIDIFICATION IN SHIPYARD ABRASIVE BLASTING

Techniques, Dos and a Few Don'ts

BY NICK KLINE, POLYGON US

Using dehumidification in shipyards during abrasive blast-cleaning operations has been a widely accepted practice for three decades. A lot has been learned and techniques have become much more sophisticated, but the basic goal of preserving the blasted steel and creating the right conditions for coatings application remains the same. This article discusses how various combinations of desiccant dehumidification, heating and cooling equipment have been utilized properly and provides some examples of when things did not work out so well.

HEATING SYSTEMS

Heat is the oldest form of preservation. Even before we fully understood what was required to protect a virgin surface, there would be times when, luck would have it that, the surface did not require re-blast cleaning. This is all because air's ability to hold moisture increases as air is heated and decreases as it is cooled. So, if the air is warm enough that the ratio of moisture in the air as related to air's ability to hold moisture is low—we call this relative humidity—then it is possible that we have a situation where we can hold the blast. Most of the time, this is not the case without some extra effort being put in.

The next progression in preservation is heating the air. If we heat the air without adding moisture, then we have increased the air's ability to hold moisture. This can be a very effective way to protect surfaces—especially when it is cold outside. This is because if it is cold outside to start with, then the air will have a limited amount of moisture in it simply because there is only so much moisture that it would be able to hold. Relying on this phenomenon has limitations. If it is already warm, then adding additional heat to the space could create unsafe work conditions due to temperatures being too high. The less obvious situation is if we are relying on cold temperatures to hold low moisture levels and the weather changes; then, we could be faced with a situation where heating the air alone is not enough to protect the prepared surface.

COOLING SYSTEMS

Cooling is the first form of dehumidification. Essentially, what is happening is that we are letting Mother Nature do the drying for us. As mentioned previously, air's ability to hold moisture increases as air is heated and decreases as air is cooled. If we cool air below the level that it can hold moisture, then the water vapor starts to fall out of the air in the form of liquid water. This is called water condensate, which is typically seen coming out of a cooling system. Think of it as if we are wringing out the moisture from the air.

This form of dehumidification is very simple. One simply places a piece of cooling equipment into a setting, and moisture starts to be removed. There are however, limitations to this type of dehumidification system. For example, utilizing cooling to dehumidify air in shipyards tends to have limited dew points when used alone. This is because if we have a cooling system that produces air below 32 F, then the water will start to freeze. This can lead to clogged systems and can stop air flow all together. Another significant limitation to cooling is that because we have cooled the air to the dew point, we are feeding the space with air that is greater than 80% relative humidity. This means that we are relying on the weather conditions external to the space to heat the surface enough that the relative humidity at the surface we want to protect is low enough to protect it. This situation can make it difficult to prevent occurrences like bloom and blush, especially overnight and when it rains. These concerns are exacerbated if this cold, saturated air is coming in direct contact with a surface that we are looking to hold the blast on or coat.

The basic goal of preserving the blasted steel and creating the right conditions for coatings application remains the same.

COOLING WITH RE-HEAT SYSTEMS

Building on the principles of heating and cooling in dehumidification, the next dehumidification progression is combining heating with cooling. While cooling has the same limitations as discussed previously, when we combine it with heat, we start to create a more stable and predictable environment. By precooling the air, we are removing moisture in the form of condensate as we discussed above.

The advantages of simplicity and cost effectiveness remain the same. When we add heat to this precooled air, we start forcing down the relative humidity. The cooled air that leaves the cooling equipment at less than 80% relative humidity can quickly become 50% RH by increasing the air temperature as little as 15–20 degrees F. While cooling alone is efficient, when we add in the reheat, we end up with a costly method of dehumidification. This is because it is typical for reheat to roughly double the amount of energy required when compared to cooling alone. This may be a small price to pay if it is only required while it is raining or occasionally during nighttime conditions. However, this starts to require more involvement from the operator. The operator needs to be aware of upcoming changes in weather and must be knowledgeable enough to understand when these changes are significant enough that reheat is required.

