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My first order of business for this article is to welcome Brian Goldie as Consulting Editor for Corrosion Management. I expect that you will notice the work that Brian has started in both the content and style of the magazine, as additional space has been liberated by re-styling the sustaining membership list, and dropping the ICATS registered companies. Brian with his experience in corrosion prevention and in editing coatings magazines will bring a new group of contacts to Corrosion Management and we will need the extra space for this interesting content. This July/August issue will be the first that Brian will edit and I hope that you can see some of the innovations Brian will bring to the magazine over the next several issues.

It should be pointed out that Square One will continue to produce and publish Corrosion Management and I can report that they are enthusiastic about the plans that Brian has put forward for the changes to the magazine.

The move to the new ICorr office is going well, and the new address according to Google Maps is only 0.6 miles from our current office. The new office is on the second floor of Barrett House, which is a former shoe factory on Kingsthorpe Road. The office space has been refurbished since it was vacated by the previous tenant and it includes our own meeting room. The wiring and computer cables have been installed and all that remains to make the new office habitable is the telephone lines and broadband connection that BT is to provide. The agreement for the office allows us to move in any time after 1st July and we hope to be up-and-running by 5th September. A more formal announcement of the move, and the new postal address and telephone number, will be made in the magazine and on the website, once we are established there.

You will all have received your subscription renewals by the time this is published and I urge you to take action to renew your subscription as soon as possible. Without your continued support the Institute cannot continue to work to help manage and mitigate corrosion in all its forms.

John Fletcher
President of the Institute of Corrosion

The purpose of the Corrosion Engineering Division is to provide an informal forum for the exchange of ideas and information pertaining to Corrosion Engineering issues, including providing a mechanism for members to jointly prepare documents that are of immediate and practical use to them in their field of activity (e.g. codes of practice, guidelines for processes and techniques, input to standards bodies, etc.), and is a means of liaising with working parties of international organisations (e.g. EFC, NACE).

Following the successful CED working day held at the National Motorcycle Museum, Birmingham in April, on the subject of “Microbial Corrosion Issues in Heating and Cooling Systems” organised jointly with the International Biodeterioration and Biodegradation Society, the next meeting is expected to be held in April 2017 in the Sheffield area on a theme related to corrosion in concrete.

The Coatings Working Group will hold a meeting on 15th November, at BAM Nuttall Ltd, Halesowen, W. Midlands, with a presentation on “Waste Categorisation” by G Bourke of Scangrit. The meeting starts at 12.30, and a free working lunch will be provided by BAM Nuttall. For further details and to register contact david.horricks@bamnuttall.co.uk.

The next meeting of the Corrosion in Concrete Working Group will be held jointly with the Corrosion Prevention Association on 6th October at Ullenhope Court Hotel, Lutterworth, starting at 10.30. There is no fee for the meeting, and lunch is provided, but pre-registration is required. For further details and to register contact Chris.Atkins@mottmac.com.

Full details about the Division and the current working groups can be found on the Institute’s website.

The Division has recently produced a number of draft documents relating to coatings (Inspection and testing, surface preparation methods, application methods, generic types, thermal spray, etc. The secretary (Douglas@harbridge.freeserve.co.uk) would welcome comments on these documents.
Most ICorr members, including those from outside the coating industry, will be aware of ICATS, but for the benefit of new members who may not fully appreciate the way the scheme operates, a brief summary is given below.

ICATS was developed in 2005 under the leadership of David Deacon in response to industry pressure, as advances in industrial paints and the associated preparation standards made the application of modern coating systems a skilled operation. Using unskilled, unqualified operatives, drastically increases the risk of a costly coating failure. It is the premier training scheme in the UK in this area.

The scheme is mandated by the Highways Agency, Network Rail, MOD and many of the oil companies, and is the minimum requirement for any operative carrying out industrial coating application at any of their sites. It focuses on safe working practices, surface preparation and application techniques working to recognised industry standards, and is operated by Correx Ltd, a wholly owned subsidiary of ICorr, which as a registered charity cannot directly undertake commercial ventures. Correx Ltd have a long term contract in place with the providers of the training material and the website, so the content is maintained and kept up to date.

