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Soluble salt testing

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Surface Profile Measurement

The Surface Profile Probe, part of Fischer’s materials testing range, measures blasted surfaces, enabling the user to prepare the substrate, select the cleaning method and apply the right amount of coating.

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The President Writes

It is with great pleasure that I am able to write to you in my new role as President of the Institute. I would like to express my thanks to John Fletcher and the whole steering committee for their hard work and time they have dedicated over the past two years, as they hand over the reins.

As an organisation, we are entering a period of change as we are faced with continued pressures and challenges in the world around us, but it is a challenge we are facing head-on.

I hope to attend local branch meetings as much as possible, and look forward to more collaboration between the branches and headquarters.

Over the next two years I intend to continue the good work already started to deliver added value to our members, grow our network and membership numbers. Chris Bridge has been elected as the Young ICorr representative, and will be the focus for the younger members. Other initiatives such as the joint working group with the Marine Corrosion Forum will begin to solidify, and I encourage participation by all members in any activity they can, to bring people into the world of corrosion.

We are a members-driven organisation, and we genuinely value your thoughts and ideas, and I ask that you contact me at any time to share these.

A steering group has been set-up to look at the “road to Chartership”, and I will keep you up-dated with the progress on this, and other matters.

You will start to see more visible changes in the website and this publication, which I hope you will see benefit in.

Thank you for your continued support of the Institute, and I look forward to working with you all.

Sarah Vasey,
President - The Institute of Corrosion

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From the Editor

I would like to add my welcome to that of the new President. I have been working with Square One, the publishers of Corrosion Management, for the last few months to improve the content of the magazine and offer more benefit to members.

You will see from this issue that we have made changes to the layout to improve the visual impact and have stopped publishing the ICATS listing, freeing up valuable space for more technical content. Over the coming months, I would like to improve the technical content further, and perhaps add a “technical problem questions and answers” column, and a training column covering the various topics within our industry.

As this is your magazine, I value your feedback on these new developments.

I look forward to your participation as a reader, a writer, or a critic, and I can be contacted through the Northampton office.

Brian Goldie, Consulting Editor

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AGM

The 2016 AGM of the Institute was held on Wednesday, 30 November 2016 at The Council Chambers, Birmingham, where the thirty-four attendees were welcomed by Trevor Box, Chairman, Midlands Branch. The minutes of the previous AGM were accepted unanimously. Dr A J Collins, Hon treasurer, provided his report on the Institute’s accounts, and Brian Wyatt proposed a vote of thanks to him for generating a good surplus in the current year. Finally, the Trustees and Directors of the Institute were elected as follows: President, Sarah Vasey, Sherwin Williams Ltd; Vice-President: Gareth Hinds, NPL; Hon Treasurer: Dr A J Collins; Hon Secretary: Dr Jane Lomas, Amtec Corrosion and Coatings Consultants Ltd; Technical Secretary: Dr Douglas Mills, University of Northampton.

Visit the ICorr website for all the latest news

www.icorr.org
NEW SUSTAINING MEMBER

PIPELINE TECHNIQUE

Pipeline Technique has been providing Field Joint Coating services to Onshore, Offshore, Multi-Jointing and Spool Base projects worldwide since 2000 for its parent company, Heerema Marine Contractors. They also offer FJC solutions outside of the parent group to the onshore and offshore pipeline market.

To deliver on both quality and cycle-time, Pipeline Technique has developed application equipment that is based on pre-programmable, automated techniques, providing repeatable application methods both onshore and offshore. They apply standard and specialist materials for corrosion protection, mechanical protection and insulation. Safety, environmental protection and quality are set to the highest standards, satisfying the more demanding requirements of recent projects.

The staff are their greatest asset, with key personnel having the necessary ability and experience not only to deliver FJC projects successfully, but also ensuring that all personnel are suitably trained in all aspects of their role. They are proud members of NACE, ICORR and run ICATS training parallel to the in house operator training.

With the challenging times seen in the industry, Pipeline Technique are stepping up their innovation activities and are actively developing new FJC solutions to reduce costs and maintain safety and quality.

MCL SITE PROJECTS LTD

MCL Site Projects is a leading coating applicator serving the whole of the UK, and specialising in on-site surface preparation and application of industrial, protective, decorative, commercial and hygiene coatings. In addition to coating application they are specialists in concrete repairs as well as supply and installation of anti-slip floor/deck systems.

They have built-up trusted supplier relationships with the leading coating suppliers in the market, and with ISO9001 and CHAS, as well as Highways Agency and Network Rail approvals, are able to provide their services across a number of sectors with assurances that work is carried out to exacting standards.

Their aim is simple, which is to build and maintain relationships and, with repeat business by working together with their clients in order to ensure that the end users receive the best possible service they can expect.
Institute News

ICORR TRAINING COURSES

Level 2 cathodic protection technician – marine metallic structures course

ICorr are pleased to announce the first Level 2 CP Senior Technician Course, Marine Metallic Structures, to be held at the Royal Naval Submarine Museum in Gosport, on 8 – 12 May 2017.

Certification of all cathodic protection personnel is a requirement within the cathodic protection industry throughout Europe in accordance with BS EN 15257 (soon to become an ISO Standard). This Institute of Corrosion course and examination, for Level 2 Senior CP Technicians, is in compliance with the above standard and suitable for candidates with a minimum Level 1 experience in cathodic protection (note that full certification to Level 2 requires assessment of CP experience), and will cover the application of cathodic protection (CP) to a variety of marine structures.

The course will be conducted by Engineering Training Solutions (part of the Institute of Mechanical Engineers) on behalf of Institute of Corrosion. David Harvey, a very experienced CP Specialist and long term ICorr Fellow, will be the course tutor. Full details about the course and examination can be found at trainingsolutions@imeche.org.

Advanced Cathodic Protection Course Success in Stratford upon Avon - and Links between ICorr and SGK

The first Institute of Corrosion Advanced Cathodic Protection Course, in conjunction with the Swiss Society for Corrosion Protection (SGK), was successfully held between 1st and 3rd November 2016 at the Crowne Plaza hotel, Stratford on Avon. The course was prepared and presented by the head of SGK, Dr Markus Büchler. Dr Büchler is one of the leading researcher practitioners in CP worldwide.

The course covered the basics of chemistry and electrochemistry, introduced new insights into the mechanisms of CP based on literature, the effects of time variant interference (ac and dc), the relevance of backfill and mass transport, and the consequences of these on the protection criteria in BS EN 12054 and ISO 15589-1. It also covered the mechanisms of stray current corrosion and relevance of these on the current revision of BS EN 50182.

The design of CP buried pipeline systems was addressed, including modelling of pipelines to mitigate the corrosion risks. Numerical modelling of specific risk scenarios were undertaken by the participants, including in high resistivity soils, anaerobic environments and poor bedding/backfill conditions.

New concepts based on established electrochemistry were modelled by all participants using SGK developed software, based on real polarization curves - the software was provided to all participants for their future use. Finally, the impact of these concepts on CP criteria and on the mechanisms that lead to effective cathodic protection, were presented.

Attendees came from UK, Holland, Kuwait, Sweden and Singapore; feedback was excellent with an average mark of 5.4 from a maximum of 6 from a rigorous marking scheme. ICorr is considering running the course again in 2017 and, together with an examination, it may form part of the ICorr Course that is anticipated to be necessary for the Cathodic Protection Specialist (presently Level 3, but expected to be Level 4) Competence Assessment and Certification, in the forthcoming ISO 15257.

Following from this cooperation between ICorr and SGK, ICorr are in the process of applying to become an Expert member of SGK, and SGK have become a Sustaining Member of ICorr. Dr Büchler has applied for Professional Membership of ICorr. Thanks are due to John Fletcher, Immediate Past President, for progressing this cooperation.

IF you are interested in attending this course in 2017 please contact the ICorr Administration and, if sufficient numbers are interested, ICorr will arrange for a repeat course, with Dr Büchler again presenting.

CEOCOR 2017

Date Change

The CEOCOR Conference to be held in Luxembourg will now take place on 16 - 19 May 2017. Full details can be found on the dedicated website, http://ceocor.lu

CEOCOR 2018

Planning for the 2018 conference in Stratford upon Avon is going well. A sponsorship package has been put together, and details will placed on the ICorr website and some potential sponsors will also be contacted directly. A major sponsor has already been confirmed and some smaller packages also agreed. Further details about the event will be available soon.
Institute News

ICATS

The first presentation of the new Supervisor Course will be on 14-15 March and an application form can be obtained from www.icats-training.org, in the News and Events section, or by calling the Correx office on 01604 438222.

