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JULY 2014
VOLUME 31, NUMBER 7
SSPC The Society For Protective Coatings
The Voice of SSPC: The Society for Protective Coatings

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The Society For Protective Coatings

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Managing Editor: Charles Lange / clange@paintsquare.com
Technical Editor: Brian Goldie / bgoldie@jpcleurope.com
Directory Coordinator: Mark Davis / mdavis@paintsquare.com

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Production / Circulation:

Director, Production Operations: Milissa M. Bogats / mbogats@paintsquare.com
Art Director: Peter F. Salvati / psalvati@protectivecoatings.com
Associate Art Director: Daniel Yauger / dyauger@paintsquare.com
Production Assistant: Mikaela Longo / mlongo@technologypub.com
Circulation Manager: JoAnn Binz / jocbinz@aol.com

Ad Sales Account Representatives:

Vice President, Group Publisher: Marian Welsh / mwelsh@paintsquare.com
Associate Publisher, Advertising Sales: Bernadette Landon / blandon@paintsquare.com
Advertising Sales: Bill Dey / bdey@paintsquare.com
Classified and Service Directory Manager: Lauren Skrainy / lskrainy@paintsquare.com

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SSPC:

SSPC Individual Membership: Terry McNeill / mcneill@sspc.org
SSPC Organizational Membership: Ernie Szoke / szoke@sspc.org

Finance:

Accounting Manager: Michele Lackey / mlackey@technologypub.com
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Periodical class postage at Pittsburgh, PA and additional mailing offices. Canada Post: Publications Mail Agreement #40612608 • Canada returns are to be sent to: American International Mailing, PO Box 122, Niagara Falls, ON L2E 6S4 Canada The Journal of Protective Coatings & Linings (ISSN 8755-1985) is published monthly by Technology Publishing Company in cooperation with the SSPC (877/281-7772). Editorial offices are at 2100 Wharton Street, Suite 310, Pittsburgh, PA 15203. Telephone 412/431-8300 or 800/837-8303; fax: 412/431-5428

Copies of articles are available from the UMI Article Clearinghouse, University Microfilms International, 300 North Zeeb Road, Box 91, Ann Arbor, MI 48106. **Subscription Rates:** $90.00 per year North America; $120.00 per year (other countries). Single issue: $10.00. **Postmaster:** Send address changes to Journal of Protective Coatings & Linings, 2100 Wharton Street, Suite 310, Pittsburgh, PA 15203. Subscription Customer Service: PO Box 17005, North Hollywood, CA 91615 USA, Toll Free: 866 368-5650, Direct: 818-487-2041, Fax: 818-487-4550, Email: paintsquare@espcomp.com

Printed in the USA PAINTSQUARE www.paintsquare.com

Editorial

Changing of the Guard

Messages from the Outgoing and Incoming SSPC Presidents

I cannot believe how fast a year goes by. I have been honored to be the SSPC President for the years 2013–2014, and I must say it is a privilege that I never dreamed I would have when I joined SSPC in 1981. I want to again thank the Board for electing me as their chairman. I hope the membership realizes what a great group of individuals serve on the SSPC Board of Governors, and I want to thank them for their support over the past year. I hope the membership also appreciates the great staff at SSPC and the fact that they come to work every day thinking of opportunities to make our association better.

At the annual awards luncheon in Orlando in February, I stressed two things. The first was participation. SSPC's core product has always been standards, and we do need your technical expertise on committees to make the standards we need for this industry and to make our industry better as a whole. Participation also means we need feedback from you to make this association better. The Board has 14 individuals who give freely of their time to serve the members and attempt to do what the membership requests. Without feedback from members, the job is even more difficult because the Board might be guiding the organization into areas that members do not feel are right for our association, or there might be areas or issues that the association needs to address that are being missed.

The second thing was getting young people involved. We had five scholarship winners last year. They and other young folks are our industry's future, and our challenge is to get more young people in training and getting their certifications to advance not only their individual careers, but our industry as well.

Again, I have been honored to be the SSPC President, and I want to thank the Board and the staff for their support. For those of you who know me personally, I plan to be around a few more years in this industry and will continue to serve the membership of this association as a member of the Board. It is something I enjoy and a way that I can give back to an industry that has given me a great career.

Benjamin S. Fultz
Bechtel Corporation

It is an absolute honor to serve SSPC as its President for the 2014–2015 year, and I would like to be the first to thank Ben Fultz for his leadership this past year. I will have the privilege during the next 12 months of working with a very talented Board and an SSPC staff dedicated to serving the needs of our industry and the membership.

SSPC, your organization, remains vibrant and strong, with a membership that now exceeds 10,300. However, as with any organization, there are challenges out there that continue to need our attention. As a contractor working in this industry, I understand that there are many facility owners recognizing the need for and demanding that contractors provide a more skilled and qualified workforce on their projects. As such, we need to continue to work on the development of new and the updating of existing training programs in order to meet the needs of our contractors and industry owners. We must also continue to realize the impact of today's global economy on our industry, and the fact that we are, indeed, a global society. To that end, we must remain focused on an important part of the long-range plan, that being the development of a strategic and structured plan of global participation. I would also like to echo what Ben said about young people in our industry. We need to keep that momentum going in the hopes of seeing many new and younger faces participating at future conferences.

As I've learned over the years, the success of any organization rests with the enthusiasm and participation of its membership. We welcome each member's input and encourage you to get involved. I look forward to a great year working with the Board and staff in our mutual goal of moving this organization forward, and I hope to meet all of you at this year's conference in Las Vegas.

Jim King
John B. Conomos, Inc.

SSPC Accepting 2014–2015 Structure Awards Nominations

SSPC is currently seeking nominations for the annual Structure Awards, which recognize the work of teams of contractors, designers, end users and coating manufacturers for excellence on particular coatings projects.

Nominations must be submitted to SSPC by Oct. 15, 2014. The awards will be presented on Feb. 3, 2015, at the annual Awards Luncheon during SSPC 2015 featuring GreenCOAT, held Feb. 3–6, 2015, at the LVH Hotel in Las Vegas.

SSPC seeks nominations for all structure types, including bridges, tanks, concrete structures and other industrial or commercial facilities. With the exceptions of the Charles G. Munger Award for longevity and the Military Coatings Project Award of Excellence, the work on structures must have been completed between July 1, 2013 and June 30, 2014.

The following are descriptions of the Structure Awards to be presented.

- E. Crone Knoy Award: For outstanding achievement in commercial or industrial coatings work that demonstrates innovation, durability or utility. The qualities that may represent outstanding achievement in this area include excellence in craftsmanship or execution of work, use of state-of-the-art techniques or products to creatively solve problems, or the provision of long-term service.
- Charles G. Munger Award: For the outstanding industrial or commercial coatings project demonstrating longevity of the original coating. The structure may have had spot repairs or overcoating with the original coating still intact.
- William Johnson Award: For outstanding achievement demonstrating aesthetic merit in industrial or commercial coatings work. The qualities considered for aesthetic merit include color, gloss or texture, or the coating on the structure complimenting the environment while enhancing the structure itself. The coating may represent a theme, an object or a specific graphic design.
- George Campbell Award: For outstanding achievement in the completion of a difficult or complex industrial or commercial coatings project. The qualities that may represent achievement in a difficult or complex industrial structure may include work occurring in harsh or extreme environmental conditions, work completed under strict time constraints, work done with limited access or in high-traffic areas, work on a structure with complex structural components or work on a project that requires coordination with multiple trades or subcontractors.
- Military Coatings Project Award of Excellence: In recognition of exceptional coatings work performed on U.S. military ships, structures or facilities.

USS Freedom, *a 2013–2014 Military Coatings Award of Excellence recipient. Photo courtesy of David Clapp.*

A representative of the structure's owner must be willing to attend the luncheon at the SSPC conference to accept the award and must give permission for the project to appear in a *JPCL* photo essay.

For more information or for a copy of the nomination form, please contact Terry Sowers, SSPC Director of Member Services, at sowers@sspc.org; call 877-281-7772, ext. 2219; or visit sspc.org.

AkzoNobel Names CFO, VPs

Coatings manufacturer AkzoNobel has announced several new leadership positions, including chief financial officer and two vice presidents for North American protective coatings markets.

Maëlys Castella will succeed Keith Nichols as AkzoNobel's CFO, the company announced June 17. She will officially take over the position Sept. 15. For the last 14 years, Castella has worked at Air Liquide, most recently as group deputy CFO. She also served the company as Europe chief financial officer and corporate finance and treasury director.

Nichols announced his plans to leave the company on Jan. 15. He joined AkzoNobel in 2005 and became CFO in 2008. In late 2012, he led the firm when CEO Ton Büchner abruptly left for what was billed as a short rest but stretched into a medical leave of three months. Büchner will take over CFO responsibilities during the transition period between Nichols' departure and Castella's start date. Castella will be nominated for appointment to the board of management and will be based at the company's headquarters in Amsterdam.

Maëlys Castella

Scott Doering and Fernando Macedo have also been appointed as vice presidents overseeing the International and Devoe protective coatings brands in North America. Doering will lead the North America Eastern region, and Macedo will run the West Coast and Latin American region.

Doering, who joined AkzoNobel in 2005, has over 30 years of experience in the coatings industry and is a NACE-certified Coating Inspector. Macedo has 28 years of experience in the coatings industry and started with AkzoNobel in 1991.

Doering and Macedo will be responsible for setting growth strategies for their regions and customer market segments in the oil and gas, water and wastewater, chemical processing, power, mining and high value infrastructure industries. They will work on identifying new market opportunities, technology growth and expansion of the International Protective Coatings Centers (IPCC).

SSPC Training Expands to Turkey, Nigeria

SSPC has broadened the reach of its international training programs with the licensing of new training providers in Turkey and Nigeria.

The Society recently announced the approval of STM Coatech as an authorized licensee for the Protective Coatings Inspector Program (PCI) in Turkey.

Established in 2013, STM Coatech is comprised of a team of highly experienced paint inspectors and coating specialists with backgrounds in chemistry, chemical engineering and mechanical engineering.

Individuals who attend SSPC courses given by STM Coatech will be awarded the appropriate IACET (International Association of Continuing Education and Training) Continuing Education Units (CEUs) for each course they successfully complete.

To register for an SSPC PCI Class through STM Coatech please con-

tact Seda Omercikoglu at (90-534) 745-1980; or email sedaomercikoglu@gmail.com or info@stmcoatech.com.

SSPC also announced the approval of Harrybeat International Services Ltd. as an authorized licensee of SSPC training programs in Nigeria. Harrybeat is a wholly-owned Nigerian company with experience in engineering, construction, maintenance and procurement in the oil and gas sector and government establishments. The company specializes in anti-corrosion services, tank construction and maintenance, automated tank cleaning (non-entry) and the supply of coating inspection instruments, surface preparation equipment and materials.

Harrybeat is licensed to deliver SSPC's Abrasive Blasting Program (C7), Spray Application Basics (C12), Marine Plural Component Program (MPCAC, C14), Coating Application Specialist Program (CAS), Basics of Estimating Industrial Coatings Projects (EST) and Protective Coatings Inpector Program (PCI).

To register for an SSPC class through Harrybeat, please contact Agha Abani at harrybeat1@yahoo.co.uk.

All certifications are issued and maintained by SSPC: The Society for Protective Coatings, headquartered in Pittsburgh, Pa. Information on SSPC licensees can be found at sspc.org at the bottom of each course page and in the SSPC Training Catalog. Certification status for individuals can be also be confirmed on sspc.org.

The BUZZ on PaintSquare.com

HOT! This Month

TRENDING: The Art of Pothole Patching

Chicago artist Jim Bachor has been filling potholes around the city with hand-crafted mosaics, drawing the ire of the Chicago Department of Transportation (The Art of Pothole Patching, June 27).