ICATS is a comprehensive structured training scheme for the registration, training and certification of industrial surface preparation and coating operatives, and consists of a mandatory Basic Unit, ‘Industrial Coating Applicator’ comprising 6 modules – Health & Safety, Access, Plant & Equipment, Surface Preparation, Coating Types, Coating Application and Quality Control, plus two specialist modules; Abrasive Blast Cleaning Operator and Paint Sprayer. A further module for Supervisors is currently being prepared.

Companies wishing to have a workforce certificated under ICATS must first register with Correx and nominate experienced employees to ICATS for prior approval as company trainers. Once qualified, the ICATS certificated trainers can then carry out the training and assessment of operatives in their company and on successful completion of the ICATS course, operatives are certified by Correx. ICATS also offer a number of approved training providers who run courses in all modules and are strategically located throughout the UK. Full details can be found at www.icats-training.org

The next Trainer Seminar will be held on 5th October in Northampton. For the latest news, see the website, or the Industrial Coating Applicator Training Scheme on Linkedin.
YOUNG ENGINEERS PROGRAMME

During 2012-2013, the Institute of Corrosion embarked on a new initiative to address a perceived shortage of young entrant engineers showing an interest in materials and corrosion. The initiative was developed by a group of senior ICorr members, who formulated a programme covering corrosion control and related subjects such as coatings, materials selection, cathodic protection, painting and coating, inhibition and NDT, and recruited expert speakers to deliver it. As part of the programme, the young engineers were split into teams of 4 and given case studies to consider, and then present their conclusions at a London Branch evening meeting held at the Royal Overseas League. The event was a great success, with over 140 members and other interested parties attending the meeting.

Given the success of this first programme, the same group of ICorr members agreed to repeat the event bi-annually. The second training programme was therefore run during 2015 with the support of BP, who also agreed to sponsor a prize for the best team case study presentation, consisting of a visit to the NACE national conference in Vancouver at the beginning of 2016, with conference registrations being generously provided by NACE HQ. The prize was won by the team consisting of Christian Bridge, Na Mi, Harriet Wade and James Warren, with a presentation on their findings and solution to a glycol boiler failure. The group were accompanied on the Vancouver visit trip by Sarah Vasey Vice President of ICorr and Trevor Osborne the Immediate Past President, the other key member of the organising team David Mobbs could not attend due to pressures of business. Their report on the NACE conference is on pages 14-15.

The next Young Engineers programme is planned for 2017, and further details will be published in the magazine and on the website.

NATIONAL HIGHWAY SECTOR SCHEME 19A APPOINTS TRAINING ADMINISTRATOR

The Institute of Corrosion has been appointed as Training Administrator for the National Highways Sector Scheme 19A, which relates to corrosion protection of ferrous materials by coatings. This will involve reviewing and approving training schemes that enable contractors to be certificated in coating application and inspection. National Highways Sector Schemes (NHSS) are tailored quality management systems for companies working on the UK road network, based on the ISO9001:2008 standards, and published by UKAS. Companies supplying services to Highways England under the Specification for Highways Works (SHW), must be certified. Thus where NHSS 19A applies need to continue to existing cards will naturally phase out as they expire.

Under the new arrangements skills cards issues by training schemes approved and registered by the Training Scheme provider will bear the NHSS 19A logo demonstrating that the training meets the Sector Scheme’s requirements. Existing skills cards issued by registered training schemes will continue to be accepted until the expiry date shown on the card. Personnel certificated under the new arrangements will receive skills cards direct from the training providers, bearing the NHSS 19A logo and the Institute of Corrosion Crest. The existence of existing cards will naturally phase out as they expire.

Agents responsible for overseeing the application of coatings to UK infrastructure where NHSS 19A applies need to continue to check people have the correct skills cards, but be aware that there may well be a number of acceptable cards still in existence.

Stephen Hankinson, Chair of the committee said “The introduction of a Training Administrator is a significant change for the scheme and the committee was delighted to have been able to appoint the Institute of Corrosion to this important role. Moving forward the introduction of additional training providers will be a further change and this can only be of benefit to the scheme and the industry”.

Chris Atkins, Chair of the Institute of Corrosion’s Professional Development and Training Committee added “This is a great step for the coating industry, the Institute of Corrosion and asset owners. It provides a clear vision for the future of corrosion protection to steel assets.”