As you will see, Corrosion Management magazine has a new look, and changes have been made to make it more readable and interesting for members. The previous regular listing of ICATS Registered companies will be replaced by a listing on the ICATS website. However as a printed listing is still useful to many, an ICATS Directory will be introduced and published with Corrosion Management twice a year. Further details are given in the enclosed leaflet.

ICATS will be attending the Surface World Show at the NEC on 22 and 23 March 2017, and have a stand within the “Knowledge Centre”.

You can keep up to date with ICATS at the above website or through the ICATS group on LinkedIn.

ISO 9001 and Quality Assurance

The Institute of Corrosion (and Correx) have embarked on a route to obtain Certification to ISO 9001: 2015 Quality Management Systems. LRQA has been engaged to carry out this certification and the process is well in hand. The Quality System Manuals for ICorr and Correx have been completed and the Quality Policies have now been published on the respective websites. It is hoped that the process will be completed by mid-2017 and regular updates on the progress will be published.

One of the reasons for obtaining certification is that Highways England will require it for the ICATS Scheme, and it will also enhance the credibility of the institute.

Members should visit the websites and make themselves familiar with the Quality Policies and the areas covered, as part of their CPD QA training.

Corrosion Engineering Division

The next CED working day will be held on Thursday 27 April at the Institution of Mechanical Engineers’ Engineering Training Centre, Sheffield Business Park. The theme of the day is ‘Corrosion Engineering and Concrete’ and a combination of invited talks, CED working group meetings, a laboratory visit to Sheffield Hallam University and presentation of the inaugural Paul McIntyre award, are planned. Further details are given in the enclosed leaflet.

The CED Coatings Working Group met on 15 November 2016 and discussed progress on the production of a set of technical papers that are intended to be a general introduction to anti-corrosive organic coatings, but in particular to provide basic guidance for ICorr level 1 inspectors. Six documents are in preparation, although further documents could be added (e.g. a document on abrasives is planned); they are:


Once they have been published they will be available on the Institute of Corrosion’s website in the CED section of the member’s area, where minutes from the working group meetings can also be found.

Young ICorr

Christian Bridge has been elected as the Young ICorr Council Representative. The intent of the role is to encourage Institute membership for younger engineers working within the corrosion community, and to engage existing young ICorr members with events and other initiatives.

Christian is a Materials and Corrosion Engineer working at BP and supports the Angola Operations Organisation where BP operates two blocks in ultra-deep waters of the Congo basin.

Christian studied Materials Science (MEng) at the University of Oxford and has been involved with the Institute of Corrosion since participating in the Young Engineers Competition in 2015. Chris can be contacted at chris.bridge@uk.bp.com

For all the latest news, events and debates join us on LinkedIn
BRANCH NEWS

Aberdeen Branch

The November meeting was a joint session with IOM3 and there were two topics presented - “Managing Marine Corrosion on Offshore Wells - Avoiding Structural Failure” by Ian Taylor of Shell, and “Cormorant Alpha Leg C4 Leaks – Cause, Response and Lessons Learned” by Fraser Selfridge (TAQA).

Ian gave an explanation of surface casing corrosion, where issues have been seen in practice, what was done, how inspections are performed and examples of repairs carried out. Photographs and diagrams were used to demonstrate subsea well components, how wells were built and typical corrosion issues experienced. Wells must be structurally self-sufficient and that the key was to prevent structural collapse, in particular the effect of corrosion on surface casing loading. He explained measurement techniques used to quantify wall thickness especially the use of Pulsed Eddy Current (PEC) with results later combined with structural modelling to improve predictions on failure. The mitigation approaches, such as loading redistribution, installation of supports, grouting and replacement, were discussed, and he emphasised the importance of an initially good design such as using good grade steels, appropriate centralising, and consideration of the effects of corrosion, among others. Ian concluded with a project example of how corrosion was identified and how a repair was performed using collars and load transfer techniques.

Fraser discussed leaks experienced on leg C4 of Cormorant Alpha. The platform was similar in design to a number of North Sea concrete structures – topsides steel process area on concrete legs, with a vast area of concrete storage cells below the legs. There were particular problems and a high risk area below the GTF (Gas Tight Floor) of leg C4, with limited isolation possibilities to control leaks. Follow-up inspections (for remaining life) are challenging, expensive and difficult to implement. The root cause of the failure was considered to be Corrosion Under Insulation (CUI) which was missed during the Risk Based Inspection (RBI) process. He explained that there were limitations on the pre-inspection techniques as in some cases, pre-inspection results showed no indications even when significant degradation was present after passive fire protection removal. He went on to discuss the project to implement suitable clamping repairs which were challenging due to the location. Also surface preparation and the presence of a lot of fully welded lengths poses extra challenges. Fraser concluded his talk by explaining that RBIs may not necessarily identify issues indicating technology limitations and lack of access issues may introduce gaps in the process.

The next meeting will be held on 28th February, when Gary Wallace of Permasense will discuss “Monitoring High Temperature Corrosion Attack: correlation between Crude Corrosiveness and results from online Corrosion Monitoring”. Online monitoring of corrosion is fast becoming industry best-practice over traditional periodic manual inspection as a means of gathering an up-to-date and more thorough picture of asset integrity. This talk will demonstrate how data delivered by an online corrosion monitoring system correlated with micro-changes in the measured corrosion influencing variables during a period of high temperature corrosion attack. This will be held at the usual venue, the Palm Court Hotel, 81 Seafield Rd, Aberdeen AB15 7YX, with the evening starting at 18.00 and the presentation at 18.30.

On 28th March there is a visit to Cosasco at Bridge of Don, where the topic discussed will be, “Latest Advances in Real-Time Monitoring and Safe Retrieval”. The event starts at 18.00 and full details will be advised later.

A calendar of local events of interest to corrosion professionals in the Aberdeen area and the opportunity to sign up to the branch mailing list is available at https://sites.google.com/site/icorrabz/home.

London Branch - The 28th Annual Christmas Luncheon

After Grace was said, the proceedings were underway, and once the main course was finished, the diners were entertained by the Italian Maître d’, the French Head Chef and a young French waitress who performed an operatic musical rendition to the delight of the audience.

It was a fantastic performance by a group called the Singing Waiters who received rapturous applause.

The London Branch Chairman, Jim Glynn, thanked the guests for their continued support and introduced the new President, Sarah Vasey, who noted that it was a delight to see so many young engineers in the room and she commented that she was committed to continue the initiative to make the Institute of Corrosion a valuable fraternity for both young and the more established engineers.

Overall it was a really memorable occasion, and thanks must go to all those who continue to support The Institute of Corrosion, those that sponsored the event, and of course the organising sub-committee who pulled all this together so expertly.

As a footnote, it was noticeable there was a much better cross section of experienced and younger, male and female engineers, which made for a more relaxed atmosphere and with plenty of raucous laughter throughout the afternoon.

Continues...
The last technical meeting of 2016 was a joint meeting with TWI, where an excellent presentation was given by Richard Pargeter Technology Fellow at TWI, entitled “Testing in aggressive environments, a multidisciplinary approach”. Richard discussed sour degradation in carbon and low alloy steels, sour exposure and fracture of steel. These issues are complex and interdisciplinary and can include fatigue, fracture mechanics, chemistry, corrosion, metallurgy, welding and equipment control/design. This makes for a wide range of potential interactions and the conditions often mean that specific testing is required. Richard explained that TWI has concentrated efforts on these complex issues and has excellent and flexible facilities to provide important information on the behaviour of materials in these aggressive environments.

London Branch moved its evening meetings to Imperial College Kensington, London SW7 2BB last year and the new venue has been a great success. There is state-of-the-art presentation equipment with accommodation for up to 100 persons in pleasant, modern and comfortable surroundings. Since moving to this new location attendance at evening meetings is up on previous years.

The next London Branch event at Imperial College is on Thursday 9th March 2017, when the ICorr President, Sarah Vasey, will talk about the Institute, its mission and new initiatives.

North-West Branch

The North-West Branch has not been very active of late due to most of the committee being involved at National level. In recent years the North-West has provided four Presidents, the Honorary Secretary and been responsible for Chartered Scientist Licencing and liaison with the Science Council. Looking to the future the Branch is keen to resurrect activities at a local level and a questionnaire was sent to the members, to which several offers of help had been received. There are plans for a half day seminar and some evening meetings if a suitable venue can be found, as the previous venue was lost when the owners of the hotel chain went into liquidation. The North West branch covers a vast area from Cheshire to Cumbria and from the Pennines to the Irish Sea including North Wales, so finding a convenient venue for everyone is difficult. Any suggestions for evening meetings and suitable venues would be very helpful - ideas can be sent to the Honorary Secretary NW Branch.