Photo: bachor.com

IN THE BLOGOSPHERE

Going Beyond the 'Good Old Boys'

This month, Cynthia O'Malley of KTA-Tator Inc. penned a blog that asked the question, "where are the women in coatings, and why aren't there more of them?" The blog studied the results of a 2011 SSPC member survey regarding the state of women in the coatings industry, and the results drew some interesting conclusions and comments from readers.

Alison Kaelin: *Excellent observations, Cindy. Keep up the good work until that glass ceiling is shattered for all of us and we evaluate by qualifications, not gender.*

Will Fultz: *I think this conversation needs to go a little deeper than just gender alone. The workforce involved with protective coatings is quite "aged" to say the least. It is, for the most part, still overwhelmingly dominated by baby boomers (born from 1946 to 1964). It is also amazing how many pre-baby boomers (born prior to 1946) are still working as well. While these individuals have done a tremendous job in advancing our industry, little work has been done in grooming Generation X (born 1965 to 1982) and millennials (born 1983 to 2004) to step up to take their place. The fact is, younger people who have any sort of experience at all will advance rapidly as baby boomers start to retire in droves in the coming years. There is simply no "bench" or minor league system for the industry to go to in order to fill roster spots. Our industry is unfortunately getting ready to experience a massive brain drain. Anyone who puts in the work, regardless of gender or anything else, will have a massive amount of opportunity for advancement.*

PSN TOP 10 *(as of July 1)*

- Paris Bridge is for Too Many Lovers
- Two Killed in CA Bridge Project
- AkzoNobel Names CFO, VPs
- NYC Bridge Crews Loathe Love Locks
- Rejected NY Painting Contract Back On
- Vibrations Shake Off Paint in Ship Test
- Bridge Coating Performance: Two- vs. Three-Coat Systems
- 1 Killed, 2 Hurt in Tanker Cleaning
- Vanishing Spray Paint is a Real Kick
- Gold Coating Proves a 24kt Failure

MOST POPULAR Quiz *(From June 1 to July 1)*

Among the various types of antifoulings for ships, what are foul-release coatings?

A) Ablative coatings that release toxins at a controlled rate as a ship moves through water
B) Any coating that releases biocides
C) Coatings that release copper biocides
D) Coatings with low-energy surfaces slippery enough to prevent or minimize attachment of foulings

(Answer at bottom of page)

QUIZ LEADERBOARD (As of July 1)
Farooq M. 23/23
Mark Gierke 22/23
Juan I. Ordinas 22/23
Mark Allen 22/23
Dave Heyne 22/23

Results

Answer: D) Coatings with low-energy surfaces slippery enough to prevent or minimize attachment of foulings

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Problem Solving Forum

On Blistering In Demineralized Water Tanks

I have several 20-year-old carbon steel tanks for storing demineralized water. The original coating (type unknown) has started to blister. What material should be used (and at what DFT) to refurbish the coating?

Steve Brunner, WPC Technologies

Demineralized water is claimed to be the most corrosive water (I'll exclude salt water in this case). One claim is that this is due to an osmotic gradient. (*Editor's Note: For more information on osmotic blistering, see this month's F-Files article on p. 21.)*

OK, at 20 years of age, the best fix is to remove the existing coating by abrasive blasting. Next, inspect the metal for imperfections, repairing if necessary. There are several coatings that will provide resistance to this material, including baked phenolics and epoxy phenolics, which are generally applied to a thickness of about six mils and require heat of 350–400 F to cure. Two-component epoxy coatings can also be considered. Here, I suggest a novalac or a Bisphenol A-cured with an amine adduct or cycloaliphatic amine adduct. Generally, the thickness will be in the range of 15 mils.

In short, there are several possibilities for coatings designed to resist demineralized water. Check with your coating manufacturer for the best fit. Whatever you choose, remove the existing coating first.

Keith Gabbard, TCR Coatings

As Steve alluded to, the osmotic gradient in demineralized water service is the primary concern. The osmotic pressure associated with "pure" water through a semi-permeable (coating) film is at its maximum, because any soluble contaminant left on the prepared substrate sets up the "optimum" blister scenario. The solute concentration differential between the demineralized water and contaminated substrate is exacerbated due to the fact that demineralized water is theoretically free of mineral contaminants. The contaminant could also include solvents, some of which have partial solubility. Therefore, critical components of successful systems in demineralized service include SSPC-SP 5 followed by thorough salts removal and testing; use of a thick-film, 100%-solids lining with low permeability; use of low-embedment abrasive; and pinhole detection and repair.

William Gusnard
Southern Company Services

I work in the power industry. Demineralized water is my worst agent. I've been working with demineralized water for almost 30 years. I agree with what Steve has said. Also, do not use sand as your blast material and make sure the coating gets a proper cure for immersion service. I had a tank lining not cured properly in cold weather. When it warmed up, the coating continued to cure.

The VOCs given off messed up the organic compound readings in my demineralized water. The coating then started peeling off. It was blasted with sand and not cleaned up very well. Then the silica started messing up my water chemistry, as well. I had to dump 2.5 million gallons, blast off the failed coating and reapply a new coating. This plant was down for about one month during peak season to get the repairs done. Choose the coating carefully and make sure all the application rules on the data sheet are properly followed.

Curtis Goad, GOAD Company

Many variables come into play in a coatings application which, if compromised, may result in premature failure. Bonded linings of either rubber or weldable thermoplastic may be a better long-term solution. If the vessel lining could experience a vacuum-type pull, a vulcanized rubber lining would provide the better adhesion. However, plasticized PVC linings will cost less, have a strong bond and have performed in demineralized water service for 30 years or more. Both linings are thicker (one-eighth of an inch to a quarter-inch) than coatings and are spark-tested at much higher voltage (12,000 to 24,000 volts) to assure that no pinholes or voids exist. Many years later, if damage has occurred, both linings have proven track records of successful repairability.

Tom Schwerdt
Texas Department of Transportation

First, does the coating actually need to be refurbished? If the blisters are intact, the steel isn't corroding and the water isn't being contaminated, I would leave the original coating in place, but schedule more frequent inspections. Sometimes, blisters are just an aesthetic issue, which shouldn't matter inside a tank after a 20-year service life.

SSPC PROTECTIVE COATINGS SPECIALIST

Q&A with JAY KRANKER

by Charles Lange, *JPCL*

Jay Kranker is a Regional Sales Manager with DRYCO, an industrial climate control equipment rental company and distributor. With over 15 years of experience specializing in dehumidification equipment, Kranker plans and implements sales strategies, identifies new and emerging market opportunities, guides and mentors other employees to meet sales objectives, demonstrates products during regional and national trade shows, develops customer service strategies to retain loyal customers and conducts weekly company meetings to address any issues that may arise. In 2013, he was elected to serve a four-year term on SSPC's Board of Governors. He earned a bachelor's degree from the University of Utah and a Graduate Business Certificate from California State University, Long Beach.

JPCL: How did you get your start in the industry?
JK: I came across dehumidification equipment when I was a territory salesman selling protective paints to water and wastewater treatment plants 15 years ago. I was not familiar with dehumidification at that time and became very interested in the applications of dehumidification equipment for industrial coating projects. At that time, use of dehumidification equipment on industrial coating projects was relatively new itself.

JPCL: Can you tell me anything about the importance of dehumidification and climate control that most people might not be aware of?
JK: Most people do not know that there is a true science behind dehumidification and climate control equipment and how to produce dry air. Psychrometrics — the study of the properties and behavior of moist air — is the basis of how dehumidification works. In other words, we are not "guessing" or "giving what we think will work" at how to provide dehumidified air for certain applications — we are using psychrometrics to provide the correct means to dehumidify.

JPCL: You helped organize the Young Professionals Get-Together at the SSPC 2014 conference in Orlando this past February. Why do you think it is so important to engage young people in this industry? How would you like to see this group progress in the future?
JK: As the SSPC membership ages, I think that it is critical that the involvement of young professionals increases in the activities of SSPC. The Young Professionals group represents a dynamic and energetic, yet underrepresented group of members. We need to keep this group attracted to SSPC so as to build momentum and maintain a strong membership into the future.

I would like to see the Young Professionals group take an active role in expediting the growth of SSPC in the next few years while developing diversity of membership from all backgrounds within the industry.

JPCL: What are some of the things that you would like to accomplish in your role on SSPC's Board of Governors? Are there any goals or changes you'd like to see?
JK: As a BOG member, I would like to see that the endeavors and programs put forth by SSPC are successful and that they are consistent, financially sound and remain effective so as to grow the membership each year. Among my top goals as a BOG member is to grow SSPC not just domestically, but globally.

JPCL: What has been the highlight or most memorable moment of your career thus far?
JK: After I gave a presentation to a large consulting engineering firm that wrote specifications for several municipal water agencies in the Southwest that was not familiar with dehumidification for recoating water storage tanks and pipelines, I was asked to assist in providing verbiage to incorporate dehumidification in their "standard" specifications that they were updating for all clients.

Specifications are often long, but they are essential for painters in order to complete a job properly.
Photo: ©iStock.com/SilviaJansen

Conforming with Job Requirements

If you've ever had your hands on a painting specification for a job, then you probably know just how much information they can contain. Some specifications can be an inch or two thick. Why do engineers come up with so many regulations and requirements? And what does a specification actually do?

A specification is written to let you, the painter, know what has to be cleaned and painted, and what your customer's minimum standards of quality are in carrying out cleaning and painting operations. When all the requirements are put together, then you have a specification. In other words, a specification is nothing more than a description of requirements and special directions written down in a particular order.

Sections of a Specification

Most of the specifications for painting that you'll run across will have about seven main sections: Scope, Safety, Surface Preparation, Paint to be Used, Paint Application, Inspection and Repair. Let's take these seven sections and go through each one.

Editor's Note: This Applicator Training Bulletin is an update of a previous article written by Bob Meadows of Brown & Root. It was first published in the March 1989 issue of JPCL *and has been updated for this issue by Cory Allen, PCS, of Vulcan Painters, Inc.*

Scope

This section tells you, or your company, what your customer wants painted and generally what the specification itself has written in it.

Safety

This part is mainly to protect you, the painter. Sometimes, there are special conditions that the engineer is concerned about such as explosion hazards, working in confined spaces or maybe toxic fumes from nearby equipment. Ordinarily, the major health concern is that solvent fumes, or the paint itself, may be harmful. You might also find requirements about the use of safety harnesses with

100 percent tie-off when working greater than six feet above the floor, or the use of respirators, safety glasses and goggles, hardhats and other safety equipment when cleaning or painting. This section is important. Follow the instructions provided here and those discussed at jobsite safety meetings very closely. You don't get overtime in the hospital.

Surface Preparation

You will sometimes see surface preparation requirements written using just letters and numbers, such as SSPC-SP 6/NACE No. 3. These are shorthand for the long descriptions of the type of surface preparation needed for the paint to work the best, such as Commercial Blast Cleaning (SSPC-SP 6/NACE No. 3) or Near White Metal Blast Cleaning (SSPC-SP 10/NACE No. 2). Standards referenced are as much a part of the specification as anything else written. Therefore, someone in your company must have a copy of the referenced documents.

For example, one of the surface preparation requirements that you will almost always see used is SSPC-SP 1, Solvent Cleaning. This is to make you aware of the importance of using clean solvent and clean rags to remove all the visible grease, oil, soil and other soluble compounds from the steel before you blast. You can't blast grease contamination off of a piece of steel; you will only blast it into the steel. Tests have shown that oily spots are left on the steel that you can't see, even after blasting. That's why you should solvent clean it before you blast it. Even if SP 1 is not specified in the contract, all of the other SSPC cleaning specifications require it. The other surface preparation standards are descriptions of how clean the steel should be when using Hand Tool Cleaning (SSPC-SP 2), Power Tool Cleaning (SSPC-SP 3, SP 11, SP 15), Waterjet Cleaning (SSPC-SP WJ-1/NACE WJ-1, SSPC SP WJ-2/NACE WJ-2, SSPC-SP WJ-3/NACE WJ-3 or SSPC-SP WJ-4/NACE WJ-4) or Abrasive Blast Cleaning (SSPC-SP 14/NACE No. 8, SSPC-SP 7/NACE No. 4, SSPC-SP 6/NACE No. 3, SSPC-SP 10/NACE No. 2 and SSPC-SP 5/NACE No. 1).