ICORR/MCF JOINT COMMITTEE ON NEW ENTRANTS TO CORROSION ENGINEERING

The Institute of Corrosion / Marine Corrosion Forum joint committee’s main aim currently is on promoting awareness, information, contacts and mentoring to potential, upcoming and new entrants to a career in corrosion science, technology and/or engineering at all levels. The focus for the different entrant groups is support for career guidance/insight drawing on industry links, opportunities for furthering technical knowledge and expertise through attending meetings and training courses, broadening exposure and contact within and across industry sectors. Further details can be obtained from ICorr or MCF (www.marinecorrosionforum.org).
LOCAL BRANCHES

The local branches offer a great opportunity to meet and network with others from the corrosion industry, and the technical presentations and seminars are an excellent way of keeping informed of the latest developments in corrosion protection, as well as contributing to an individual member’s Professional Development requirements, an essential requisite for those seeking, and maintaining, chartered status.

Some general information about the branches is given below, and up-to-date details of their technical presentations and events can be found on the diary page and in the 'conferences and events' section of the Institute’s website.

ABERDEEN BRANCH NEWS

Thanks to the branch sponsors, Aberdeen branch are able to host a technical programme of monthly presentations from September through to May (except December) each year. Meetings are typically held on the last Tuesday of the month at the Palm Court Hotel, 81 Seafield Road, Aberdeen, AB15 7YX, and start at 18:00 with a complimentary light buffet and the opportunity to network with other corrosion professionals, followed by a technical presentation at 18:30.

For more information about becoming an Aberdeen branch sponsor, please contact committee member, Kevin Paterson kpaterson@stoprust.co.uk, or if you would like further information on the Aberdeen Branch’s events and activities, contact the secretary, Frances Chalmers icorrabz@gmail.com

LONDON BRANCH NEWS

London branch hosts a technical programme of monthly presentations from September through to May each year as well as special events such as the Christmas luncheon. Meetings are held in the Skelton Building of the Civil Engineering Department, Imperial College (SW7 2AZ) and begin at 18:00 with drinks and the opportunity to network with other corrosion professionals, followed by the technical presentation at 18:30. After the presentation there is a complimentary buffet and bar open for discussions about the presentation and to continue the networking. Imperial College, can be reached directly by an underground walkway from South Kensington Tube Station.

The next meeting, which is jointly with the London Materials Society, is Thursday 13th October where Professor Gordon Blunn, University College, London will present a talk on “Corrosion of hip replacements – Is it a problem?”

For further information on the London Branch’s events and activities, contact icorrlondon@gmail.com, or george.winning@element.com

MIDLANDS BRANCH NEWS

The Midlands branch of the Institute of Corrosion covers the West Midlands, East Midlands, North & South Warwickshire, Worcestershire, Shropshire, Northamptonshire and Staffordshire. Events and technical meetings are held at various venues across the Midlands. The next confirmed meeting is an afternoon event on 30th November at the Council Chambers, Birmingham City Council House which will be followed by the ICorr AGM.

For further information, contact trevor.box@acivico.co.uk

NORTH EAST BRANCH NEWS

The Branch holds technical meetings at two venues in the Newcastle area, and their next meeting is scheduled for 13th September. Currently the Branch is looking for a new secretary, any members interested in helping in this important role, should contact the Branch as below or for further information, contact icorrne@outlook.com
CEOCOR has been bringing together international experts in buried pipeline corrosion, coatings and cathodic protection for 60 years. Its beginnings date back to 1956, when contributors from different energy companies came together to exchange experiences and expertise in the field of pipeline corrosion and protection, both internal and external.

In 1981, CEOCOR became an international non-profit scientific association and now represents over a hundred organisations and individual experts from research institutes, associations and companies in the field of pipelines for drinking water, waste water, oil and gas. It is a very active organisation and its members regularly participate in European and International standardisation working group. Many such activities of which have commenced with pre-standards produced in the CEOCOR working groups, which meet twice a year for open discussion about current topics in the field of corrosion and corrosion protection.