Midlands Branch

A half day seminar was held on 30th November 2016, prior to the Institute AGM. Three presentations were given on the topic of “Pipe lines and Stray Current Corrosion”.

Patrick Lydon, IACS Corrosion Engineering Ltd, discussed “Pipeline coatings past and present” and gave a brief introduction to the commonly used pipeline coating systems and information on their typical properties. The primary topic of the paper was the use of a 3 layer polyethylene coating system on a UK gas industry pipeline project, and the reasons why this system was selected for sections of the pipeline in preference to the conventional fusion bonded epoxy coating system. Some of the issues that the project faced in terms of coating repair and inspection requirements were discussed, together with the requirements for field joint coating prequalification.

David Buxton, Intertek Production and Integrity Assurance, presented “Managing stray current from UK rail systems” which focused both on the management and control of corrosion, caused by stray currents. An introduction to stray current was provided along with a description of typical stray paths, and the importance of controlling stray current at the design stage, during construction and finally during operation, was stressed. The impact of interference was discussed and illustrated with some examples of failures, including recent data collected from the Midland Metro system where an earthing issue at a traction substation resulted in a temporary increase in interference and long range interactions.

The final presentation, given by Bill Whittaker, Cathodic Protection Engineering Ltd (CPEL) was entitled, “Pipeline AC Corrosion, examples and latest thinking”. Pipelines routed parallel to HV overhead cables will have an AC voltage induced in them caused by changing electro-magnetic fields. During the positive part of the cycle, passive behaviour is induced; during the negative part of the cycle, metal loss occurs. Older pipelines and those with poorer coatings are more prone to this type of corrosion and will corrode at higher rates. Electric fields affecting AC corrosion include: configuration, current loads, load balance between phases of power lines, electrical resistance of coating(s) and soil resistivity, which can be counteracted by insertion of zinc (or less commonly, copper) ribbons to isolate “active” migration.

At the end of the technical talks, Jim Preston, Corrosion Protection Ltd, was presented with an award given by S.E.E for the best P.R.I. (Professional Review Interview) for registration as a Chartered Engineer in 2015, by Mr Peter Vincent, President and Prof M Leonardo de Calcina, Past President and Trustee of the Society of Environmental Engineers (SEE). S.E.E is a fully-licenced body of the Engineering Council, with which ICorr has an agreement (along with seven other Professional Affiliates of the Engineering Council) to oversee ICorr registration for CEng, IEng, Tech Eng. The award came in the form of a framed certificate, S.E.E medal and a cheque for £250. It is indeed an honour that an ICorr person should receive this.

North East Branch

The Branch now has a new secretary, Alex Sandilands of Sherwin Williams. The 2017 schedule of evening meetings will be announced later, and a summer event at Durham Castle is planned and further details will be given in the next CM.

The Chairman would like to thank all those who have supported the North East Branch throughout 2016 and he hopes that support continue throughout 2017.
Industry News

John Fletcher Joins ASTM International Board of Directors

John Fletcher, the ICorr immediate past President, will serve a three-year term on the ASTM International board of directors. John holds an HNC in electronics from Stockport Technical College and a diploma in industrial management from Manchester Polytechnic. He is a Chartered Scientist (CSci), and has worked at Elcometer since 1982 and previously served as a development group leader at Mullard Ltd. He has been a member of ASTM International since 2007 and is currently serving as the vice chairman of Committee on Paint and Related Coatings, Materials, and Applications (D01).

Outside ASTM International, John is a Fellow of the Institute of Corrosion, a member of the National Association of Corrosion Engineers (NACE) and The Society for Protective Coatings (SSPC).

Sherwin-Williams scoops major industry award

Leading coatings manufacturer Sherwin-Williams has scooped a major industry award for Sustainable Innovation in developing a breakthrough product for asset protection in harsh environments. The company won the British Coatings Federation Award for its development of Dura-Plate 301W, a new product which is helping to change the face of the energy and infrastructure markets in Europe. The product offers a longer painting calendar and with it increased efficiencies and reduced overall project costs.

Ian Walker, managing director of Sherwin-Williams Protective and Marine Coatings Europe, Middle East and Africa (EMEA), said: “This is recognition of some great work from the team behind the scenes and how important it is to listen to customers. “Thanks go to all of our staff involved, and we’re delighted that our customers have benefitted from the difference we have made to their asset protection challenges.”

This award comes on top of the Queen’s Award for Enterprise: Innovation 2016 - for its development of the same product. According to the company, the technology has already won plaudits from the oil and gas industry for its use in atmospheric service conditions in offshore, marine, industrial and infrastructure applications.

Acoustic Emission Technology Enables Improved Crack, Corrosion Detection

ABS, a leading provider of classification and technical services to the marine and offshore industries, has published the ABS Guidance Notes on Structural Monitoring Using Acoustic Emissions. This industry-leading guidance presents best practices for planning and executing Acoustic Emission Testing (AET). AET is a passive non-destructive examination technology that has been successfully applied to detect and monitor crack propagation, corrosion activity, cavitation erosion and leaking in structures made of steel, aluminum, composites and other materials, and is being investigated as means to detect weaknesses and monitor structural health in a broad spectrum of structures, from storage tanks, suspension bridges, nuclear plants, pressure vessels and LNG tanks to mooring chains and airplanes. The guide can be downloaded from www.eagle.org.

Number of coatings industry suppliers gets smaller as majors get stronger

Akzo and BASF consolidate their positions in the market. AkzoNobel has finalized the acquisition of BASF’s global Industrial Coatings business, which supplies a range of products for industries including construction, domestic appliances, wind energy and commercial transport, strengthening its position as the global number one supplier in coil coatings. The transaction includes relevant technologies, patents and trademarks, as well as two manufacturing plants in the United Kingdom and South Africa. Approximately 400 employees from BASF’s Industrial Coatings business join AkzoNobel, bringing expertise to innovate and serve an expanded customer base worldwide. According to the company, completing this transaction also positions AkzoNobel as a full service coatings provider for the protection and maintenance of wind turbines, providing essential protection to wind power stations around the globe.

BASF has now completed its acquisition of Albemarle’s global surface treatment business, Chemetall, and through this acquisition, the BASF Coatings division becomes a more complete solutions provider. According to the company, BASF will combine its know-how in chemistry and coatings applications with Chemetall’s market-leading expertise in surface treatment, and the combined businesses will benefit from each other’s global infrastructure, scale and market access, driving new growth opportunities by offering an unmatched solutions competence to customers. To prepare for a seamless integration, BASF has established a Global Integration Management Team, which will ensure business continuity while maintaining a clear priority on meeting customer needs.
Element Materials Technology opens a new Dutch facility

Element Materials Technology, headquartered in London, has announced the launch of its Coatings Centre of Technical Excellence at its Amsterdam, Netherlands, facility. According to the company, this investment expands capacity in its existing coatings testing services for pipelines and field joints, while adding a wide range of tests for coatings for offshore and onshore assets. With this centre, Element will be able to offer full services for pipeline and marine coating clients, combining coatings testing services with its materials testing capabilities in fracture mechanics and corrosion.

The facility’s extended capabilities reportedly allow clients to test to a full range of global coatings standards—from ISO 20340 to NACE TM104-404—as well as in-demand standards and methodologies required by major oil and gas companies and their supply chain partners. Moreover, its capacity for pipeline coatings testing will include new capabilities for high-temperature cathodic disbondment (CD) tests (for temperatures greater than 100 degrees Celsius), the company stated.

The UK’s European Marine Energy Centre (EMEC), new research project on corrosion and marine coatings.

EMEC, based in Orkney, and Canada’s Fundy Ocean Research Centre for Energy (FORCE), are working with coatings manufacturer Whitford to see how coatings perform under water. According to EMEC managing director Neil Kermode, corrosion and other associated issues are a big challenge for wave and tidal energy technologies given that devices could be deployed at sea for years at a time. During discussions it was realised that the marine conditions experienced at FORCE’s test site in Nova Scotia are very different from what those seen at EMEC, in Orkney. Hence a joint study looking at issues such as marine growth, corrosion, and other environmental and technological factors, will ensure developers adopt the correct approach wherever they end up deploying their new technologies.

European Coatings Show

The Biennial ECS will be held at the Exhibition Centre Nuremberg from 4 – 6 April 2017. Manufacturers will exhibit the latest developments in raw materials and services as well as testing, measuring, laboratory and production technology.