DESICCANT SYSTEMS

The next step in dehumidification came with the introduction of the desiccant dehumidifier. A desiccant system relies on molecular forces and absorption to dry the air. Air passes through a desiccant wheel and as it passes, molecular forces between water vapor and the desiccant material cause the water vapor to cling to the desiccant surface. This results in dryer air on the outlet side of the desiccant wheel. Heat is then used in a reactivation cycle to remove this waste water vapor from the desiccant wheel and put it into a reactivation air stream, which is typically vented to the atmosphere. This regeneration cycle is essentially the exact opposite of what happens in the drying cycle in that it uses the same molecular forces. Heating the air gives the air more capacity to hold moisture, and if we can heat the air up to the point that it has more capacity to hold water than the desiccant wheel, then we can make this water vapor that was clinging to the desiccant wheel shift over to the heated air stream.

This is a very reliable and consistent system; however, it takes a significant amount of heat to overcome the molecular forces holding the water vapor to the desiccant material. This heat can be costly from an energy standpoint, and this is why desiccant dehumidifiers have hot air. Desiccant systems can achieve extremely low moisture levels but tend to be more costly to run than cooling.

documentation, is critical. There are even some systems out there that can offer remote control of the dehumidification system so that equipment can be adjusted and even turned on or off remotely. In this author's opinion, artificial intelligence is only a step or two away in this progression.

What might this look like? From this author's viewpoint, this might entail entering set points along with thresholds—in other words, entering in what is an ideal, acceptable, okay or unacceptable condition. If we can program this into a control device, we can then have this device start to adjust the equipment settings while taking in feedback on how these changes affected the delivered condition. By doing this, we could have a device that essentially teaches itself how to control the environment.

HYBRID SYSTEMS

One of the most recent steps in dehumidification is the introduction of the hybrid dehumidifier.

This style of dehumidifier uses the efficiency of cooling dehumidification and then adds in a desiccant wheel, which is reactivated with the waste heat from the compressors on the cooling cycle. This all comes together to create, arguably, the most efficient dehumidification system available from an energy standpoint. It is a complex system, has the same temperature limits that cooling does, and is limited in the amount of moisture removal the desiccant wheel can do. However, under the right circumstances, it can be a very effective technique.

BLENDED SYSTEMS

Blended systems are similar to the hybrid system in that we are using multiple techniques of dehumidification. These techniques, however, are each executed individually to play off of the strengths while minimizing the weaknesses of each technique. For example, we might precool the air, then send that air through a desiccant dehumidifier, and then post-cool it again to get cool dry air. Because we are using multiple systems, we can have tremendous flexibility. When executed well, these systems can be some of the most energy efficient and versatile systems available. They can, however, be difficult to design.

REMOTE CONTROLLED SYSTEMS

Remote monitoring and control of dehumidification systems are becoming more and more popular. Advances in the complexity of dehumidification systems, along with the sensitive nature of preservation, have come to a point where the ability to see what is happening at all times, as well as record what the conditions for purposes of

DOS—AND A FEW DON'TS

As we explore all of the various options out there for dehumidification, the ultimate question is: What is it that we should do and what is it that we should not do to ensure that we get what we want and need?

Surely, there are times when all of us have been in a situation where our dehumidification system fell short of what we needed it to do. We thought we were covered, but something was missing. We wonder things such as: How did this happen? Did I miss something? Why didn't we know that?

First, let's discuss what it is that we should do to get what we want and need. The first thing we should do is understand what is required. While this seems pretty basic, if we don't understand what the ultimate goal of our system is, then there is no way to be able to ask for what we need. This is everything from understanding what the required conditions are, to how long we will need to hold these conditions, to what the outside factors are, to how we will execute the system. Essentially, this information is what we need to form an accurate and complete specification for what it is that we need. This end specification can come in many forms, but the first step is simply to ensure that we have a full understanding of what is needed so that we can accurately convey this to

There are inherent design differences between equipment from different manufacturers ... which means that different machines with similar-looking specifications can yield different results.

whoever is designing or assisting us with the dehumidification system.