SSPC-SP 14/NACE No. 8 is Industrial Blast Cleaning, SSPC-SP 7/NACE No. 4 is Brush-Off Blast Cleaning, SSPC-SP 6/NACE No. 3 is Commercial Blast Cleaning, SSPC-SP 10/NACE No. 2 is Near White Metal Blast Cleaning, and SSPC-SP 5/NACE No. 1 is White Metal Blast Cleaning. It is helpful to remember that the numbers are not in any order of cleanliness. SP 14 is the least clean, or lowest level of cleanliness, and SP 5 is the highest level of cleanliness.

Surface preparation standards are written descriptions of what the steel should look like

Painting specifications contain specific instructions for surface preparation and paint application, as well as post-work inspection.
Photo: ©iStock.com/arenacreative

after it is cleaned. The owner or his or her inspector may also use visual standards to judge if the proper degree of cleaning has been achieved. These visual standards may be photos, such as those found in SSPC-VIS 1, or they may be job-prepared standards.

Prepared visual standards are samples of blast cleaning on a substrate or steel surface at the job site. The owner or his or her inspector will test and select a sample showing what the end result of cleaning should look like. The selected sample may be coated with a clear coating so that its appearance will not change. It then becomes a reference that can be used to judge the quality of surface preparation on the total job.

You have to know what the cleaned steel should look like after surface preparation if you are going to do your job right. It is important that you, your supervisor and the customer or his or her inspector agree on the desired appearance of the cleaned steel before you begin the cleaning operation.

The customer's engineer decides which degree of cleaning is needed depending on what type of paint is to be used and where the steel will be placed.

Another thing you will almost always see in this section is blast profile depth. A blast profile is another way of telling you how rough the steel needs to be after blasting. Some paints need only a half-mil profile, which is very smooth, while others need a five-mil profile, which is very rough. Blast profile is controlled by how coarse or fine the abrasive that you use is and by air pressure. As before, the engineer specifies the best blast profile for the type of paint to be used. Your company should consult with the abrasive supplier or coating manufacturer to determine which grade of abrasive will achieve the specified blast profile depth.

Paint To Be Used

The specifier may select coating types. He or she has to consider everything before choosing what paint to use. In this case, everything truly means everything. Where is the steel going — offshore, to a chemical plant, a paper mill, a tropical area or even a nuclear power plant? What are the actual conditions where it will be used — a tank lining, underground, outdoors or indoors? In what conditions will the paint be applied — in cold weather, in warm weather or in a humid or dry area? Are there any government regulations that will impact the types of coatings that can be used? All of these conditions and factors affect what kind of paint is written into the specification. The engineer may specify a paint that is difficult to apply. Keep in mind that the paint you're applying was chosen for a lot of reasons, and it may be the only paint that will work for this specific application.

Paint Application

Now the specification is detailing how to conduct and control the work. You will often see SSPC-PA 1, Shop, Field, and Maintenance Painting, written into this part of the specification, which provides instruction on how the paint should be applied. It gives you general direction on such things as thinning, spraying, brushing and how to check what you are doing. Pay particular attention to this section. It contains some very useful information. Other specifications may tell you to put the material on in accordance with the published coating manufacturer's written instructions. The coating manufacturer's Product Data Sheet contains written instructions for application of the product.

As with surface preparation, you, the painter, control what happens here. You must mix and thin the paint properly, spray it on at the right thickness, let it dry enough before putting on the next coat, check before starting to see if the air or the surface is too hot or cold (you should stop painting if it does) and stop if the substrate gets wet or starts to sweat. If you do not pay close attention to these items when you are applying the paint, film defects may occur. If you don't follow the specification, then the paint you are applying will not do what it is supposed to do and will not last as long as it was meant to.

Inspection

There is almost always a section in a specification on inspection. Sometimes, you may have to do some of the inspection work, like keeping track of batch numbers and how much thinner you use. Measuring wet film thickness is part of your job, too, although sometimes the

Post-application inspection procedures, including dry film thickness testing, are usually included in painting specifications. Photo courtesy of Vulcan Painters, Inc.

inspector may be with you, looking over your shoulder.

Inspection is used to find small errors before they turn into big problems. Most often, the primary inspection tasks are to check that surface preparation was performed properly and to verify that the paint was applied as thick or thin as the specification called for. Sometimes, holiday detection is required. Almost every lining application has pinholes.

Repair

This is usually the last section in a specification. Sometimes, the repair paint is different from the original paint and doesn't require blasting. The customer's engineer expects some isolated repair due to film defects, handling damage and welding or erection. The repaired areas won't be as strong as the adjacent undamaged areas, so extra care is needed. Follow the specification very closely; your skill can make a lot of difference here.

Conclusion

As stated earlier, a specification is nothing more than a description of requirements and special directions put in a particular job order. The engineer spent a lot of time researching and compiling project specifications.

It doesn't matter, though, how thorough the specification is, or how closely the coating work has been monitored by the inspector, unless a skilled blast operator and painter perform the actual work. Skilled craftsmen, such as SSPC-certified Coating Application Specialists (CAS), who follow a good specification will increase the likelihood of a good looking, long-lasting and quality paint job.

Common Causes of Blister and Bubble Formation in Industrial Coatings

By James D. Machen, PCS, KTA-Tator, Inc.
Rich Burgess, KTA-Tator, Inc., Series Editor

Fig. 1: Dense osmotic blistering. All figures courtesy of KTA-Tator, Inc.

Fig. 2: Spotty osmotic blistering

Blistering formation in high-performance industrial coatings is a common phenomenon. Understanding why blisters form is sometimes very simple and in other instances quite complex. For example, understanding and describing the process by which moisture migrates through a coating film at a molecular level to achieve equilibrium can be very complex, especially to the layman. On the other hand, understanding why blisters form as a result of coatings application on surfaces with elevated temperatures or on porous substrates (such as concrete) is much simpler.

Frequently in the coating industry, the terms "blistering" and "bubbling" are used synonymously. Technically, this is not correct. When blisters form by an osmotic mechanism, the term "blistering" is more common and correct. However, when they are caused by non-osmotic methods, the term "blistering" is somewhat misleading and the term "bubbling" is more accurate. Blister formation is typically a result of increased pressure from moisture accumulation at certain points in a coating film, while bubbles are typically formed as a result of gas and vapor pressures within the coating film or the substrate. Despite this, these terms will likely continue to be used interchangeably.

This article addresses both osmotic and other non-osmotic methods by which blisters and bubbles form and identifies the roles that environmental conditions, substrate type, generic coating type and surface contamination can play in their formation. Because carbon steel and formed concrete are the most common substrates to which industrial coatings are applied, those substrates will also be the focus of this article.

Osmotic Blistering

Osmosis is the process by which moisture molecules are transferred through a semi-permeable membrane. In this case, the coating film is the semi-permeable membrane.

Osmotic blistering (Figs. 1 and 2) is probably the most recognized type of blistering that occurs in coatings applied to carbon steel that is subject to immersion service or prolonged exposure to high-moisture environments. The period of time that industrial coating systems are exposed to moisture in normal atmospheric service environments is typically not sufficient to produce osmotic blistering.

There are some well-known mechanisms or driving forces that fuel osmotic blister formation. In simple terms, the actions of these forces (discussed in greater detail later in this column) result in the accumulation or concentration of moisture at specific points within the coating film. These driving forces are:

- contamination of the steel substrate by water-soluble salts;
- water-soluble solvents trapped within the applied coating film; and
- thermal gradients (temperature differences) across the coated surface.

Osmotic Blistering Due to Water-Soluble Salts and Entrapped Solvents

Osmotic blisters can form as a result of water-soluble salt contamination on the surface of the steel being coated or water-soluble solvents that are retained or "trapped" within an applied coating layer. Because water-soluble salts (such as chlorides, sulfates and nitrates) are typically non-visible, detection of these contaminants in blister liquids requires specific analytical test methods such as ion chromatography (IC) to confirm their presence. While retained or trapped solvents can often be detected by the telltale solvent smell of liquid taken from blisters (blisters are often liquid-filled), their presence is verified by using laboratory analytical methods for the solvent detection such as gas chromatography/mass spectroscopy (GCMS).

Osmotic blisters resulting from the presence of water-loving soluble salts or retained solvents occur when there is ample moisture in contact with a coating film (i.e., a coating in immersion service) and when there is a difference on each side of the film in the concentration of dissolved salts or solvents. This relative difference on each side of the semi-permeable coating creates osmotic pressure and causes water molecules to slowly penetrate through the molecular infrastructure of the coating. As moisture penetrates, it migrates toward and accumulates at the point where the more concentrated solution of salt or solvent exists. The osmotic forces accelerate the transport of water through the coating in an attempt to equalize pressures (reach equilibrium) on each side of the coating film. Depending upon the concentration of soluble contaminants on either side of the osmotic cell, pressures can reach high levels (reportedly exceeding 15,000 psi). When higher concentration differentials of soluble salt contamination are present on either side of a coating film, a greater accumulation of free moisture results and blisters can be larger and more concentrated. When these pressures exceed the coating's adhesive bond to the substrate, a blister forms.

Osmotic Blistering Due to Thermal Gradients

This phenomenon is commonly known within the coatings industry as the "cold wall effect." Thermal gradients occur when the metal or steel substrate in the immersion zone of a tank or vessel is at a lower temperature than the liquid contained within the tank. Blisters form as the warmer water molecules in the stored liquid penetrate the coating film and then condense at a cooler interface within the lining or at the lining/substrate interface. Ultimately, sufficient quantities of liquid accumulate, creating pressure that causes liquid-filled blisters to form in the coating. One method to minimize thermal gradients is to use exterior insulation on tanks that may develop sufficient temperature differences if otherwise left uninsulated.

Non-Osmotic Blistering: Bubbles

Even though many blistering problems are commonly associated with coatings in immersion service and high continuous moisture exposures, blisters can and do form by other mechanisms. These non-osmotic blisters, which we call bubbles, are often associated with characteristics of the substrate or environmental conditions during coating application.

Coating Application During High and Low Temperatures

In many locations, the coating application season is limited to a time when environmental conditions are favorable (i.e., typically in late spring, summer and early fall). Those "blue sky" days must be productive. The environmental conditions that give us these kinds of days are usually advantageous; however, they also have their pitfalls. For example, applying a coating to a surface in direct sunlight exposure or applying the coating thicker than recommended can result in bubble formation. Bubbles typically form because the heat from the sun causes the surface of the applied coating to dry more rapidly than the body of the coating film. This rapid surface drying process creates a rigid, "skinned over" surface layer that prevents solvent within lower levels of the film from escaping. As the solvent in the lower layers heats, it volatilizes and expands and creates vapor pressure within the coating film. It is the vapor pressure that causes bubbles to form.

In other instances, bubbles can form in coatings due to cooler temperatures or high relative humidity during application. When application occurs during cooler temperatures or elevated humidity, the drying and curing of the coating film is slowed considerably. As a result, the proper release of solvents from the film does not occur. Consequently, if the next coating layer is applied too soon, the solvent in the underlying film becomes trapped and bubble formation can occur. However, the bubbles may not occur immediately, and their appearance can be delayed until the environmental conditions become warm enough to cause the entrapped solvents to volatilize.