Running semi-concurrently with the show, international experts will discuss the latest trends and challenges at the ECS Conference on 3 and 4 April. 24 sessions will explore issues like environmentally compatible formulations, UV curing, and functional paints and coatings that help prevent corrosion or microbial growth. The keynote speech in the plenary session will be given by Renaud Nicolay from the City of Paris engineering school ESPCI (École Supérieure de Physiques et de Chimie Industrielles). He will discuss how covalent bonds can be used to realise new coating properties. Ten additional pre-congress tutorials on 2 April are offered as an option to provide a practical introduction to the conference.

For more information on the European Coatings Show and Conference go to: www.european-coatings.com

Kansai Paint to acquire the Helios Coatings Group

According to Kansai, the acquisition of the Helios Group, will increase its presence across Europe and consolidate its position as one of the premier coating companies. Helios will then become Kansai’s European centre for R&D, innovation and business development. The president of Kansai Paint, Hiroshi Ishino, commented, “for Kansai Paint, Helios Group, with almost EUR 400 million turnover, represents a pillar in the very important market of Europe. We already had a strong presence in Asia, Africa and Middle East but very limited in Europe, so the purchase was made with a purpose to develop and expand the coating business in that continent.”

TO ADVERTISE IN CORROSION MANAGEMENT please contact
Jonathan Phillips or Debbie Hardwick at: Square One
+44 (0)114 273 0132
enquiries@squareone.co.uk

www.icorr.org January/February 2017 II
Standards Up-date

ISO Standards

The following final drafts of ISO standards have been submitted to the member bodies for formal approval:

**Paints and varnishes**
ISO/FDIS 16773-4 Electrochemical impedance spectroscopy (EIS) on coated and uncoated metallic specimens — Part 4: Examples of spectra of polymer-coated and uncoated specimens. (Revision of ISO 16773-4:2009)

**Corrosion of metals and alloys**
ISO/FDIS 15257 Cathodic protection — Competence levels of cathodic protection persons — Basis for a certification scheme

New International Standards published by the end of November 2016:

**Paints and varnishes**
ISO 15741:2016 Paints and varnishes — Friction-reduction coatings for the interior of on- and offshore steel pipelines for non-corrosive gases

**Corrosion of metals and alloys**
ISO 12696:2016 Cathodic protection of steel in concrete

**Ships and marine technology**

SSPC, The Society for Protective Coatings (Pittsburgh)

SSPC-Guide 22, “Use and Retention of Pre-Construction Primers on Steel in Shipbuilding,” provides specifiers and users with information regarding the use of pre-construction primers (PCPs) on structural steel in shipbuilding. The guide contains information on the reasons to use and retain PCPs, types of PCPs, their application and inspection, and the secondary surface preparation processes that are used when PCPs are retained as part of the final coating system, are given.

SSPC-PS 26.00, “Aluminum-Pigmented Epoxy Coating System Materials Standard, Performance-Based,” was developed as a resource for owners, specifiers and coating manufacturers who need to qualify aluminum-pigmented epoxy coatings by performance testing. The standard contains benchmarks and evaluation criteria for physical properties, such as mechanical stability, flexibility and package stability of the liquid coating. Moreover, it includes performance requirements for corrosion resistance properties that are evaluated using accelerated weathering tests.

The standard also allows for two types of coatings: Type I coatings intended for use over hand-cleaned steel, and Type II coatings intended for use over blast-cleaned steel, the association explains, and includes criteria for preparation of test panels used for corrosion resistance testing of each type of coating.

MACAW Engineering Ltd to use the ROSEN brand

As of 16 January, 2017, MACAW Engineering Ltd., a member of the ROSEN Group, will provide its services under the ROSEN brand. The UK contact numbers will remain the same.

MACAW and the ROSEN Group have been working together very effectively since 2006 and have built a strong relationship based on providing integrity services for industrial assets. With a common goal to provide the best possible support to operators, the decision was made to integrate all services under one brand. There will be no personnel changes, and the services will continue to be provided by the trusted experts.

Operators will still have access to an integrated worldwide team. Experts in all areas of asset integrity are available to provide everything necessary for high-quality, safe and efficient asset integrity management.

Roland Palmer-Jones, ROSEN global business line manager for integrity services, said, “Aligning all our services under one brand will simplify our customer relationships and demonstrate our commitment to making ROSEN the world’s leading specialist for ensuring the integrity of industrial assets.”
Accelerated corrosion test methods have been used for a long time to predict performance of coating systems in real applications. These methods have also been used for qualifying individual systems, and for benchmarking different systems in particular applications.

Cyclic accelerated test methods, where preferably humidity and temperature vary in a specified way during the test period, have been used for roughly 80 years. Even older are test methods which have constant temperature, humidity and in some cases continuous addition of salt spray, for instance testing in neutral salt spray (NSS). Different accelerated methods have been developed over the years depending on which branch of the industry, or company they were used, but they all struggle against a common problem; they do not show comparable results to that achieved during long field exposure.

New coating systems, including new pretreatments, have been developed for different purposes, e.g., environmental, health and/or cost, but also ease of maintenance and corrosion protection properties. When it comes to corrosion protection by paint systems, it may be that the development is connected to an accelerated method which may not correspond to realistic outdoor conditions, i.e., the correlation factor is low. This can mean that although a paint system fulfills the specified requirement based on accelerated testing, it can fail quickly under real conditions.

This article describes results from accelerated corrosion testing of paint systems, including pretreatments, compared to field testing for 18, 30 and 43 months in a marine atmosphere. Most of the paint systems and pretreatments tested are classified as relatively new, and more or less “environmentally friendly”, but more traditional systems were also studied. In total, 48 different combinations of steel, pretreatments and paint systems were tested, including wet and powder paints from five international suppliers, and passivating chemicals from three different suppliers. Traditional grit blasting was also included in the test matrix, and in some cases in combination with passivating layers.

The accelerated test methods used in this study (all including chloride addition) were:

- ISO 11997-2; Cycling including UV/condensation, salt spray as well as freezing. Test period 12 weeks. This method (called “ISONEW”) is intended to be used for qualification of paint systems on offshore steel constructions.
- Volvo STD: 423-014; VICIT (Volvo Indoor Corrosion Testing); cycling between two humidity levels at a constant temperature with addition of acidified salt solution twice a week. Test period 6 weeks. This method (“VICIT”) was selected as it had been used for a long time within Volvo and their contractors, in order to qualify paint systems and other surface treatment systems for cars and car components.
ISO 11474; SCAB testing; natural outdoor cycling conditions with addition of salt solution once a week (semi acceleration). Test period 2 years, test rig ca 10 km from the Swedish west coast (Gothenburg). This method (“SCAB”) was selected as it is often used in Sweden to semi accelerate and simulate marine environments.

The purpose of adding salt solution/spray was to simulate the marine environment and also generally increase the rate of corrosion.

The Project
In 2007, a joint project group in Sweden, led by Swerea KIMAB and Swerea IVF, started a project titled Heavy corrosion protection. The main aim was to study the correlation between three standardized accelerated corrosion test methods and long-term field exposure testing in marine atmosphere of different coatings. Furthermore, the project group wanted to find out the correlation between short and long field testing times. A further aim was to see if chemical pretreatment can make the total coating system more robust.

Sample preparation, testing and evaluation
Cold and hot rolled steel sheets (100 x 150 x 3 mm, from the same batch) with specified coating systems, were used in the study. As pretreatment, five different passivation systems (all free from phosphates, chromium and heavy metals), or grit blasting, were used, including in some cases blasting in combination with passivation, and in one case zinc/manganese phosphating. The passivation chemicals were based on zirconium (one supplier) or silane (two types from each of the suppliers).

In the test matrix, paint systems with 1, 2 and 3 layers, excluding the potential passivation layer, were tested. These included powder coatings, waterborne paints as well as solvent borne paints with low VOC (Volatile Organic Compounds) identified as HS (high solid) systems, and in a few cases, more traditional solvent borne paints, were used as a part of the paint system.

A typical 3 layer solvent borne system used for bridges in a corrosivity class C4 environment was used as a reference system – a zinc rich epoxy primer, micaceous iron oxide pigmented epoxy intermediate layer and an aliphatic PUR topcoat.

All test panels were degreased with an alkaline solution and dried before pretreatment according to the test matrix. Degreasing, pretreatment and painting were performed by Swerea IVF in Gothenburg. In total 3 panels for each type of exposure environment and coating system were produced. After painting, the back and the edges of the panels were protected with epoxy mastic.