Another often overlooked good thing to do is to take ownership of the performance of the preservation system. This author has heard people say things like, "How am I supposed to hold anyone accountable for the performance?" The answer to that is simple: Clearly define the operating parameters along with the performance expectations, and then check performance upon execution of the system. While checking performance may seem like a difficult task, there are some very useful tools that the manufacturers have to assist with this process. More often than not, reputable manufacturers are interested in helping to make sure equipment is operating properly, as they understand that it is their reputation that often gets questioned when there are issues. So, if you aren't getting clear answers and aren't sure how to do the math, give the manufacturer a call to see if they can help.

Now, let's discuss what it is that we should not do to get what we want and need. The biggest mistake this author sees is for someone to rely on a generic number of air changes and specify a value (in cubic feet per meter [cfm]) of dehumidified air based on that. The first concern with doing it this way is that the required number of air changes can vary drastically. Smaller tanks typically require many more air changes than larger tanks because the smaller tanks are more susceptible to infiltration.

There also is the issue of what type of dehumidifier is needed at a given airflow. The obvious answer is to decide on cooling versus desiccant or hybrid. The less obvious answer is based on variances from manufacturer to manufacturer. A 5,000 cfm desiccant from one manufacturer is going to behave and have different benefits and drawbacks from another manufacturer. This is because there are inherent design differences between equipment from different manufacturers, such as different thickness desiccant wheels, different horsepower blowers and different amounts of reactivation heat. The interesting thing here is that these are all primary drivers of performance, which means that different machines with similar-looking specifications will yield different results.

CONCLUSIONS

In order to hold the blast and preserve an abrasive blast-cleaned surface prior to coating application, dehumidification can play a huge part. Selecting the right type of equipment and performing checks along the way to ensure that your DH equipment is working properly are essential to ensure that you are creating the right conditions. As with any other piece of equipment, it is wise to consult the manufacturer to work out any kinks and ensure that your system is working as efficiently as possible. JPCL

ABOUT THE AUTHOR

Nick Kline is a Regional Operations Manager for Polygon US. He directs and coaches operational personnel and salespeople within the Mid-Atlantic region. Kline has been involved in the climate control industry for more than 15 years and has published and presented technical papers at several national events. He holds a B.S. in Mechanical Engineering from the University of Pittsburgh.

SSPC COURSES (Course information available at sspc.org)

Dec. 4	C5 Lead Pt Refresher, San Diego, CA	Dec. 9–11	CAS Ctg App Spclst, Theodore, AL
Dec. 7–8	C7 Abrasive Blast, La Porte, TX	Dec. 10–11	ACAS Aerospace Ctg App Spclst, Bakersfield, CA
Dec. 7–8	Shipboard Surface Prep/App, San Diego, CA	Dec. 11	Insulation Insp, Kenner, LA
Dec. 7–9	Aerospace Maint Ctg App, Bakersfield, CA	Dec. 11	C5 Lead Pt Refresher, Santa Fe Springs, CA
Dec. 7–9	CAS Ctg App Spclst, Chesapeake, VA	Dec. 12	Lead Pt Worker Safety, Santa Fe Springs, CA
Dec. 7–10	CCAS Conc Ctg App Spclst, Portland, OR	Dec. 12	PCS Prot Ctgs Spclst, Irondale, AL
Dec. 7–10	C3 Lead Pt Removal, Santa Fe Springs, CA	Dec. 14–15	C7 Abrasive Blast, San Diego, CA
Dec. 7–11	CCI Conc Ctg Insp, Daytona Beach, FL	Dec. 14–15	C13 Waterjetting, Chesapeake, VA
Dec. 7–11	Ground Vehicle Corrosion/Ctgs, Newington, NH	Dec. 14–17	Aerospace Eng Ctg App, Pittsburgh, PA
Dec. 7–11	C2 Plan/Spec, Irondale, AL	Dec. 14–20	PCI Prot Ctgs Insp, La Porte, TX
Dec. 7–13	PCI Prot Ctgs Insp, Pittsburgh, PA; Warren, MI; Portland, OR	Dec. 16–17	C12 Spray App, San Diego, CA, Chesapeake, VA
Dec. 9–10	C6 Power Tool Surface Prep/App, San Diego, CA	Dec. 18–19	C14 Marine Plural Comp App, San Diego, CA