The CEOCOR Congress, which is held every year, features between 30 and 40 technical presentations of the highest level, focusing on advancing understanding, science and technology by exchange of data from research and practice, and principally organized by the Presidents of the two CEOCOR Commissions and the General Secretary.

This year the Congress, organised by Energetika.NET d.o.o. (a media and conference organizer, specialising in energy and ecology in Slovenia and SE Europe), was held in the beautiful historic city of Ljubljana, the capital of Slovenia. The principal sponsor was Plinovidl d.o.o., the natural gas transmission company in Slovenia.

Icorr is an Adherent member of CEOCOR and our Board Member is Chris Lynch. Individual members are welcome to join CEOCOR. Next year the CEOCOR Congress is in Luxembourg on 16th to 19th May, and in 2018 it will be in Stratford on Avon in the UK, when Icorr will be the organisers.

The Congress was further supported by specialist exhibitors in the pipeline, corrosion protection and cathodic protection fields (an integral part of the Congress). In the foreground is immediate Past President of CEOCOR Lucio Di Base. Next to him is the speaker Elisabeth Fluri from the French research laboratory ENGIE talking to Clara Calvi of LK2 S.r.l.

The Technical Papers from previous Congresses can be found on the CEOCOR website http://ceocor.lu/documents/proceedings, along with the Abstracts from the 2016 Congress (the full papers are accessible to non-attendees and non-members of CEOCOR after 12 months).
As many of you who read my column know, I am a part-time academic working at the University of Northampton. One of the delights of that job is encountering bright students. If you have been working for forty years or so in one particular field, in my case corrosion prevention by paints and particularly use of electrochemical techniques, you think you know most things. But a fresh pair of eyes can produce ideas which you hadn't thought of before and this in turn can lead to some interesting and useful developments. So it has been with my student "Leo" who has been working in my lab for the last two years.

The importance of a coating's ionic resistance in controlling its ability to prevent corrosion can be based on the empirical Bacon, Smith and Rugg (1) criteria for coatings on steel after long term immersion in sea water, a resistivity (ohms-cm²) of < 1E6 was poor, 1E6-1E8 was fair and >1E8 was good (Jack Mayne provided some theoretical justification for this many years ago and more recently John Sykes discussed this in the July 2015 special issue of Progress in Organic Coatings). It is reported, a typical single coat (50-100um) of a cross-linked coating system has areas within it which are towards the lower end of that resistance spectrum (1E6 to 1E8 in 3% NaCl), however many other areas of the film have a higher resistance. To investigate this, the ionic (DC) resistance of a large number (eg 20) of smallish (eg 3cm²) detached pieces of the same paint or varnish coating are measured, giving a parameter called the D to I ratio, which according to the Bacon, Smith and Rugg work, relates strongly to the anti-corrosive protection property of the coating, with the lower the D to I ratio, the better the corrosion protection ability of the coating.

Traditionally the D:I ratio has been determined by clamping each piece of the coating between two glass cells, each filled with a chloride solution and measuring the resistance at two different concentrations (see figure 1-left). Leo found this time consuming (also less than ideal for more brittle coatings), and so designed, and implemented a "quick test" (See figure 1-right) which is essentially analogous to the glass cell approach. In this, the test solution is placed on areas of a stainless steel plate, pieces of coating under examination are placed on top, followed by the same solution. The DC resistance is then measured between an external inert electrode contacting the top test solution and the stainless steel base plate. The test solution is then changed from say 0.1M NaCl to 1M and the DC resistance measured again. Using this, twenty pieces of any particular coating can be categorised as D or I in relatively short time. Leo also wanted to know why the resistance was important and whether the criteria varied with the conditions or when the requirements for the coating in service were different, and we intend to produce a technical article on this for a future issue, in which we will also discuss the whole concept of resistance. This shows that a student’s ideas are stimulating and can help move a subject forward.

References
THE ISO HULL AND PROPELLER PERFORMANCE STANDARD PASSES FINAL HURDLE AND JOTUN REFINES HPS GUARANTEE

According to Jotun, the ISO 19030 standard is finally nearing publication, a move that has the potential to save the shipping industry as much as USD 30 billion in annual fuel costs.

In response Jotun, a global manufacturer of marine antifouling coatings, has adapted its Hull Performance Solutions (HPS) guarantee to ensure it is fully ISO/DIS-19030-2 compliant.