The coated test panels were conditioned for at least 1 month after painting and before corrosion testing, a 1 mm wide scribe down to the steel substrate was made using a scratch machine, in order to avoid residues of (zinc) primer on the blasted surfaces, which could lead to the risk of undesired anodic corrosion (figure 1).

Results from field testing and accelerated corrosion testing
The average corrosion values measured/calculated from the 3 panels of each system, after 43 months of field exposure testing (k 43), are given in detail in Table 1 which is published in the on-line version of the article, http://www.icorr.org/news. The ranking of the coating systems in the field testing (k 43), are given in detail in Table 1 which is published in the on-line version of the article, http://www.icorr.org/news. The ranking of the coating systems in the field testing at 18 and 30 months exposure, are also given in the table (r18 and r30, respectively), as are the results from the three different accelerated tests, M_sn, M_scab and M_scab according to above calculations and abbreviations given at the start of the article.

From this investigation it is quite clear, and not surprising, that coating systems which perform best after 43 months are those with 3 layers, i.e. with a zinc rich epoxy primer, an epoxy intermediate layer and a PUR or polysiloxane top layer (see systems 23, 19B, 20, 13 and 19A) and with a total thickness of between 140-300 µm. None of these five systems showed any defects in the coating, except in the region of the intentionally made scribe. One of these top five systems is the reference system which is regularly used for painting of bridges (no. 13).
It is worth mentioning that system 4 (blasted hot-rolled steel), ranked as number 6, had only two layers (epoxy primer and PUR topcoat), but had a silane treatment after blasting, showed no defects other than those at the intentionally made scribe, on the three tested panels.

None of the systems on cold rolled steel with either a silane or zirconium passivation treatment, and coating systems based on 1 or 2 layers of powder or waterborne paint, or a 1-coat high solid solvent borne paint, showed good results.

When trying to decide whether an extra passivation step contributes to better corrosion resistance on blasted hot rolled steel or not, three cases were compared:

■ In the first case, blast cleaned hot-rolled steel with silane passivation and a mixed powder coating (2B) was compared to the same system but without the silane treatment (system 6) from the same supplier. The results showed that in this case, the silane passivation treatment lead to reduced corrosion, both in field testing and in all three accelerated environments.

■ However, in the second case, when comparing the influence of silane treatment under 1 layer PE powder coated samples (system 1B to 7B), much more corrosion occurred with the silane treated samples than for the untreated ones. Two of the accelerated methods (ISONEW and SCAB) also showed somewhat better results for the panels with zirconium treatment, but not in the VICT testing.

■ In the third case, comparing the influence of zirconium treatment on 2 layer coated panels with waterborne paints (system 3E to 7B), the field testing showed better results for the zirconium treated samples than for the untreated ones. Comparing silane and zirconium treatments on cold rolled steel, in one case, under a waterborne 2 layer system from supplier 3 (system 11 A to 11C), and in the other, under a 1 layer PUR system from supplier 1 (system 15B to 25), both gave similar results, i.e. no difference between zirconium and silane treatment with respect to corrosion protection. Panels with waterborne 2 layer systems, or with a waterborne primer and a solvent borne topcoat panels 3B-E, 7A, 17A-B), as well as panels with one layer of a high solid solvent borne paint (panels 14A-E), showed filiform corrosion – figure 3.

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Correlation between longer and shorter exposure times in field testing

The correlations between long and short term exposures in field testing at Bohus Malmön of the different coating systems are shown in figures 4 and 5.

For a good correlation, the coefficient, \( r \), according to Pearson, should be close to +1. For example, if all the points in figures 4 and 5 fell on the line, the correlation would be exactly +1. The summation of the deviation of the points from the line is often calculated as \( R^2 \), and the square root of it is Pearson’s correlation coefficient, \( r \) (the nearer to +1, the better the correlation). Figure 4 shows a strong correlation between 18 months and 43 months. Figure 5 shows an even better correlation for 30 months - the Pearson coefficient is 0.914 compared to 0.873 after 18 months. This was the expected result.

System 26R (ranked as no. 17), a 3 layer system with zinc primer, epoxy intermediate and PUR topcoat, is an evident outlier in the first case, blast cleaned hot-rolled steel with silane passivation and a mixed powder coating (2B) was compared to the same system but without the silane treatment (system 6) from the same supplier. The results showed that in this case, the silane passivation treatment lead to reduced corrosion, both in field testing and in all three accelerated environments.

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Correlation between field testing and accelerated testing

Comparing results from field testing to results from the three accelerated tests, the correlation is much weaker than the correlation described above, as shown in Fig 6, where the correlation between field testing after 43 months and accelerated testing according to ISO 11997-2 is described. There have also been other investigations carried out which confirm this weak correlation between accelerated testing and field testing (offshore).2,3

This weak correlation (\( r=0.568 \)) between field testing for 43 months and ISO 11997-2 is in line with an earlier study performed by Sverrea, where other accelerated corrosion testing methods were compared to field testing after 105 months1. Also in that investigation, short term exposure in field testing (19 months) gave a relatively strong correlation to long term exposure (105 months) in the same environment. However, a better correlation with field testing after 43 months
The best accelerated method tested in this study to predict real corrosion performance in marine environment. The best method currently to predict corrosion performance is to perform field testing for a relatively short time, say 18 months, which gives a good correlation with longer term performance. It is still a challenge to design an accelerated test method that can accurately simulate corrosion and the degradation processes that occur in field exposure, therefore it is difficult to rank the coating system performance based only on accelerated testing.

However, a possible method could be to use the accelerated VICT and SCAB tests, to compare new coating systems with a reference as a screening tool, and if the new system has similar or better results compared to the reference sample in these two accelerated tests together, it can be classified as "promising" and be qualified for further testing in short term field tests. If the new system is much worse than the reference sample in VICT and SCAB testing, it will have a high probability of poor performance in field testing.

As mentioned above, and as expected, three layer paint systems with a zinc rich primer, an intermediate epoxy layer and a top coating of PUR or polysiloxane coating, were confirmed as the best with respect to corrosion resistance. Also in the top five systems there were three systems with waterborne zinc rich epoxies.

When it comes to passivation of the surface with zirconium or silane based treatments, the results vary. A passivation treatment does not always seem to improve the corrosion resistance with blasted hot rolled surfaces, and regarding the influence of zirconium or silane treatments on corrosion protection on cold rolled steel, no difference between the passivation methods was seen.

**References**


**Acknowledgements**

The project was mainly financed by VINNOVA (the Innovation Agency of Sweden), with part financed by one of the member research consortia (MRC) within Swerea KIMAB.

The authors would like to thank Patrik Reuterswärd, CPA Consult (earlier at Swerea KIMAB), Arne Finman, Finman Färgkonsult AB and Lars Osterberg (both earlier at Swerea IVF) for initiating and doing most of this study with respect to preparing samples and evaluations.

The authors also thank the suppliers of chemicals and paints; Beckers (Sherwin Williams), Candor, Chemetall, Dupont, FreiLacke, Henkel, Jotun and Tikkurila. SSAB is thanked for their contribution of hot and cold rolled steel sheets.

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Measuring Sodium Chloride, Salt and Soluble Contaminants - Part 1

By Frankhuizen, TQC, The Netherlands

Everyone in the coating industry knows that salt contamination underneath a coating can cause serious problems in future years. This is due to the hygroscopic nature of salt. The tendency to attract water in combination with the permeability of a coating, creates an accumulation of water molecules between the substrate and coating. The presence of these water molecules together with the entrapment and migration of oxidation agents, in conjunction with the salt molecules present, are ideal to create an electrochemical shift, causing corrosion. Blasting or mechanical cleaning will not remove these salt molecules completely and often causes salt inclusion into the substrate, making the situation even worse. Washing the surface with deionized water is the most used solution. A substrate free of soluble salts is critical in today’s protective coating work and is an issue in each professional paint specification, which nowadays can include limits for soluble salts. For example some regulations set the maximum concentration of soluble salts, measured as sodium chloride, on a surface to 20 mg/m².

This 2-part article deals with the issue of analyses of surface contaminates using presently available techniques. The amount of variation in analyses, and more importantly, statements of the results, can cause serious problems. The first part will cover the chemistry of salts and their occurrence, together with some of the common errors made in their measurement.