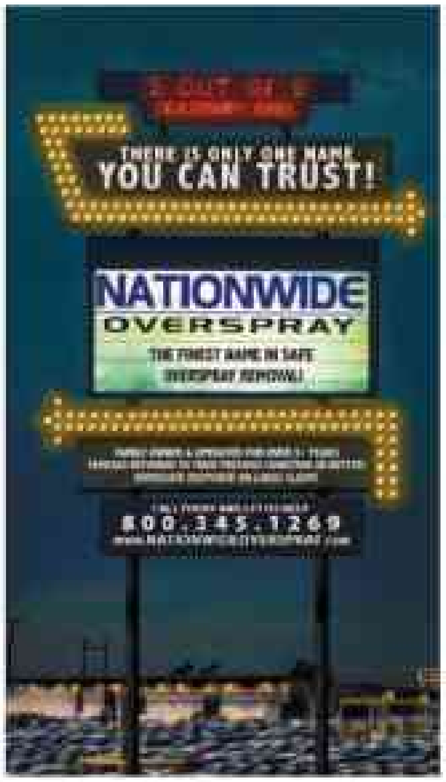
Consulting

Consulting

Equipment

Equipment

Overspray Removal



Overspray Removal

Resinous Floor Coatings

Sale, Rent or Lease

Sale, Rent or Lease

Test Instruments

CLASSIFIED

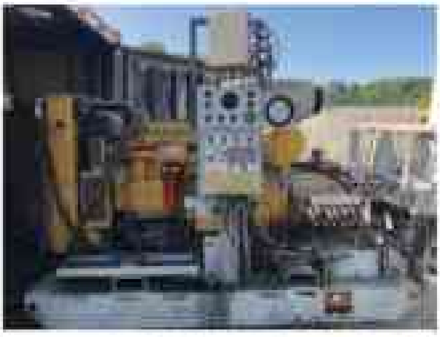
Test Instruments

EMPLOYERS:
Post your next job opening at paintsquare.com/classifieds and get *additional* exposure in the upcoming JPCL print issue!

Job classified advertisers also receive 30 days of Resume Access online.

For rates and details, contact sales@paintsquare.com

For Sale



For Sale
2- Flow hydroblasters, 10k each or 2 for 16k.
Dan 206-399-2936
Parts Only. Hours and condition unknown.

Statement of Ownership, Management and Circulation: Title: Journal of Protective Coatings & Linings (#8755-1985 [print] #2688-741X [online]) is published monthly. Annual subscription price $90.00. Mailing address: 1501 Reedsdale St, Ste 2008, Pittsburgh, PA 15233-2341. Marian Welsh, VP, Group Publisher; Charles Lange, Editor in Chief. Owners: Technology Publishing/ PaintSquare: Southside Holdings. Bondholders/ Securityholders: None. Extent and Nature of Circulation: Average denotes the average copies during the preceding year (Oct 19 – Sep 20). Actual denotes copies for the September 2020 issue. Total Copies: Average 9,037; Actual 8,166. Total Paid Circulation (Outside county, in-county, mailed via USPS & by other classes): 8,370; Actual 7,703. Total Free or Nominal Rate Distribution (outside county, in-county, mailed via USPS, other classes & outside the mail): Average 505; Actual 291. Total Distribution: Average 8,874; actual 7,994. Copies not distributed: Average 162; Actual 172. Total: Average 9,037; Actual 8,166. Percent Paid and/or Requested Print: Average 94.3%; Actual 96.4%. 16a Total Electronic Paid and/ or Req Circulation: Average 1,200; Actual 1,394. 16c. Total Distribution: Average: 10,075; Actual: 9,388. 16d. Percent Paid and/ or Requested: Average 95.0%; Actual 96.9%. Signature of CEO – PS form #3526, filed November 3, 2020.

INDEX TO ADVERTISERS