Coating Application Over Porous Substrates

Coating application on porous substrates such as formed concrete and concrete block (CMU) can also result in bubbling. In such instances, the inherent porosity of the concrete substrate often contains trapped air or moisture. In that regard, air is present because it will occupy any open space that is not under vacuum, and moisture enters from the exterior or interior of the structure. Exterior moisture typically enters through the natural porosity of the concrete substrate and along cracks, crevices or control joints, and interior moisture can result from "vapor drive" (i.e., humidity and condensing moisture) from the interior of the structure.

When a non-breathable coating is applied over these porous substrates, the air and moisture often becomes "sealed" in the substrate. As a result, any condition (i.e., sunlight) that causes the air to warm and the moisture to vaporize causes expansion and increased pressure within the concrete. The increased pressure on the backside of the coating often causes bubbles to form.

Coating Application Over Moisture

Bubbles do not always appear on the surface of the coating. Bubbles sometimes form within the coating or on the backside of the coating film. For example, moisture-cured urethane (MCU) coatings that dry and cure by reaction with atmospheric moisture and other coating types (i.e., aliphatic polyurethanes) that are formulated with moisture sensitive components can also bubble.

Moisture-Cured Urethane Bubbling

When applying an MCU coating under moist conditions, such as conditions where residual moisture remains on the surface, relative humidity is too high or condensing moisture or rain contact the uncured MCU surface, the coating performs as designed, readily reacting with moisture to achieve curing. Unfortunately, when moisture is abundant, the reaction occurs rapidly and carbon dioxide gas (CO_2) is generated (commonly termed "out-gassing") as a byproduct of this reaction. When excessive moisture accelerates curing, the CO_2 is often trapped in the coating film, and the resulting increase in vapor pressure can produce bubbles within the coating. In fact, when a cross section of the coating is viewed microscopically, it often has a Swiss cheese-like appearance.

Aliphatic Polyurethane Bubbling

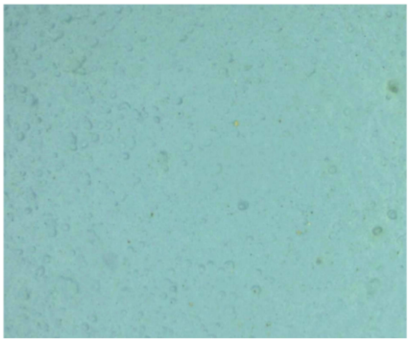


Fig. 3: Bubbling on the backside of a polyurethane paint film

Two-part, aliphatic urethanes cure by polymerization of the two components (polyol and isocyanate). However, when applied over moisture, bubbles can form on the backside of the urethane film (Fig. 3). This occurs because the isocyanate component of the urethane formulation reacts with moisture. As with the MCU reaction discussed earlier, CO_2 gas is formed. The gas is typically trapped in the lower layers of the urethane coating film and also at the interface of any previously applied coating where the moisture was present. Again, the pressure created by the gas formation causes bubbles to form. One difference with this formation process is that the bubbles can be very fine and are not always visible to the unaided eye. When viewed microscopically in a cross section, the fine bubbles often have a foam-like appearance. For this reason, this phenomenon is typically referred to as "foaming."

In the case of bubbles with MCU and aliphatic urethane formulations, the outgassing that occurs between layers can disrupt adhesion. Typically, other forms of bubbling have little to no adverse effect on coating adhesion, unless very intense and concentrated.

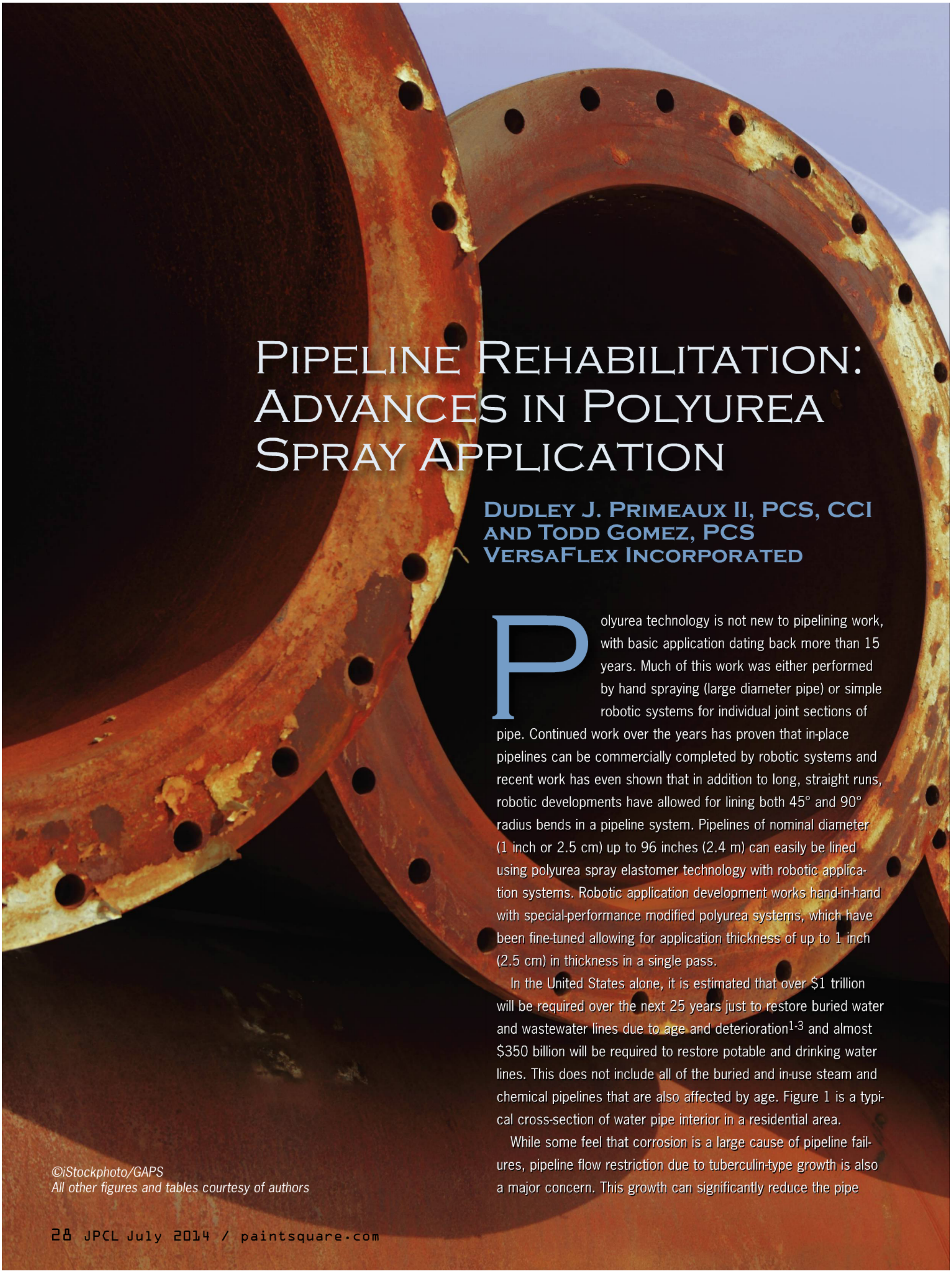
Conclusion

In summary, blistering and bubbling are common coating problems that occur for several different reasons. While this article presents and discusses the osmotic mechanisms that produce blisters, bubbles have several causes.

There are differing opinions as to the damage that can result from blisters and bubbles. One opinion is that if they remain unbroken, they may not be considered a coating defect that requires repair. For example, some more recently developed 100%-solids, thick-film coating formulations such as elastomeric urethane, urethane hybrids and polyurea are often applied to form a thick, monolithic and flexible protective film. While blistering and bubbling may still occur in these films, the monolithic and flexible nature of the film prevents them from fracturing and the underlying substrate often remains uncompromised. In addition, when used in immersion service, the actual weight and pressure of the liquid contained within the vessel can serve to hold the monolithic coating film in place on the substrate being protected. Under such circumstances, whether there is any benefit to cutting out and repairing the blisters requires careful consideration. Even though blisters or bubbles are present, the flexible and monolithic film often has sufficient structural integrity of its own that allows the coating to fulfill the originally expected service life.

About the Author

James D. Machen is a senior coatings consultant with KTA-Tator, Inc., a coatings consulting engineering firm and distributor of inspection instruments, where he has been employed for over 20 years. Machen is an SSPC-certified Protective Coatings Specialist, a NACE-certified Coatings Inspector Level 3 (Peer Review) and a Level II Inspector in accordance with ASTM D4537. He performs coating failure analyses, coating system recommendations, specification preparation and major project management for a variety of clients in the transportation, water and waste, power generation, chemical processing and marine industries. He is a graduate of The Pennsylvania State University.



Pipeline Rehabilitation: Advances in Polyurea Spray Application

Dudley J. Primeaux II, PCS, CCI and Todd Gomez, PCS
VersaFlex Incorporated

Polyurea technology is not new to pipelining work, with basic application dating back more than 15 years. Much of this work was either performed by hand spraying (large diameter pipe) or simple robotic systems for individual joint sections of pipe. Continued work over the years has proven that in-place pipelines can be commercially completed by robotic systems and recent work has even shown that in addition to long, straight runs, robotic developments have allowed for lining both 45° and 90° radius bends in a pipeline system. Pipelines of nominal diameter (1 inch or 2.5 cm) up to 96 inches (2.4 m) can easily be lined using polyurea spray elastomer technology with robotic application systems. Robotic application development works hand-in-hand with special-performance modified polyurea systems, which have been fine-tuned allowing for application thickness of up to 1 inch (2.5 cm) in thickness in a single pass.

In the United States alone, it is estimated that over $1 trillion will be required over the next 25 years just to restore buried water and wastewater lines due to age and deterioration[1-3] and almost $350 billion will be required to restore potable and drinking water lines. This does not include all of the buried and in-use steam and chemical pipelines that are also affected by age. Figure 1 is a typical cross-section of water pipe interior in a residential area.

While some feel that corrosion is a large cause of pipeline failures, pipeline flow restriction due to tuberculin-type growth is also a major concern. This growth can significantly reduce the pipe

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All other figures and tables courtesy of authors

diameter, thus affecting liquid flow through the pipe, flow backup, and in the case of potable water lines, poor water quality and unhappy consumers.

Current pipe materials used in most utility sectors in the U.S. are composed of cast iron, ductile iron, concrete, steel, some asbestos cement, or PVC (polyvinyl chloride), and will differ by regions of the country. It is noted that over 65 percent of all municipal pipeline systems are over 30 years old, with a vast majority being over 50. According to a water main study by the Utah State University Buried Structures Laboratory, over 8 percent of these systems are beyond their useful life expectancy in the U.S. market. As corrosion has been the leading cause of pipeline system failures, PVC has been shown to have the lowest failure rates.

The traditional method of addressing these failures has been to dig up and replace the damaged pipe. This creates a very large footprint for excavation, is disruptive, and can be a very expensive process. Given the fact that many pipeline systems are a complete maze, crisscrossing with various other pipe lines, many of which are underneath buildings and other structures, this can be a very impractical process.

Trenchless Rehab Methods

Alternatives to digging up and replacing pipeline systems are a number of trenchless technology options that are gaining in use and acceptance. These options can save up to half of the overall cost compared to traditional trenching methods, and as a result are advantageous to consider.[4]

Pipe Bursting and Jacking

This method employs forcing a slightly smaller diameter pipe into the existing host pipe sections. The forced pipe can include steel, polyethylene (PE) or polypropylene (PP), or PVC. This method requires a large excavation "footprint" for access to an end of the existing pipe, but not complete excavation. This process is more suited for straight runs and does not work well for pipe bends.

Cementitious Lining

This process provides for a very economical advantage, and we all know that concrete is fairly sound. However, this method cannot be used in aggressive (highly acidic) environments or where highly abrasive or erosive action is present because the concrete can crack over time. To employ the cementitious lining method, cleaning of the host pipe is required, followed by minimal surface preparation procedures.