<table>
<thead>
<tr>
<th>MAXIMUM SOLUBLE SALT CONCENTRATIONS MEASURED AS SODIUM CHLORIDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany: &lt; 16 mg/m²</td>
</tr>
<tr>
<td>Sweden: &lt; 20 mg/m²</td>
</tr>
<tr>
<td>USA: &lt; 50 mg/m²</td>
</tr>
<tr>
<td>Norsok: &lt; 20 mg/m²</td>
</tr>
<tr>
<td>SSPC &lt; 70 mg/m²</td>
</tr>
<tr>
<td>Australia: &lt; 50 mg/m²</td>
</tr>
</tbody>
</table>

Table 1: example maximum salt concentration in various countries. Source: diverse standards and specifications. The values may vary by contract.

company commonly referred to mixed salts, which are related to the sodium chloride value by a factor 0.83.

The principle of a Bresle test

One of the most common field tests for measuring soluble salts is the Bresle test, which is covered in ISO 8502-6 [1]. When performing the Bresle soluble salt test, water is injected into a patch placed on the surface. This injected water dissolves the salt present. The solubility in water depends on the type of salt. Common salt, also called sodium chloride, can be dissolved in cold water to a concentration of 357 g/l. Not only solubility differs between salts, but also their conductivity. Thus, when taking a measurement, not only common salt is dissolved, but also all other salts present on the surface. This mixture of salts is eventually measured with a conductivity meter or by other means.

Misunderstanding of what is actually measured

Because it is impossible to predict which salts are present at the surface, an assumption is made in the Bresle method. The term “measured as sodium chloride” indicates that this mixture of salts is interpreted as being only sodium chloride. Clearly indicating how the conductivity is interpreted is
essential when producing a report. At present there are several interpretations in use. Some speak about sodium chloride, others mention mixed salts or just chlorides, and each has a different calculation factor.

**Salt, sodium chloride and soluble contaminants.**

Our vocabulary is full of words that have a double meaning. If you ask people what salt is, they virtually always reply by referring to the stuff put on their French fries. If you ask what sodium chloride is, they say that it is salt. This statement is true, however, the other way around it is not. Think of it as follows; a cow is an animal, however an animal does not have to be a cow. The same is true for sodium chloride (common salt). Sodium chloride is a salt; however salt does not have to be sodium chloride. Here the wide meaning of the word salt starts to cause a problem. The chemical meaning of the word salt is a lot wider than that of the common word. Salt is a neutral product formed by a reaction between acids and bases. This reaction product is an ionic compound. This means that when the product is dissolved in water it splits into an anion (negatively charged particle) and a cation (positively charged particle). Both the anion and cation can be inorganic or organic as well as mono- or polyatomic (one or multiple atoms combined). This breaking down into a cation and anion produces an electrolyte in water. Only the products that dissolve in water and not those that disperse, will create this electrolyte. Within an aqueous solution, sodium chloride is no longer present as such; it has split into sodium and chloride ions. This also indicates that it is not possible to have just chloride ions on a surface.

**Solubility**

The nominal volume in the test chamber of the original Bresle patch is 2.5 cm³. Considering this volume, and solubility of salt, it is possible to dissolve 892.5 mg of common salt in the patch. This correlates to 7.29 x10⁵ mg/m² sodium chloride. Comparing this to the IMO specification of 20 mg/m², there is a factor of approximately 36000 between these concentrations. Thus the solubility of salt is not an issue when conducting the test. A level of 20 mg/m² sodium chloride relates actually to only 0.025 mg sodium chloride in the patch. Even salts that are harder to dissolve will be present in such concentrations that should not provide any solubility problems.

Not all salts are equally soluble in water. Whereas sodium chloride can be dissolved to 357 g/l, its chemical brother silver chloride can only be dissolved to give 0.00089 g/l. This is stated as the solubility product $K_{sp}$. At these concentrations the solution is saturated, and equilibrium is reached between dissolved and non-dissolved species. A dissolved salt produces ions and forms an electrolyte. The non-dissolved salt doesn't produce ions and doesn't produce an electrolyte, thus there is no significant increase in conductivity.

To determine if a salt is soluble there is a simple chemical rule. In chemistry, a concentration in milligrams per litre is not important. This due to the difference in weights between different molecules - it is the number of molecules that is of interest to a chemist. A chemist looks at a concentration in Moles per litre. The term Mole is the unit of measurement for amount of substance, and can be simply defined as the amount of a chemical substance that contains as many atoms as there are atoms in 12 grams of carbon-12. In chemistry the solubility is described by three groups:

- A salt is soluble if it dissolves in water to give a solution with a concentration of at least 0.1 Moles per litre at room temperature. A salt in air would not be considered soluble if the concentration of the solution is less than 0.001 Moles per litre at room temperature, and slightly soluble salts give solutions that fall between these extremes. (When taking a conductivity reading of the solution acquired with the Bresle method, all dissolved salts are measured, even the very small dissolved portion of the insoluble salts).

- This electrolyte is what can be measured by a conductivity meter. The higher the concentration, the higher the conductivity. The conductivity of an electrolyte not only changes with concentration, but also varies with the ions present. The same concentrations of sodium chloride or potassium chloride both produce an electrolyte, but with a different electrical conductivity. Conductivity is thus quantitatively and qualitatively dependent. Temperature and pressure also influence the measurement. The higher the temperature in a solution, the higher the conductivity, and modern conductivity gauges compensate for this temperature influence.

The method of measuring the conductivity of an electrolyte is not the same as for a copper wire. Conductivity is measured by passing an alternating current between two plates (electrodes) set at a defined distance from each other. Between these plates the ions in the electrolyte conduct the current back and forward. The size and distance between the plates determines the cell constant, which is also a factor that is adjusted during calibration of the meter.

**What can be measured?**

Chemically every element can be measured, from hydrogen (atomic number 1) to organesson (118). However it makes no sense to measure all elements, as not all elements are present in nature in such abundant amounts that they can cause problems. When looking at a table of elements in sea water, the top two elements are oxygen and hydrogen - the chemical building blocks of water. The third most common element is chlorine, followed by sodium. However the composition and concentration of elements in sea water varies by location, as can be seen in table 2:

- All elements can form an almost endless combination of possible salts. Clearly specifying all the salts present in sea water is more a study in advanced mathematics then common sense. The salts that are formed by these ions on surfaces however are more relevant. Though table 2 shows the salts present in seawater which comprise a significant part of the surface contamination, industrial influences and pollution affect the final deposition and can give quite different surface concentrations.

**Methods**

To analyze the surface concentration of salts there are multiple analytical options. Both non-specific or specific methods can be used. The range of possible detection technologies and measurement kits available can be dazzling, but many methods are unfortunately not as robust as we sometimes hope. Conductivity for example measures everything that forms an electrolyte. One would imagine that a switch to an ion-selective method would then be admirable, unfortunately these methods have their own quirks. The proper selection of a suitable test method is often not defined by its possibilities, but by looking at its impossibilities.

The following sections discuss a variety of the available methods that are, and could be deemed, suitable for field analysis of soluble salts.

**Conductivity**

Conductivity is a non-specific measurement method; it detects all soluble salts, in all different varieties. The salt mixture that is found in the measurement cell usually is not made up of one type of salt. This multi-ion electrolyte requires
Concentrations given in mg/l (source: Stephanie Enzler, Lenntech). Table 2: Major Ionic compounds in seawater at various locations.

<table>
<thead>
<tr>
<th></th>
<th>TYPICAL SEAWATER</th>
<th>EASTERN MEDITERRANEAN</th>
<th>ARABIAN GULF AT KUWAIT</th>
<th>RED SEA AT JEDDAH</th>
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</thead>
<tbody>
<tr>
<td>Cl-</td>
<td>18.980</td>
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<tr>
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<td>11.800</td>
<td>15.850</td>
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<td>SO₄²⁻</td>
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<td>BO₃³⁻</td>
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<tr>
<td>F⁻</td>
<td>1</td>
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<td>SiO₂⁻</td>
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<tr>
<td>I⁻</td>
<td>&lt;1</td>
<td>2</td>
<td>-</td>
<td>-</td>
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<tr>
<td>TDS</td>
<td>34.483</td>
<td>38.600</td>
<td>45.000</td>
<td>41.000</td>
</tr>
</tbody>
</table>

Table 2: Major Ionic compounds in seawater at various locations. Concentrations given in mg/l (source: Stephanie Enzler, Lenntech, www.lenntech.com).

an interpretation when the conductivity has to be reported as a concentration. The interpretation of this is one of the biggest misunderstandings when quoting results. The results according to ISO 8502-2 [1] and ISO 8502-9 [2] have to be reported as mg/m² soluble salts measured as sodium chloride. The statement “measured as sodium chloride” means that not only sodium chloride is measured, but also all other dissolved salts. To have a traceable result, an easy reference salt has to be selected. Sodium chloride can be thought of chemically as a reference salt. Not only due to its solubility, but also the fact that it is the biggest cause of problems and has the highest concentration, that makes it the ideal salt to report. As stated before, there are multiple interpretations in use with the most common being the reference to sodium chloride. Others are mixed salts and chloride, thus with the Bresle method we have the respective correlation factors 6, 5 and 3.6. When expressing the conductivity, for a 15 cm² sample, then, for sodium chloride, 1 µS/cm equates to 6 mg/m², expressing as mixed salts, then 1 µS/cm equates to 5 mg/m² and for the industry fantasized possibility of having only chloride ions present, then 1 µS/cm equals 3.6 mg/m². Even when test methods are specified, it would still be very helpful if all involved parties state the salt concentration the correct way. Not stating the answer with the right interpretation can cause serious differences in the final result. If the specifications are for chloride, and the measurement is made as sodium chloride, there is a significant difference that can lead to increased costs due to unnecessary cleaning.