The standard, which prescribes practical methods for measuring changes in ship-specific hull and propeller performance, has now been approved by the ISO’s Draft International Standard (DIS) ballot, with 93% of country representatives voting in its favour. This resounding approval rate paves the way for final publication, with ISO 19030 expected to be publically available at the end of Q3 2016.

Geir Axel Oftedahl, Jotun’s Business Development Director - Hull Performance Solutions, managed the project on behalf of the ISO, and is clear about its importance. “Poor hull and propeller performance is estimated to account for around 10 per cent of the world fleet’s energy costs (USD 30 billion),” he notes. There are very effective solutions for improving performance but, until now, no globally recognised and standardised way for measuring this and providing return on investment for ship owners. ISO 19030 satisfies that demand, prescribing measurement methodology and defining performance indicators for hull and propeller maintenance, repair and retrofit activities.

AKZONOBEL OPENS TECHNOLOGY CENTRE IN CHINA

AkzoNobel has opened a new €6.5 million technology centre in Songjiang, Shanghai, the company’s largest research facility in China, to support product innovation and the development of next-generation paints, coatings and specialty chemicals.

The centre is equipped with a full array of state-of-the-art material analysis and performance testing facilities and currently employs 150 scientists, which is expected to rise to 200 by 2020. The majority of the products supported by the new facility will be waterborne and powder-based, in line with the company’s ambitions to develop more eco-premium solutions.

NEW MARINE PAINT COMPANY

Nippon Paint Marine Coatings Co. Ltd. of Kobe, Japan, and Wilckens Farben GmbH of Glückstadt, Germany have announced the formation of Nippon Paint Marine (Europe) GmbH.

The new company, based in Glückstadt/Elbe near Hamburg, is a joint venture of the two partners, who have been working together in the marine paint market for the last 10 years.

It will be responsible for all of Nippon Paint's marine sales activity in Europe and Turkey. With around 35 experienced marine coating sales professionals based all over the continent, as well as a dedicated team of coating advisors, the new company aims to become a major marine paint supplier in Europe.

MAJOR AWARD FOR AKZONOBEL’S METHODOLOGY FOR SUSTAINABLE SHIP OWNERS

AkzoNobel’s pioneering methodology for rewarding ship owners who use sustainable hull coatings has been named Environmental Leader Product of the year for 2016. Environmental Leader is a leading daily trade publication covering energy, environmental and sustainability news. The award recognizes the introduction of the shipping industry’s first carbon credits methodology, which was developed by the company’s Marine Coatings business and launched in 2014 in conjunction with The Gold Standard Foundation and Fremco Group. The scheme is based on ship owners converting existing vessels from a biocidal antifouling system to a premium, biocide-free hull coating such as Intersleek, part of AkzoNobel’s International range of marine coatings.

The methodology financially rewards ship owners for using sustainable hull coatings that improve operational efficiencies and reduce emissions. This is reflected in the award, which specifically recognizes the role of the initiative in improving environmental and energy management in the shipping industry, while delivering bottom line benefits to those who participate.

Earlier this year, Neda Maritime Agency Co Ltd, a leading Greek tanker and bulker owner, became the world’s first ship owner to be awarded carbon credits through AkzoNobel’s landmark scheme. The company received a total of 13,375 carbon credits - potentially worth around $60,000. Each carbon credit accrued represents the avoidance of one ton of CO2 being emitted to the atmosphere, meaning that Neda Maritime has offset a total of 13,375 ton of CO2 from its business.

The award was presented to AkzoNobel during the recent Environmental Leader Product & Project Awards ceremony held in Denver in the US.
A NEW TYPE OF FOUNDATIONS DEVELOPED BY BAM FOR OFFSHORE WIND TURBINES

Royal BAM Group has been awarded a contract by EDF Energy Renewables via SPV Blyth Offshore Demonstrator Ltd, to design, fabricate and install five full-size gravity base foundations for wind turbines of 41.5MW in capacity off the Northumberland coast. The foundation design will utilise ‘self-installing’ technology, which has been developed by two BAM companies, BAM Nuttall Ltd and BAM Infra bv. The design is being undertaken by BAM Infraconsult.