Fig. 1: Uncoated flange area of line pipe

lining applications given its fast reactivity and 100% solids formulation base.

One method, hand spray application, is well suited for large diameter pipe systems, but not very practical for smaller diameter pipe sections. A recent study has shown that when galvanized corrugated pipe is coated or lined with a general polymer or "plastic" system, 75-year life expectancies can be realized.[5,6]

For prelining joint sections of pipe, a simple robotic spray head or a retractable lance spray gun can be used. The pipe is rotated and the spray lance pulled from the pipe. This is a very practical approach and is employed

Cured-In-Place Pipelining (CIPP)

CIPP is an emerging technology that was introduced about 20 years ago and has been used quite extensively. A polymer-impregnated "fabric sock" is inverted into the end of a pipe section and formed in place to the existing pipe using hot air or hot water. The typical polymer systems are either epoxy or vinyl ester-based materials. This process covers lateral intrusion, but does allow for pipe bends. Because the fabric sock is of one size in the run, varying pipe diameters in the system cannot be completely accommodated. Annular space between the CIPP and the host pipe does exist and can lead to leakages.

Sprayed-In-Place Pipelining (SIPP)

A newer concept than CIPP employs the use of robotic application heads to deposit liquid, thin- and thick-film lining systems to the interior surfaces of prepared pipe. This procedure uses polymer technologies such as epoxy, vinyl ester, polyurethane and polyurea. Because the lining is deposited in a spray fashion, lateral tie-ins remain open and clear. This process can accommodate various pipe diameters as well as radius bends.

SIPP and Polyurea

The use of the polyurea spray technology has proven to be a successful coating type for utilization of SIPP for a variety of coating and

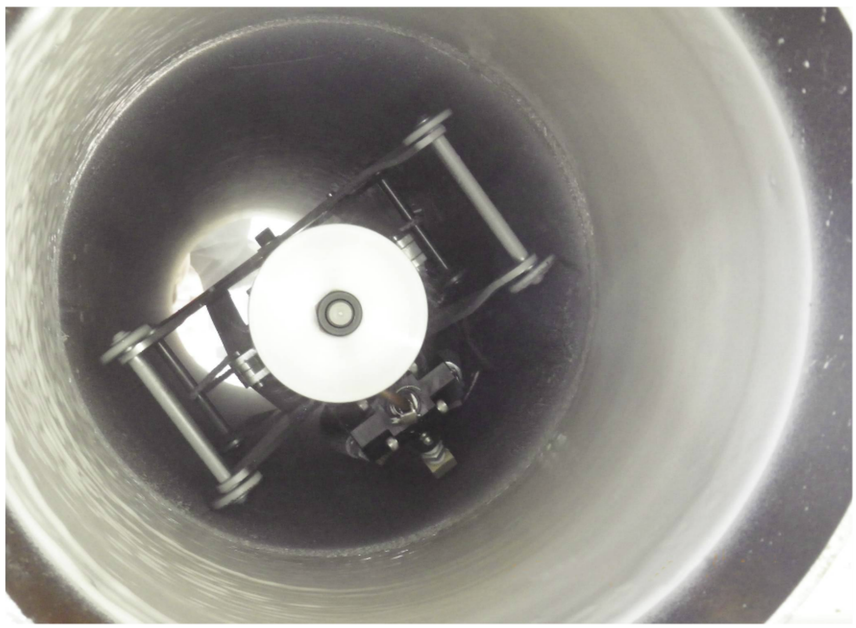

Fig. 2: High revolution-per-minute spinning cup

Table 1: Type of Polyurea for SIPP Work

	Standard	Semi-Structural	Fully Structural
Flexural Modulus, MPa	~345	~690	>1725
kpsi	~50	~100	>250
Tensile strength, MPa	~13–20	~20–34	~28–41
kpsi	2–3	3–5	4–6
Elongation, %	400	250	<20
Hardness, Shore D	50	58	65
Tg, C	~230	~260	~170*
Gel time in seconds - relative unlimited applied film thickness	6–8	6–8	6–8*

** 60 second gel; modified aliphatic/aromatic PUA, limited film thickness, Tg<80 C*

Table 2: Type of Polyurea and Application Area

Industry Uses	Standard	Semi-Structural	Fully Structural
Potable water	yes	yes	yes
Wastewater	yes	yes	yes
Process water/salt	yes	yes	yes
Power generation	yes	yes	yes
Chemical plants	conditional	yes	yes
Low pressure steam	no	yes	yes
Oil sands	yes	yes	no
Mining/processing	conditional	yes	no
Deteriorated pipe	no	conditional	yes

using not only polyurea systems, but also epoxies and polyurethanes, as well as other coating types.

One area of great concern here is the use of more elastomeric systems and the point of termination in the pipe. For flanged pipe, the material must be carried out and onto the flange. Otherwise, hydraulic effect from liquid flow could disbond the applied lining causing collapse and plugging inside the pipe. Figure 1, (p 30), shows an improper termination of applied polyurea inside a flanged joint of pipe.

This process does work well for sections of pipe and is currently being employed for the tailing lines and oil movement for the Oils Sands Project in Ft. McMurray, Alberta. Polyurea-lined pipe joints (applied at ~150 mils/3.8 mm) have been in service there for approximately 5 years, whereas the carbon steel pipe is typically rotated 90 degrees at flange areas every 3 to 6 months due to erosion.

Robotic In-Place Polyurea Application

To effectively rotate a section of pipeline that is already in the ground, the polyurea system is dispensed onto a spinning disk and the centrifugal force broadcasts the material onto the pipe. This method was successfully used in 1989 by the Texaco Chemical Company. The polyurea system used had a 3–6 second gel time. This concept was employed in order to have an entry-free installation.

A variety of configurations have been employed in pipeline polyurea application depending on the internal diameter of the pipe. These include rotating a spray gun on a pulled cart; multiple spray guns attached to a large, slow-spinning plate (primarily for vertical work); and spray guns attached to a swinging arm for ride-on type units in large diameter application work.

The most common methods used to deposit the fast set polyurea (PUA) are a high revolution-per-minute (RPM) spinning cup (Fig. 2, p. 30) or a high-pressure, static mix tube fitted with a hollow cone spray tip (Fig. 3, p. 34). For larger diameter pipe work (>48 inches or 1.2 m), a robot with rotating plural component spray guns should be used. Each of these two methods has its own set of characteristics.

The spinning cup method produces oscillation movement that simulates hand spray work. This allows for uniform application and keeps the spray orientation perpendicular to the host pipe substrate.

With the high-pressure static mix and hollow cone spray, the spray pattern is not perpendicular to the host pipe substrate. In some cases, depending upon the condition of the pipe substrate, a secondary pull through in the opposite direction might be required to ensure uniform coverage.

The proportioning equipment used to feed the spray head is standard high-pressure, high-temperature plural component equipment. The hose bundle can be up to 600 feet (183 m) and operates from a computer-controlled hose reel so that speed of pull can be adjusted to provide the required applied film thickness. Closed-circuit TV enables real-time viewing and recording of the installation work.

Polyurea Types Used in SIPP

Depending upon the type of pipelining work to be performed, various polyurea systems can be used to meet specific application requirements. As noted previously, the polyurea systems used are the fast gel time systems, so that varying thickness of application can be accomplished in one pass through the pipe. Table 1 (p. 30) describes these systems.

Table 2 (p. 32) explains polyurea types appropriate for various industry applications. There is no "one size fits all." Relevant to the specific industry use, polyurea is very well suited for multiple application options. Based on the water and chemical makeup that the coating will come into contact with, varying degrees of shore hardness and structural integrity of systems are utilized for the best performance needed.

In an effort to further improve application thickness and coverage of SIPP systems, especially in small diameter pipe (1 to 6 inches or 25.4 to 153 mm), equipment and systems have been designed to apply via electrostatic deposition. For this electrostatic work, the polyurea systems must be a slower version to

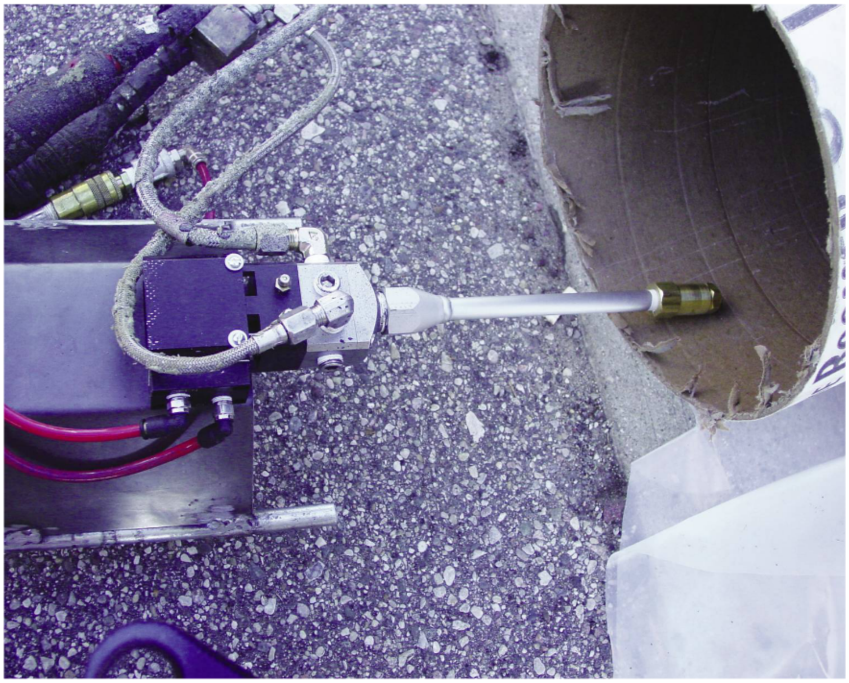

Fig. 3: High-pressure, static mix tube fitted with a hollow cone spray tip

pass through the smaller spray deposition head. These are typically thin-film applications (10 to 20 mils, 254 to 508 μm).

Conclusion

The use of polyurea technology is a valid solution for pipelining application work and the use of a thick-film system conforms to the interior surface of the pipe with no annular space. The fast set of this technology allows for thickness build of lining material in a single pass, and therefore, rapid return to service. Since this application process also employs the same 100%-solids nature of polyurea technology, a level of safety and more environmentally-friendly application results can be achieved. Currently, equipment such as robot spray heads is not prevalent in the commercial marketplace, but the technology itself is moving forward by being specified and used more often.