**Dilution**

Contrary to solubility, dilution is a major cause for possible errors. In order to make it possible to measure the soluble salts with an electronic conductivity meter, a 15 ml. sample volume is normally required to fully submerge the instrument's probe. Since the actual volume of sample liquid in the Bresle patch is only 2.5 ml, it must be diluted to 15 ml, which means that the final measured result has to be multiplied by a factor 6 to get the true value. Any errors that were made during any stages of the test will be multiplied by a factor 6 as well.

**Effect of dilution on the test results**

On average a residue of 0.15 ml of the liquid remains in the patch after removing the sample for testing. This, and the inaccurancy and improper use of syringes, are some of the causes for errors, however diluting the sample liquid in a separate 15ml plastic cup in the field, causes the majority of the problems. Good analytical practice shows that the number of steps required to obtain a final test result has to be limited as much as possible. Dilution to 15ml was required in the past not only to create sufficient quantity of sample solution to submerge the conductivity probe, but to prevent extreme static disturbance from the plastic measuring beaker. This disturbance is caused by the “insulation” due to the use of a plastic cup. This disturbance is easiest explained as the echo of the measuring signal. Usually, in analytical laboratories, measurements are always carried out in glass apparatus and at a volume preferably greater than 100ml. All conductivity gauges on the market are influenced by this static disturbance, which can lead to a difference of up to 5 µS/cm per conductivity measurement. Diluting the sample liquid by a factor 6 implies automatically that the test result has to be multiplied by a factor 6 as well. In practice this means that each deviation or error will be multiplied by 6. The 5 µS/cm mentioned above could end-up in a 30 µg/m² error! However, new techniques make it possible to measure in smaller samples using the Direct Sample Procedure or DSP, and this will be discussed in part two of this article.

**Gauge accuracy**

Looking at results obtained, the need for a higher accuracy proved to be an important issue. The accuracy can be increased in two ways. Firstly by taking a closer look at the gauge. Previously available handheld or mobile conductivity gauges had a resolution of 1 µS/cm, with an accuracy of 1 µS/cm. Calculation according to ISO 8502-2 and ISO 8502-9 means that the final result has a resolution of 6 mg/m², with also an inaccuracy of 6 mg/m². Therefore, when a measurement result is 18 mg/m² soluble salts, measured as sodium chloride, the actual value fluctuates between 12 and 24 mg/m². This is a 50% chance that the actual soluble salt concentration is above the IMO limit of 20 mg/m². Increasing the gauge’s resolution to 0.1 µS/cm contributes to a higher accuracy when determining the soluble salt concentration. This however is only one part of the analysis.

Besides gauge resolution, dilution also influences the measurement. The 0.15 ml of residue remaining in the patch causes an error up to 5% in the 15ml diluted solution. When this dilution is not handled as the measurement is made directly on the pure solution from the patch, the 0.15ml residue will not affect the final result. New gauges can measure in 2 ml solution with a resolution of 0.1 µS/cm. When measuring in a volume of 2.5ml, the same as the nominal volume of the patch, there is no need for a calculation factor of 6. The concentration of soluble salts measured as sodium chloride is then equal to the conductivity in µS/cm. This not only makes the determination easier but also more reliable. Results can now be given with a 1 mg/m² uncertainty and resolution of 0.1 mg/m², increasing the accuracy 60 fold.
Corrosion caused by salt contamination.

**The impact of the method**

The stakes are high when looking at surface cleanliness, but most specifications never state how the result should be reported. Just stating according to ISO 5802-6 and -9 isn’t sufficient. Different test kits have different correction factors, carefully reading the test kit’s manual is essential. Even making a small change in used volumes or patches, without correcting the factor, can turn entire measurements useless.

The acquired results of any soluble salt measurement have to be clearly formulated to indicate what, and how, they are measured and calculated. When the concentration is given as mg per square metre soluble salts, measured as sodium chloride, it does not imply that there actually is this amount of sodium chloride present, the actual concentration is lower than the measured concentration, due to the fact that there are also other salts present that are interpreted as sodium chloride. The same is true for the two other commonly used interpretations. None say what exactly is at the surface, but state what would be present when assuming only sodium chloride is present. This assumption is what makes the Bresle method so usable. Sodium chloride is the same worldwide, the difference is with the salt mixture deposited on each surface. Interpreting the result as one type of salt gives a reproducible method. One must consider the fact that it is the presence of a soluble salt that creates the possibility to form an electrolyte, which in turn causes corrosion. Non-soluble salts are not a significant factor in the formation of corrosion.

As noted above, other sampling and test methodologies are available, including the following:

**Direct Sampling Procedure**

The new Direct Sample Procedure eliminates the use of the 15ml measurement solution. At present, only one test kit/measuring instrument is available on the market as other instruments don’t have a suitable measuring cell or the required resolution. Measurements can now be made directly on the solution that is extracted from the patch, which not only increases efficiency, but also eliminates the most error sensitive part of the old procedure. To achieve this there is only 2.5 ml of deionized water injected in the patch. This also reduces the calculation factor to 1. The reading from the gauge therefore doesn’t have to be multiplied anymore to get the soluble salt measured as sodium chloride concentration in mg/m². Due to the measurement in the gauge’s own measuring cell all static disturbances are also eliminated, increasing the reliability of the analyses even further.
Quality materials

There is a large difference between the soluble salt tests kits on the market. Not only the gauge, but also the patches differ in shape and quality. A test patch should be as clean as possible. Any salts that remain on the patch during its production process influence the test significantly. The original Bresle patch is square and some of the alternatively shaped patches which can be found in the market, contribute significantly to the final measurement. During tests these patches could contribute on average, 0.7 mg/m² soluble salts, measured as sodium chloride, per patch. High quality patches such as the latex membrane square patches don’t contain any salt residue. These patches pass multiple wash cycles in a clean room-quality production plant to ensure that no contaminants are present.

The ISO 8502-6 standard states in annex A, that only certified patches may be used. This annex describes a stress test to ensure patch adhesion and wash ability. Relative to the nominal volume of the patch it has to be injected with an excess of water. Time to leakage has to be determined and eight out of twelve patches must pass in order for the type of patch to be approved. An accredited laboratory must carry out this test and the producer must be able to provide a certificate of the test. The high quality patches in the market have passed these tests. Most of the non-square patches can fail this test, as only one third of the required volume can be injected into the patch before leakage starts. When measurements are taken during arbitration using non-certified patches, all acquired values will be useless. Only certified patches may be used. Some patches also face problems with poor and irreproducible adhesion giving irregular the test surfaces. Often 20% extra surface area is exposed due to the fact the water creeps under the edges of the patch. This value is not corrected for, and causes even bigger errors in the final result. All errors caused by using inferior patches lead to higher results, which added together usually generate a significant higher and erroneous result.

Alternatives to the common

Besides the conductivity measurement stated in ISO 8502-6 and -9, there are several other conductivity-based methods available in the industry. These methods are often known under their model or brand names. As these analyses are all based on conductivity and should, if the combination of extraction method and analysis are matched, result in the same values as the Bresle method.

The second part of this article dealing with the alternative methods of soluble salt sampling and testing will be published in the March/April issue of this magazine.

References

Correct surface preparation is important for long term asset protection as it is often the process which governs the service life of the coating system. Inspections have revealed that more than 75 per cent of coating failures are due to poor or incorrect surface preparation [1]. Abrasive blasting is the most common surface preparation method used but its adoption needs to be considered against emerging data, that may tip the scales in favour of alternative surface preparation methods in an increasing number of projects. The most appropriate surface preparation method in a given situation is that which achieves the balance between quality, protection, performance, and the time and cost needed to achieve them. External factors such as coating material requirements can affect this balance, thus affecting the choice of the ideal surface preparation method in each scenario.