The five concrete and steel foundation bases will each have a base diameter of 30 metres. The gravity base foundations (GBFs) are prefabricated onshore in quayside construction yard on the River Tyne and then towed to the deployment site. There, they are filled with water and lowered onto a pre-installed gravel bed. When the GBF reaches the ground it is filled with sand, now ready for the turbine to be installed on top. At Blyth, they will be set at a water depth of 40 metres and will weigh 13,000 tonnes.

The technology, developed by BAM with Van Oord Offshore Wind Projects, has never been used before. The project itself will be a demonstration project to prove the viability of this approach to installing gravity base foundations in the offshore environment for future wind farms, and is due for completion during summer 2017.

NEW MONITORING SERVICE

Cathodic Protection Company Ltd has announced that it has been awarded accreditation from Alcumus SafeContractor, for its commitment to achieving excellence in health and safety. Safecontractor is a leading third party accreditation scheme which recognises very high standards in health and safety management amongst UK contractors.

Under the Safecontractor scheme, businesses undergo a vetting process which examines health and safety procedures and their track record for safe practice. Those companies meeting the high standard are included on a database, which is accessible to registered users only via a website.

John Kinge, technical director of Safecontractor said, “Major organisations simply cannot afford to run the risk of employing contractors who are not able to prove that they have sound health and safety policies in place.”

NEW SAFE CONTRACTOR ACCREDITATION

Cathodic Protection Company Ltd has announced that it has been awarded accreditation from Alcumus SafeContractor, for its commitment to achieving excellence in health and safety. The technology, developed by BAM with Van Oord Offshore Wind Projects, has never been used before. The project itself will be a demonstration project to prove the viability of this approach to installing gravity base foundations in the offshore environment for future wind farms, and is due for completion during summer 2017.

BAGNALLS ‘PAINTING THE TOWN’ AFTER NATIONAL AWARDS TRIUMPH

Family Business United has announced that Bagnalls, the nationwide painting and decorating business from Shipley in Yorkshire have taken the top prize at the prestigious Family Business of the Year Awards 2016.
**ARC ENERGY RESOURCES ACHIEVES INVESTORS IN PEOPLE SILVER AWARD**

Gloucestershire-based Arc Energy Resources, a specialist in weld overlay cladding and fabrication services for the oil & gas, nuclear and water industries worldwide, has been awarded a prestigious Investors in People Silver Award, an upgrade to the Bronze Award it has held since 2013. The Company also received the Good Practice award for Health and Wellbeing.

**GALVANIZING FIRM CELEBRATES ITS HEAVIEST EVER JOB**

Worksop Galvanizing, part of Wedge Group, was asked to provide hot dip galvanizing treatment to over 400 tonnes of structural steel used to create the iconic Optical Cloak, an eye-catching skyline structure in central London, for its customer Billington Structures Ltd. A few of the individual pieces weighed in at over 20 tonnes each, making them the heaviest items processed across all of Wedge Group Galvanizing’s 14 nationwide plants.

**BASF TO ACQUIRE GLOBAL SURFACE TREATMENT PROVIDER CHEMETALL**

BASF has signed an agreement to acquire Albemarle’s global surface treatment business. Chemetall develops and manufactures customized technology and system solutions for surface treatment. Their products are used in a wide range of industries and protect metals from corrosion, facilitate forming and machining, allow parts to be optimally prepared for the painting process and ensure proper coating adhesion. “Chemetall complements our current portfolio by adding the highly attractive surface treatment business to our coatings offerings. We look forward to joining forces with Chemetall’s industry-leading expert team to further advance innovation and know-how-driven surface technologies for our customers around the world,” said Markus Kamieth, President of BASF’s Coatings division.

**VAN OORD AND HIGHLAND GROUP HOLDINGS ARE TO COOPERATE ON BUILDING THE DEUTSCHE BUCHT OFFSHORE WIND FARM IN GERMANY**

The agreement covers the development, financing and construction of the wind farm, located in the German Bight, approximately 90km from the shore. It will have a rated power of 252MW.

Van Oord’s role includes the engineering, procurement and construction of the foundations, inter-array cables and the offshore substation. Van Oord and Highland Group Holdings will have a share in the equity for the offshore wind farm. Financial close is scheduled for the first half of 2017 and offshore installation is envisaged to start in the second half of 2018, with the wind farm being commissioned in 2019.