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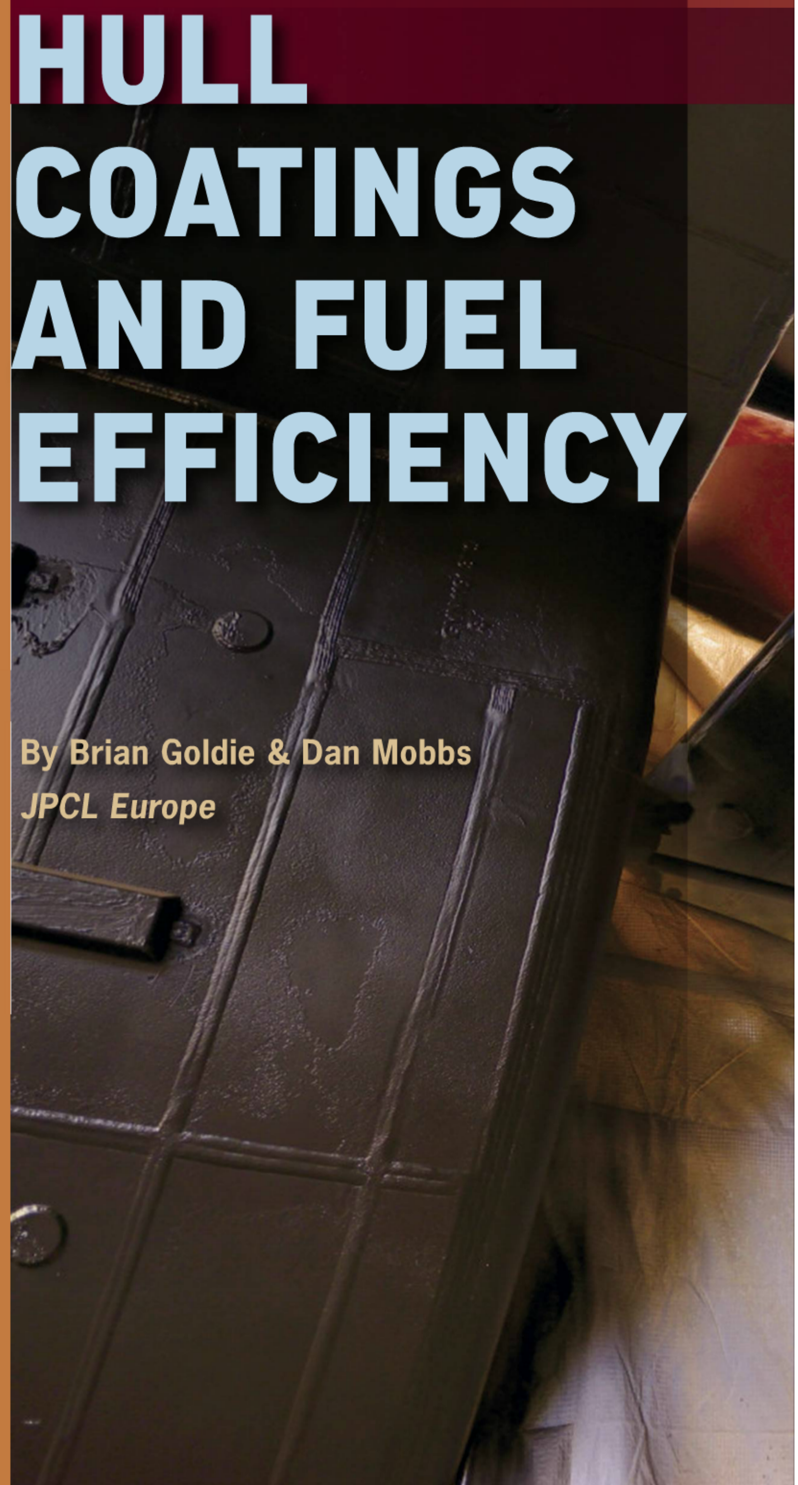
About the Authors

Dudley J. Primeaux II is a consultant and the owner of Primeaux Associates LLC (Elgin, Texas), a consultant firm for the polyurea industry. Mr. Primeaux is active in SSPC, NACE, and PDA, where he is a former president and a member of the Board of Directors. He has also earned SSPC PCS Protective Coatings Specialist and SSPC CCI Concrete Coatings Inspector certifications. He is an inventor and holds 26 U.S. patents and 8 European patents on polyurethane and polyurea foam applications, as well as polyurea spray elastomer systems and applications. He has authored over 40 technical papers on polyurea elastomeric coating and lining technology, as well as several chapters in SSPC book publications.

Todd Gomez is the Technical Sales and Marketing Manager at VersaFlex Inc., a company that formulates and manufactures 100%-solids pure polyurea protective coatings, linings, and sealants for a variety of industrial, commercial, and maintenance environments. Before joining VersaFlex, Gomez held management positions with The Sherwin-Williams Company and was a project manager with Concrete & Masonry Restoration, Inc. He earned a B.S. degree in business administration from Newman University and an MBA from Penn State University. JPCL

HULL COATINGS AND FUEL EFFICIENCY

By Brian Goldie & Dan Mobbs
JPCL Europe



It is widely understood that antifouling coatings play a crucial role in maintaining a smooth hull, as they help reduce frictional resistance and can improve optimized fuel performance by 5 percent on average, compared with traditional tin-based polishing systems. There is more to be gained, however, by further reducing the forces between a ship's hull and the water surrounding it.

Increasing demands to reduce the carbon footprint of commercial shipping have caused leaders in the marine industry — marine paint producers, in particular — to look at new technologies and seek improvements to current hull coatings. Reduced hull fouling can also lessen the transfer of aquatic species between regions where they can damage the local marine life — the so-called transfer of nonindigenous species that, for example, caused the zebra mussel infestation of the Great Lakes in North America and has now spread to many of the inland waterways.

Before examining recent developments, though, it would be prudent to recall what happens on a ship's hull when immersed in seawater.

Development of Fouling

A clean surface immersed in seawater will have an adsorbed molecular (conditioning) film within minutes, or even seconds, and within an hour, a biofilm will develop. The biofilm is initially formed of bacteria and then of diatoms and protozoa — or slime, as it is more commonly known.

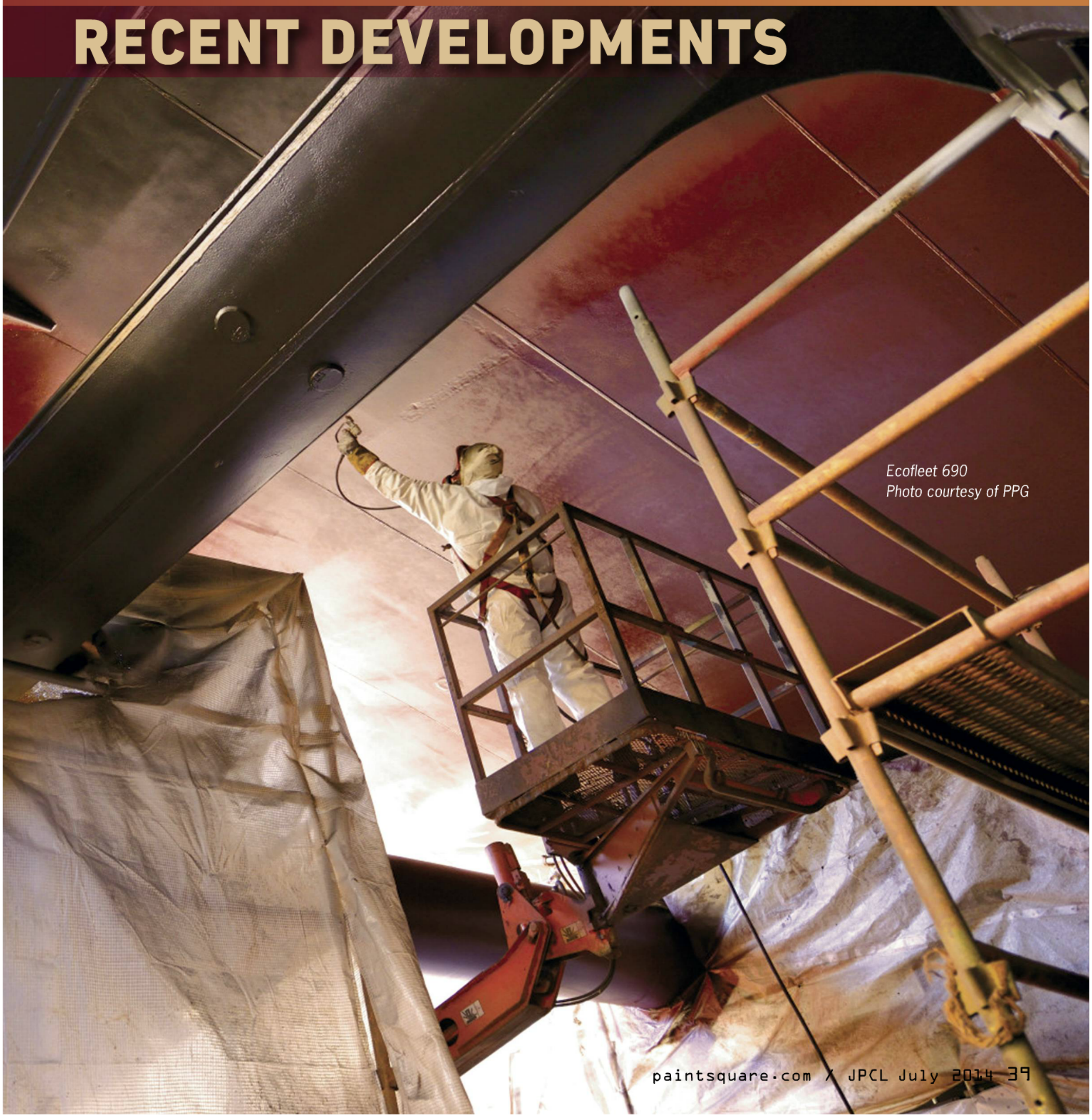
Approximately a week later, macrofouling — algal spores and animal larvae — will begin to appear and will then develop over months and years into adult organisms known as weed and shell fouling.

Hull Coatings

Current premium hull coatings, which are available from all the major suppliers, can be divided into two major groups.

1) Biocidal polishing systems based on acrylate technology: either metal (copper or zinc) acrylate or silyl acrylate, with copper as the main biocide, often supplemented by organic co-biocides; and

RECENT DEVELOPMENTS



Ecofleet 690
Photo courtesy of PPG

Hull test patch showing excellent performance
Photo courtesy of Hempel

2) Biocide-free, foul-release coatings, split into two technologies: (a) "soft" products based on silicone elastomers, and (b) fluoropolymers and "hard" products based on different resin technologies such as glass-flake vinyl ester and solvent-free epoxy.

There is no one-for-all coating, and this is reflected in the varied products offered. Also, the correct choice of underwater coating for any given vessel depends on a number of parameters, including, but not limited to; ship type, service speed, trading pattern, cost, and whether it is newbuild or maintenance painting.

Over the past five years, advances in hull-coating technology, and hence improvements to fuel efficiency, have been restricted to incremental advances. The current premium products are all very effective at preventing macrofouling (i.e., weed and shell), which has the largest effect on hull roughness and, as a result, fuel efficiency.

For this reason, research has been, and still is being, directed at solving the problem of slime buildup, which can account for about a 5 percent fuel penalty. During the past year, there have been further developments by coatings producers in their premium products.

Euphony ACE LF-Sea initial application
Photo courtesy of Nippon

Coating Developments

The latest foul-release technology from coatings supplier Hempel features a hydrogel surface modification which the company says improves resistance to slime fouling. The company has also recently launched Hempaguard, a new hull-coating concept that is said to offer both outstanding resistance to fouling during idle periods and significant fuel savings. The technology, dubbed ActiGuard, has been five years in development and is based on silicone-hydrogel and biocide science.

This technology integrates silicone hydrogel and full diffusion control of biocides in a single coating. Surface retention of the biocide activates the hydrogel, which effectively holds fouling organisms at bay, cutting friction to a minimum while utilizing a minimal amount of biocide.

Since the biocide is retained on the surface, there is no need for polishing. Thus, the product is said to release 95 percent less biocide than a standard self-polishing co-polymer type antifouling. The surface also has the same smoothness as conventional biocide-free, silicone-based foul-release coatings.

Hempel's tests have shown excellent fouling resistance of up to 120 days during idle periods as well as fuel savings of 6 percent on average. Control of fouling during loading and unloading, or at other times when the vessel is stationary, has traditionally been difficult, because the surface self-polishing that exposes fresh biocide, or water movement across foul-release systems, is greatly reduced.

There are two separate products available: Hempaguard X5, offering sustained fouling defense for up to 36 months, and Hempaguard X7, at up to 90 months of fouling defense. Both products are suitable for any type of vessel with any trading pattern as well as for extended idle time.

Another manufacturer using hydrogel technology with a biocidal polishing antifouling is Nippon Paints. The company recently launched what it calls an improved version of its low-friction LF-Sea product, which has been on the market for more than seven years and applied to more than

Grimaldi
Photo courtesy of International Paint

850 ships. According to Nippon, this technology gave ship owners about 4 percent propulsion improvement — a significant figure — but the company believed there was potential for higher gains. After working on the technology for three years, with support from shipping company Mitsui O.S.K. Lines (MOL), the Japanese government, and the classification society Class NK, Nippon now claims that ship owners can see up to a 10 percent reduction in fuel expense. Compared to the first generation product, this next version employs an enhanced water-trapping function, improved biomimetic technology, and a rheological, anticorrosive control additive.