Abrasive blasting has been able to deliver a good balance, especially in shop fabrication scenarios, however in other scenarios, the balance is more complex and additional variables need to be considered in making such judgements, including containment, ambient control, transportation and disposal of residue resulting from the blasting, together with the impact in concurrent works at the job site.

UHP water jetting has been used for the surface preparation of steel for more than three decades now, although its use has been almost entirely limited to maintenance or refurbishment situations, when the substrate is aged, coated carbon steel. Progress has been made in UHP equipment, with higher pressures, better hand held and robotic tools and reliability, and also on a better understanding of the factor governing success.

The potential advantages of UHP use include:

- More effective soluble salt removal from the surface, and the capacity to clean deep into the profile or pits is enhanced and existing profile is kept untouched. These factors were detailed as early as 2002 by Quintela et al [2]. Figures 1 and 2 give further details.
- Operation does not conflict with other site operations
- Lower environmental impact: no abrasive and contaminated abrasive waste to be dispose off, easier effluent control.

Given the technical limitations of UHP water jetting as surface preparation technique, any coating material to be used in conjunction with it must be tolerant to damp surfaces and to flash rust, at least to an acceptable level, and is not limited by dew point. They should also be tolerant to low surface profile (have good adhesion even when steel surface is smoother than the usual 50 – 75 microns requirement for high performance coatings).

Humidity and surface tolerant epoxy technology matching the above requirements has been available for around two decades and was adopted by the marine industry, including the US Navy and Petrobras in the second half of the 90’s [2] [3]. It has also been used in the maintenance of infrastructure, for example on bridges owned by the French railways, where the UHP water jetting/surface tolerant epoxy technology was also tested over both dry and wet surfaces, with similar results after salt fog 700h (ISO 9227, for C3 qualification according to ISO 12944) and pull-off adhesion around 10 MPa[4].

Despite the advantages of UHP water jetting, and coatings available which have all the necessary features, the use of this combined system has been low. The ultimate obstacle to UHP water jetting adoption is commonly the mind set of specifiers, driven by negative perceptions caused by past mistakes, when UHP water jetting was used without adequate coating selection being taken into consideration. To change the perception that a coating solution for high durability using UHP water jetting cannot demonstrate a successful long track record in harsh conditions, a trial was carried out.

The Luis I bridge, in Oporto, Portugal, is a XIX century national monument, and was coated with lead paint, and overcoated for over a century in consecutive maintenance campaigns. In 2003/2004, this bridge was fully UHP water jetted to bare metal. The agreed cleanliness grade was WJ2 according to SSPC SP12 (broadly equivalent to ISO 8501-4 standard, Wa 2 ½) with medium flash rust grade as a limit before application of the first coat. The coating system comprised two coats of a humidity and surface tolerant epoxy material, followed by

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**Figure 1** - UHP water jetting provides the best soluble salts removal performance among surface preparation options (data based in live projects exposed to marine atmosphere).

**Figure 2** - UHP water jetted surface without salts and conserving the original profile. The blue circles show clean pits.

**Figure 3** - the Luis I bridge in Oporto Portugal.
a polyurethane top coat for a total dry film thickness of 350 microns. The UHP waste water was collected and recycled to feed the UHP pumps. A 35% overall cost reduction was obtained compared to abrasive blasting, driven solely by the reduced waste disposal bill. 13 years on, the bridge is still in pristine condition (CSM environment, over the Douro river and near the Atlantic Ocean coast).

This project has shown that one of the main technical barriers to the adoption of UHP as surface preparation method, over aged (and new steel), can be removed with the help of proper coating technology selection. The combined technologies can also offer significant savings in time and manpower, and the cost of waste disposal, compared to abrasive blasting and conventional coatings.

References
3. C.A. Reis, “The PSPC from an Owner’s Point of View”, Journal of Protective Coatings and Linings, November 2010
4. SNCF, Rapport Agencie d’Essai Ferroviaire (AEF-L R01284/01, L-40) “Caracteristiques d’un system de peitures specifiques UHP – Applicable apres preparation de surfaces a l’eau sous pression"
New Polyurethane Coating

AkzoNobel has launched an elastomeric polyurethane designed to protect both steel and concrete. Polibrid 705E is an odorless, zero-VOC, two-component polyurethane that the company recommends for use in potable water, wastewater and some chemical applications.

New Soluble Salt Tester

DFT Instruments have announced the availability of the new PosiTector® SST Soluble Salt Tester by DeFelsko for measuring the concentration of soluble salts on metal surfaces.

According to the company, the important features of the instrument are, an intuitive step-by-step interface which guides users through the Bresle method, automatic calculation of surface density of salt, conforms to international standards, and can be used as a conventional conductivity meter.

Advances in Testing in the Corrosion Protection Market

Fischer Instrumentation (GB)Ltd, part of the Helmut Fischer Group, has a long standing reputation for high precision and accuracy in coating thickness measurement and materials analysis that has largely been associated with the QA laboratory or end of line production quality testing. However, Fischer have been developing its range of products to suit the corrosion market and the tough and demanding environments associated with corrosion protection.

Instruments to measure thermally sprayed aluminum (TSA) coatings, or measure both layers of paint on zinc or iron, are now available. Thick film intumescent coatings or FFP coatings can be measured with high accuracy and repeatability, as well as new probes to measure surface profile. This is in addition to the range of coating thickness gauges which are continually developed for robustness and reliability to suit this demanding market. All instruments are supplied with certified and traceable standards to assure accuracy and give peace of mind. SSPC modes are also available on relevant models to streamline measurement in this field.

For more information see, www.fischergb.co.uk

Improved Corrosion Inhibiting Coating

Cortec has launched an improved version of the VpCI®-368 coating, containing extra vapour phase corrosion inhibitors. According to the company, the original coating has a track record of use in mothballing and layup of equipment, protection of shipments, and preservation of spares, and the new VpCI®-368 EVP (Extra Vapor Protection) is also suitable for application in complex, sealed spaces where a greater concentration of inhibitor would be useful. The extra loading for application in complex, sealed spaces where a greater concentration of inhibitor would be useful. The extra loading of inhibitor vaporizes from the coating, fills the enclosed space, and adsorbs on difficult-to-reach surfaces, which is beneficial for applications such as pipe internals where it is challenging to cover all the metal substrate thoroughly.

The dark brown viscous liquid dries into a firm moisture-displacing wax-like film that can be removed by mineral spirits or alkaline cleaners. The coating is flexible, can be applied by brush or spray, offers excellent outdoor protection, and is much easier to handle and remove than traditional wax-based coatings. It is UV resistant and passes 800-1500 hours of ASTM B-117 salt spray testing applied at 2-3 mils on carbon steel, concluded the company.
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BRANCH DATES

Tuesday 28th February
Aberdeen Branch Meeting
Topic: Monitoring High Temperature Corrosion Attack: correlation between Crude Corrosiveness and results from on-line Corrosion Monitoring.
Speaker: Ruth Wardman
Venue: Palm Court Hotel, 81 Seafield Rd, Aberdeen AB15 7YX
Event starts at 18.00; presentation starts at 18.30

Thursday 9th March 2017
London Branch Meeting
Topic: Presidents talk and Branch AGM – see website for more details
Speaker: Sarah Vasey
Venue: Skempton Building, Imperial College, London, SW7 2BB

Tuesday 28th March 2017
Aberdeen Branch Meeting
Industrial visit – Cosasco HQ – Latest Advances in Real-Time Monitoring and Safe Retrieval Cosasco, Bridge of Don, Aberdeen. Details to be advised. Event starts at 18.00

Thursday 6th April 2017
London Branch Meeting - Joint with NACE
Details to follow
Venue: Skempton Building, Imperial College, London, SW7 2BB

Tuesday 25th April 2017
Aberdeen Branch Meeting
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Tuesday 30th May 2017
Aberdeen Branch Meeting
Venue: Palm Court Hotel, 81 Seafield Rd, Aberdeen AB15 7YX

ADDITIONAL DIARY DATES

Thursday 27th April 2017
Corrosion Engineering Division Working Day
‘Corrosion Engineering and Concrete’
A combination of invited talks, CED working group meetings, a laboratory visit to Sheffield Hallam University and presentation of inaugural Paul McIntyre award.
Venue: Institution of Mechanical Engineers Engineering Training Centre, Sheffield Business Park.

Monday 8th - Friday 12th May
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