For all the latest news, events and debates join us on [LinkedIn](https://www.linkedin.com).
PDA Europe is organising its 10th annual conference on 7-9 November 2016 in the Hyatt Regency Nice Palais de la Méditerranée in France.

The applications of Polyurea are widespread and the technology keeps on innovating and improving. This conference is a unique forum in Europe for all stakeholders of Polyurea and has been designed to discuss and present all its facets.

Three days packed with presentations, education courses, table top exhibition and networking moments! This year parallel sessions will be organised in French.

Registration open on 1st August!

Maximise your presence and increase your visibility thanks to our sponsorship and exhibit opportunities. Table top bookings benefits from one free registration.

Contact us
info@pda-europe.org
www.pdaeuropeconference.com

Join our LinkedIn page & help us to promote the conference on social media!
Corrosion cannot be appropriately managed if degradation mechanisms are not properly understood. This was exemplified in the ‘Refining Industry Corrosion Symposium’, where a number of presentations discussed advances in the understanding of corrosion mechanisms, including research about naphthenic acid (NAP) corrosion.

Crude oils containing NAPs have become increasingly popular in the refining industry due to their relatively low price, despite the resulting corrosion issues which can arise during processing and which is a major concern. NAPs have complex chemical compositions which make it difficult to evaluate and predict their corrosive behaviour, therefore a fundamental understanding of this type of corrosion is crucial within the industry so that risk can be suitably managed. “A Study of the Flow Effect on Naphthenic Acid Corrosion of Mild Steel” (Nicolas Jausea, Kongsberg Oil & Gas Technologies, Inc.) highlighted the locations where NAP corrosion tends to occur: furnace tubes, side stream piping, atmospheric and vacuum distillation towers, and bends of transfer lines where the corrosive effects were enhanced by the combined effect of multiphase flow and a high velocity. The study concluded that the flow pattern was the major driver, and the rate of corrosion was drastically reduced if the flow could form liquid droplets, as opposed to a film which had a greater surface contact with the metal.

In “A Corrosivity Study of Sulphur Compounds and Naphthenic Acids under Refinery Conditions” (Qin Xin, Natural Resources Canada, Canmet Energy), the effect of the interaction of NAPs with four sulphur compounds, with increasing relative thermal stability of the sulphur bonds, was discussed. As temperature increased under pure sulphidic conditions, corrosion rates in the liquid phase were generally higher than those in the vapour phase, which allowed significantly less contact time with the metal surface. The relative thermal stability of the sulphur compounds influenced the corrosion rates at each temperature tested. As temperature increased, H₂S was produced by thermolysis of the sulphur compounds and the rate of corrosion is dependent on the production rate and total quantity of H₂S. If the rate at which H₂S is being produced is relatively low, and NAP is not present, a protective Iron Sulphide (FeS) scale can form on the metal surface (See Eq. 1). However, if NAP is also present, it competes with H₂S to react with the metal surface and form oil soluble iron naphthenates (See Eq. 2). If there is an excess of H₂S present, it reacts with the iron naphthenates, regenerating the NAP (See Eq. 3), as well as forming more FeS which can remain as a suspension in the liquid, and potentially cause fouling further downstream.

\[
\text{Fe} + \text{H}_2\text{S} \rightleftharpoons \text{FeS} + \text{H}_2 \quad (1)
\]
Fe + 2RCOOH $\rightarrow$ Fe$_2$(RCOO$^-$)$_2$ + H$_2$  

(2)  

Fe$_2$(RCOO$^-$)$_2$ + H$_2$S $\rightarrow$ FeS + 2RCOOH  

(3)  

The presentation concluded that the presence of sulphur compounds alone does not protect from NAP corrosion. The amount and rate of H$_2$S produced must be considered, and it must be appreciated that the effects of the reactions of both corrosive groups are interwoven.