The use of hydrogel technology in the antifouling makes the surface of the hull behave like a liquid on a microscopic level. This behavior not only deters the fouling from settling in the first place, but also significantly reduces hull friction. The new system is included within a copper-silyl-acrylate, self-polishing antifouling paint in which the hydrogel's effect is said to be both renewed and maintained throughout the ship's service life. The company maintains that the system does not need to be applied over a fully-blasted surface and can therefore be used over existing antifouling paints quickly and with minimal cost.

As of this article's original publication in *JPCL Europe*, in January of this year, owners were being given the opportunity to try the system for themselves. Each owner was permitted by the company to apply the material to two vessels — including cruise ships, large tankers, car carriers, or bulkers — to verify the fuel-savings claims. The 3 to 4 percent fuel savings attributed to earlier antifouling systems were difficult to verify; however, this new material has the potential to produce significantly higher fuel savings, which should be easy to see in even a simple analysis.

European owners and majors have been at the forefront of demand for this new technology, and their initial results will be released soon. This year Nippon Paint expects to have at least 100 ships using the technology.

The latest premium hull coatings from International Paint include an advanced Intersleek coating and a new Intercept system. Intersleek 1100SR is based on an enhancement of the fluoropolymer used in previous generations and features a unique, patented slime-release technology. The coating is said to have improved static foul-

Severe marine fouling causes drag and excess fuel usage.
Photo courtesy of Hempel

Intercept
Photo courtesy of International Paint

ing resistance, even in warm waters, and any slime that does settle during these periods is removed as the vessel moves through the water. The company claims that this product offers proven fuel savings — and thus, emission savings — of up to 10 percent, compared to the cost associated with controlled-depletion polymer antifoulings. This coating is said to be suitable for all ship types and appropriate for slow-steaming vessels. Since its launch last year, the product has been applied to 102 vessels, with 30 contracted and 24 under negotiation across all main classes, including container, cruise, LNG, Ro-Ro, and tanker vessels.

Intercept 8000 LPP is a biocidal antifouling coating featuring Lubyon polymer technology. This hull coating is said to replicate the linear polishing behavior of tributyltin-based materials, unlike the silyl or metal acrylate biocidal systems. The Lubyon polymer produces what the company refers to as a “superhydrophilic” surface, which has a lubricating effect. It also swells in water, helping to smooth out the surface and further reduce drag. In addition, the polymer reacts with seawater through the surface-active zone, releasing only the optimum amount of biocide, the release of which is largely independent of seawater temperature.

This coating is, therefore, suited for global routes during all seasons and for all ship types, but it is specifically designed for deep-sea vessels. The company claims that the product, compared with controlled-depletion technology, achieves fuel and emission savings of 5 percent and has been applied to 51 vessels, with 15 contracted and 41 more in the pipeline.

Slime control is a feature of coatings manufacturer Jotun's latest innovation, the newly developed SeaQuantum X200-S range. The company says the product offers superior resistance to slime and fouling in addition to controlled and linear polishing, a low-leached layer, resistance against mechanical damage, a smoother coating surface over time, and low water ingress into the coating. Within the range, there are products for high-speed/high-activity vessels, low-activity vessels, static or laid-up vessels, and a universal product. The company asserts fuel savings of 10 percent above market average and 90 months of effective performance.

SIGMA NEXEON 710
Photo courtesy of PPG

A few years ago, Jotun launched its Hull Performance Solutions (HPS), which combined its premium antifouling, SeaQuantum X200, with priority technical service, tools to measure hull performance over time, and a money-back guarantee. Relying on data generated from vessel trials, the company says that its HPS offers a clean hull and, compared with a vessel after dry docking, less than 1.5 percent speed loss or a maximum of 4.5 percent increase in fuel consumption over 60 months. The company has also released its HPS Newbuilding Solution, aimed at yards delivering vessels with eco-design.

PPG's premium products include the third-generation SIGMAGLIDE 990 silicone-based foul-release coating with improved slime-resistance and -release properties and SYLADVANCE 800, a silyl acrylate antifouling coating with controlled polishing rates, and enhanced self-smoothing capabilities to optimize hull roughness reduction. The latter is said to control shell and weed fouling for prolonged periods, depending on sailing pattern and routes.

The company has also recently launched its Sigma EcoFleet 690 coating, which is said to provide high-performance, predictable antifouling protection for short-sea and coastal shipping at variable operating speeds, in aggressive fouling environments. The company asserts that this coating contains an ultra-high-volume solids content of 70 percent, thus reducing potential volatile organic compound (VOC) emissions.

PPG also released its Sigma NEXEON range — a complete copper-free antifouling solution — developed based on research and testing at the company's own facilities and in third-party studies. Within that range, Nexeon 710 is the company's antifouling solution for operational vessels and can be applied during construction and dry docking. For newbuilds where outfitting takes longer than six months, the company offers its Nexeon 750 high-activity, copper-free topcoat antifouling. Both products are said to employ self-polishing, zinc-acrylate binder technology.

Because of the absence of copper, the leveling and smoothness straight after application are said to be significantly improved, thereby delivering better fuel efficiency. A further benefit claim is the cosmetic appearance — elimination of the so-called "whitening effect" that can occur with copper in the coating.

Surface smoothness is also said to be a major advantage of the latest addition to Chugoku's antifouling range. SEAFLO NEO is a high-performance, TBT-free hydrolysis antifouling that, according to the Japanese company, utilizes a unique polymer that delivers an ultra-smooth surface and self-polishing performance. This enables the coating to provide long-term antifouling protection and low friction resistance. The company maintains that this coating reduces fuel consumption by as much as 5 percent and has the lowest VOC in the industry's hydrolyzed ship-bottom paint.

Biocide-free, foul-release coating, Bioclean, forms the basis of Chugoku's environmentally-friendly range. The product has a low VOC and is said to be 25 percent smoother than existing silicone coatings, resulting in further reduction of fouling, fuel consumption, and carbon dioxide emissions, according to the company.

The premium hull coating from Sherwin-Williams is its two-coat Sher-Release System. This silicone-based, foul-release system is made up of the SeaGuard Tie Coat and the

SeaGuard Surface Coat. It is said to be suitable for use in a wide range of operating environments for vessels trading at greater than 10 knots and is claimed to have superior cleanability compared to traditional silicone foul-release systems. Fuel savings of 6–10 percent are claimed.

Kansai's leading antifouling is its Takata Quantum Series of silyl polymer hydrolysis coatings, which the company claims will dramatically improve a ship's fuel efficiency through wear characteristics that remain stable over the long term.

Conclusion

As stated earlier in this article, hull fouling is a major contributor to the transfer of invasive species. Research indicates that biofouling is a significant mechanism for the transfer of species by vessels. A single fertile fouling organism has the potential to release many thousands of eggs, spores, or larvae into the water, with the capacity to found new populations of invasive species such as crabs, fish, sea stars, mollusks, and plankton. Minimizing biofouling will significantly reduce the risk of transfer.

The International Maritime Organization (IMO) is addressing this, which could result in further mandatory regulations, but that will take time. For now, guidelines are outlined in the "2011 Guidelines for the Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Aquatic Species," adopted in 2011 by the Maritime Environment Protection Committee (MEPC) in Resolution MEPC. 207(62) and published in 2012.

These are only guidelines and, hence, not mandatory, but IMO member countries have been requested to take urgent action in applying these guidelines and in reporting back to the MEPC on any experience gained. The guidelines call for a biofouling management plan and record book to be maintained for every ship. It also recommends the application of an antifouling system appropriate for the type of vessel and its operating speed and trading pattern, as well as compliance with the AFS Convention (IMO International Convention on the Control of Harmful Anti-Fouling Systems on Ships, 2001).

There is still a long way to go to keep ships' hulls clean of fouling for fuel efficiency and preventing transfer of aquatic species, as well as having a universal basis for evaluating fuel savings. Will this result in new coating or hull-cleaning systems? We will have to wait and see. JPCL

Surface Preparation: Adventures in FRUSTRATION

No, it's just not good enough. You'll have to reblast.

By Peter Bock
CorrLine International

These are dreaded words a contractor hates to hear, whether they come from a third-party inspector or from the contractor's own QA/QC manager. Abrasive blasters have been hard at work all morning. Just before lunchtime the blasters shut down. The spent blasting grit and the old coating (and rust) blasted from the surface have been hurriedly gathered and removed, the blasted surface blown down or vacuum cleaned to remove blasting dust, and the inspector summoned.

The inspector or QA/QC person is not the bad guy — he or she is simply following his or her interpretation of the project specification and the industry standards used to write the specification. If there has not been sufficient discussion and agreement about standards and interpretation during the pre-bid and pre-job conferences, the QA/QC person, the third-party inspector and the contractor's site superintendent may have significantly different opinions of what meets the project surface preparation specification.

This article discusses potential ambiguities in visual surface preparation standards and provides insight into preventing disagreements between owners, inspectors and contractors, and avoiding delays and costly reblasting.

SSPC-SP 5/NACE No. 1, White Metal Blast Cleaning

Surface preparation standards are almost entirely visual. SSPC's definition of a "White Metal Blast Cleaned" surface (SSPC-SP 5/NACE No. 1) reads as follows:

"2.1 White Metal Blast Cleaned Surface: A white metal blast cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products and other foreign matter."

That should be easy and straightforward — it's white or it isn't. But it's not always that simple. The standard states that the the surface needs to be white "when viewed without magnification." Does that mean the inspector has a right to get his nose half an inch from the blasted surface, or should he view it from a more "normal" range? How visible are the "visible" contaminants and foreign matter? What about non-visible contaminants?

(Left) Abrasive blasting structural beams for a coastal petrochemical project. All photos courtesy of Mobley Industrial Services Inc.

This blaster is using medium-grade garnet abrasive to obtain a Commercial Blast Cleaned surface (SSPC-SP 6) and a 2-to-3-mil anchor profile.

"2.1.1: Acceptable variations in appearance that do not affect surface cleanliness as defined in Paragraph 2.1 include variations caused by type of steel, original surface condition, thickness of the steel, weld metal, mill or fabrication marks, heat treating, heat-affected zones, blasting abrasives, and differences because of blasting technique."

Acceptable "white metal" prepared steel surfaces may in fact be several shades of gray, some of them because of abrasive blasting, some of them in spite of it, and "white metal" is a somewhat of a misnomer.

"7.4: Immediately prior to coating application, the entire surface shall comply with the degree of cleaning specified... Any visible rust that forms on the surface of the steel after blast cleaning shall be removed by recleaning…"

If the inspector thinks that the job has not been done well enough, the contractor will have to reblast the unacceptable areas. Because the contractor has already set up for painting to ensure no more deterioration "immediately prior to coating application," all that effort is wasted. Blasting equipment has to be brought back in, spent abrasive has to be once again gathered and removed, the surface has to be vacuumed or blown down again and — the dread of dreads — the inspector has to be called back to re-inspect. In the meantime, other previously acceptable areas of blasted surface may have deteriorated, so from a practical viewpoint, if the inspector turns down a portion, reblasting or at least resweeping the entire shift's work is often the most cost-effective option.

White Metal Blast Cleaning, is usually specified only for tank and vessel lining and for critical exterior surfaces. The costs and the perfection required are too high for most coating projects and SSPC-SP 10/NACE No. 2, "Near White Metal Blast Cleaning," or SSPC SP-6/NACE No. 3, "Commercial Blast Cleaning," are specified instead. "Near White Metal Blast Cleaning" allows 5 percent of a "unit area" of abrasive blasted steel surface to be less than white metal and "Commercial Blast Cleaning" allows for 33 percent. For both standards the less-than-white areas can have only "random staining" consisting of "light shadows, slight streaks or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coating."

A "unit area" is defined as a 3-inch-by-3-inch square. Therefore, if an inspector finds a 3-inch-square area in which more than 3 square inches are randomly stained, the area fails "Commercial Blast." The math is easy; the stains are not.

When is a Stain Not a Stain?

Although the *SSPC Protective Coatings Glossary* defines a stain as "An area of a surface which, when compared to adjacent areas, has an equal surface profile but is discolored (usually darker) with a material having no apparent volume;" upon visual assessment, confusion remains about what constitutes a stain versus actual rust or mill scale left on the surface. How light, slight or minor do the "light shadows, slight streaks or minor discolorations" specified in SSPC-SP 6/NACE No. 3, Paragraph 2.1 have to be to pass, especially since the following paragraph (2.1.1) of the specification allows the same steel color variations as for "White Metal?"

Just as for "White Metal Blast," "Near White Metal" and "Commercial Blast" require that "immediately prior to coating application, the entire surface shall comply with the degree of cleaning specified. Any visible rust that forms on the surface of the steel after blast cleaning shall be removed by recleaning…" But are the stains the inspector is finding on newly blasted "Near White Metal" or "Commercial" steel from before blasting, or are they new turning or rerusting of the steel?

Get the Picture

Visual comparison standards for acceptable quality of dry-abrasive-blasted surfaces (SSPC VIS 1) should be available at the job site and should have been discussed and agreed on at the pre-bid and pre-job

Beam end area has been blasted to a "Near White Metal" finish (SSPC-SP 10).

conferences. Whether using available photographic standards, or digital photos of test-blasted areas done as part of the contractor bid qualification or pre-job qualification, there should be a general agreement between the owner, contractor and third-party inspector. In advance of the project, a decision should be reached about what constitutes acceptable visual appearance of the prepared surfaces in order to conform to the specification standard. Inspection of the day's surface preparation work should be an opportunity for agreement, not a source of frustration, confusion and conflict.

After a commercial or near white blast of aged steel in a refinery or chemical plant environment (especially at a coastal location where high humidity and salt in the air are almost constant), it is often difficult to determine whether stains the inspector finds are allowable, or a result of degradation of the blasted surface.

According to the inspector, the most straightforward way to tell is to let the blasted area sit a while and see if the staining gets worse. From the contractor's perspective, this can be perceived as an expensive way for the inspector to force a reblast. Using an agreed-upon visual comparison standard up front can help to avoid disagreement.

An area of staining — or discoloration — in SSPC-SP 10 blast. Does it pass or fail?

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Procedure for Determining Conformance to Steel Profile/Surface Roughness/ Peak Count Requirements

Testing of a dry-abrasive-blasted surface for specified anchor profile can be a non-visual, quantifiable test. The traditional visual "comparator" test has been superseded by the use of profile replica tape, or of depth micrometer testing of the profile. Both replica tape and depth micrometer testing are quantitative measurements, but they measure only small samples of the entire prepared surface. The number of required anchor profile tests should follow standards as a minimum or should be specified and agreed upon at the pre-job conference. Depth micrometer testing is highly accurate, but measures only one pit per reading, so multiple groups of readings must be done to assure accuracy. The project specification should clearly state the type and frequency of blast profile tests required.

If newly-abrasive-blasted steel could be stabilized as it was blasted and without degradation, the inspector could inspect it and pass or fail the actual preparation work itself, rather than the preparation that has subsequently been affected by environmental conditions.

The presence of salts on "White Metal" blasted steel surfaces has been known since before coating inspectors were assigned CIP numbers. When the author was first learning the offshore oil field maintenance painting business in the late 1970s, there was already a primitive test for salt residue contamination on newly-blasted-steel surfaces. The original field "salt test" consisted of licking the newly-blasted steel. At that time the blasting medium was silica sand, and the steel looked clean "when viewed without magnification," so licking it was safe and sanitary, but you could always taste the salt. And, of course, the spot you licked immediately flash rusted. Then the contractor painted over all that salt, because there was no cost-effective way of removing it.

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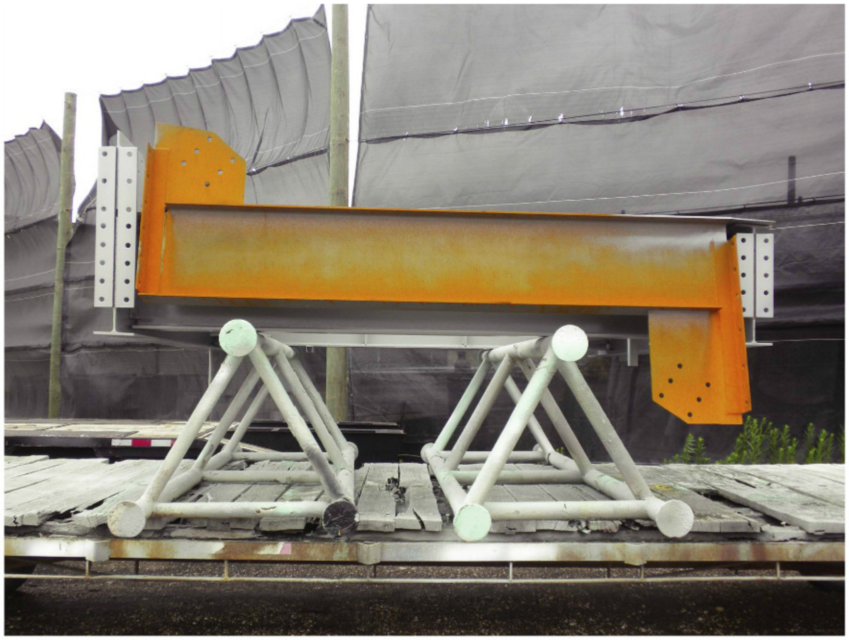
Field Methods for Extraction and Analysis of Soluble Salts on Steel and Other Nonporous Substrates

Since then, much more sanitary and quantifiable tests have been developed for measuring salt residues left on newly-blasted surfaces. Different types of salt test procedures measure different groups of salts and it should be noted that test results may vary, depending on the test method used. All the tests have in common the facts that they are expensive (anywhere from $10 to $40 for the test kit itself, excluding the cost of the measuring



Newly-blasted support beam unit has flash rusted badly after an unexpected rain shower.

device) and they are slow, typically taking 10 to 30 minutes per test. All of the salt tests are also handicapped by two other factors: first, they measure only a tiny area of the blasted surface, typically about one one-hundredth of one percent, which is then assumed to be uniformly representative of the entire prepared surface, and secondly, they do not specifically measure iron sulfides left on the surface, and these are one of the primary causes of flash rerusting.

A salt test measures salt concentration on two-to-four square inches of the prepared surface and the test results will be representing several hundred square feet of prepared surface or more. The project specification should include the specific method to be used for testing for soluble salts. It may also include the number, frequency and location of tests. There is also a "visual" component — structures tend to corrode unevenly; verification tests have often shown widely varying results, indicating that surface contaminants are unevenly distributed on the prepared surface, tending to cluster or aggregate. This accounts for the phenomenon that some areas of the same abrasive blasted surface tend to flash rust faster and more severely than others.

Both the equipment owner and a seasoned third-party inspector may have experience indicating where the structure being prepared will tend to corrode, that is, where the previous coating system failed the earliest or most extensively. Salt tests should be specified to be taken at precise areas which are expected to have the highest levels of residual non-visible contaminants. Without such specificity, there may be disagreement.

Wet surface preparation methods like wet-abrasive blasting or UHP water washing remove some non-visible contaminants, but the wet prepared steel surface can quickly flash rust as it dries. There are methods of inspecting a flash-rusted surface after wet preparation, but these are also entirely visual and are even more subjective than the "staining" described in SSPC-SP 6/NACE No. 3 or SSPC-SP 10/NACE No. 2.

The most common method of delaying flash rusting on dry-abrasive-blasted steel is dehumidification — reducing relative humidity over the newly-blasted surfaces to a level where an electrolytic cell does not exist and flash rusting cannot occur.

Dehumidification (DH) for the interior of a roofed tank being dry-abrasive-blasted is relatively simple. There are few and relatively small openings, and the steel sides and floor

Light flash rusting on steel dry blasted to SSPC-SP 10. This area needs to be reblasted.

Moderate flash rusting on steel dry blasted to SSPC-SP 10.

contain air and hold heat. Exterior structures can be scaffolded and tented with plastic sheeting to allow for DH, but such tenting can be leaky and requires more DH to accomplish the originally desired results. In either case, the cost of running the DH system continuously can be very expensive, and if the DH is stopped for any reason, the blasted steel can quickly flash rust.

An alternative and less expensive method of controlling flash rusting after dry-abrasive blasting is the use of a waterborne inhibitor chemical which changes the pH of the abrasive-blasted steel or leaves a thin residual coat on the blasted surface, or both. The inhibitor chemical can be sprayed onto the newly-blasted surface immediately after blasting is completed or it can be used as a part of a wet-abrasive-blast process.

Use of an inhibitor chemical allows a contractor some time to finish abrasive blasting and cleanup, allows the inspector time for a thorough inspection, and in some cases, allows abrasive blasting to continue for several shifts before shutting down, inspecting, and coating or lining the prepared surfaces.

Inhibitors are frequently used during maintenance work where the owner or inspector requires "Near White Metal" appearance, but blasting and coating application cannot be done quickly enough to prevent flash rusting. The process is not recommended by paint companies but is frequently used in the oil and petrochemical maintenance areas.

The dried inhibitor film is visually transparent. To the inspector's eye, the steel appears to be "Commercial" or "Near White Metal Blast," (whatever the original standard and quality of blast), so it fulfills the visual standard.

A third, relatively new method for controlling flash rust on abrasive-blasted steel is a proprietary waterborne passivation process. Unlike inhibitors, which must be applied before any flash rusting occurs, the passivation process claims to remove flash rust, restoring prepared steel to its "White Metal" stage. Visual inspection and salt testing after the passivation process are the same as for newly dry-abrasive-blasted steel.

Conclusion

Surface preparation is the first and sometimes the most important part of a successful industrial coating or lining project.

Unfortunately, specification standards for surface preparation are almost entirely visual and can be somewhat subjective. After dry-abrasive-blast-surface preparation, properly prepared surfaces can quickly degrade from their initial state on completion of blasting, and need to be quickly inspected, approved and coated.

Field-usable salt contamination tests can determine the presence of non-visible contaminants on visually-acceptable, prepared surfaces, but the tests available today are expensive, slow, and measure too small of a percentage of the prepared surface to be completely reliable.

Flash rusting of a newly-abrasive-blasted surface can be prevented by dehumidification, which keeps humidity at the bare steel surface below a level where it can act as an electrolyte, by the use of inhibitors, or by a steel passivation process.

Whichever method is used, determination of the specified level of surface preparation is predominantly a visual process. To prevent disagreements, delays, frustration and costly reblasting; the end user, contractor and third-party inspector should agree on visual acceptance standards before surface preparation begins. The best way to reach agreement is to use "visual" samples, preferably photos of acceptable surface preparation samples, available to all parties at the job site.

About the Author

Peter Bock is vice president and technical service manager for CorrLine International in Sugar Land, Texas. He is a U.S. Air Force veteran and has degrees from Tulane University and the University of Northern Colorado. Bock has 37 years of experience with sales, management and technical service in oilfield and petrochemical heavy-duty coatings in the U.S., Canada, Mexico, Venezuela, Indonesia, and Taiwan. He has experience with on- and offshore production, drilling and workover rigs, shipyard work, natural gas and LNG, pipelines, terminals, refineries, and chemical plants. He is a specialist in elevated temperature systems and CUI mitigation. JPCL

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