Another corrosion mechanism commonly experienced in the refining industry is high temperature hydrogen attack (HTHA) which affects steels operating at elevated temperatures in hydrogen environments. The hydrogen dissolves in the steel and reacts with carbon to form methane which cannot diffuse out of the steel resulting in fissures and cracking. API Recommended Practice 941 puts practical operating limits in place for carbon and low alloy steels in hydrogen service, in order to prevent HTHA. However, recently there have been a number of cases of HTHA which have occurred within the acceptable 941 limits. “A New Practical Method for Prioritizing Equipment in HTHA Service for Inspection and Replacement and the Challenges in Obtaining Process Conditions to be used in the HTHA Assessment” (Jeremy Staats, Becht Engineering) evaluated the current determinants used in modelling the susceptibility of HTHA - hydrogen partial pressure and operating temperature, and considered other contributing factors such as presence of corrosion scale and fouling, cladding type and operating data confidence in order to improve the evaluation method. The Minimum HTHA Resistance (MHR) was established by using the Nelson Curves as a starting point with various steel compositions, then adjusted to evaluate how a base material would be expected to perform when considering several other factors - Post Weld Heat Treatment, stress level, age in service, and inspection history. The original Nelson Curve and MHR curves were plotted together with the original operating condition point, and adjusted HTHA Pressure point, to give a visual display of how an item of equipment is operating and its inherent susceptibility to HTHA. The likelihood of HTHA can be determined by the position of the HTP above (bad) or below (good) the curve. An appropriate recommendation for inspection or replacement can then be inferred.

One of the biggest issues faced for evaluating susceptibility of existing equipment to HTHA is obtaining accurate historical operating data; the majority of equipment requiring evaluation has been in service for 30-50 years, before digital control systems existed, and under unknown varying operating conditions. For this reason, the maximum recommended operating conditions are extremely conservative for equipment where little is known about past operations or where data is incomplete. It was concluded that it is a more practical and realistic approach to model a piece of equipment’s susceptibility to HTHA on qualitative data, considering multiple factors and trends over the equipment’s lifetime, in order to allow prioritisation inspection or replacement. This is in contrast to the traditional method of using theoretical models which employ fewer factors and rely more heavily on obtaining an accurate and complete set of historical data in order to calculate the remaining life of equipment.

Coatings are an important barrier to corrosion and examples of research and new investigations presented at the ‘Oil and Gas Coating Technology Symposium.’ are discussed below.

“Coating Systems With Long Lifetime - Paint on Thermally Sprayed Zinc” (Ole Øystein Knudsen, SINTEF Materials and Chemistry) highlighted the importance of using correct coating application techniques and employing adequate quality control by using the findings from an investigation into corrosion of a series of Norwegian road bridges protected with a topcoated thermally sprayed zinc (TSZ) system. There were two different causes of corrosion of the TSZ on the bridges - low film thickness of the organic coating arising from a lack of control during application, and pinholes in the paint layer. The film thickness measurements were made with a magnetic film gauge which recorded the total film thickness, including the zinc, whose thickness varies, and in some areas can be sufficiently thick so that the additional paint layer is inadequately thin. The investigation identified that this problem could be mitigated by use of an eddy current thickness gauge which measures only the thickness of the paint, and not including the zinc.

The pinholes forming in the paint could be avoided if the sealant coat (typically an epoxy) was diluted and ensuring that a thin layer was applied (less than 25 micron dry film thickness) which allowed it to penetrate all of the pores on the rough zinc surface, surface, forming a dense protective film. A new bridge coating specification was written based on the findings of the investigation.

“Evaluation of Insulating Coating Systems for Offshore applications” (RoongTanupabrungsun, BP) discussed the suitability of 5 waterborne acrylic insulating coatings for offshore application in the Gulf of Mexico. The testing involved assessing each system for: ease of application, temperature reduction, corrosion mitigation, impact and adhesion, moisture permeability, inspectability of substrate and cracking resistance. Two out of the five tested systems passed all of these tests, confirming that water-borne acrylic insulative coatings systems can provide a sufficient temperature reduction to be used as personnel protection, whilst also having an acceptable mechanical resistance and offering corrosion protection.

“Evaluation of Protective Coatings to Mitigate Corrosion under Insulation” (Yang Yang, BP) discussed the development of new test protocols to evaluate insulating coatings applied to live equipment, as a means of avoiding the cost associated with stopping production. A range of coating systems were applied in the laboratory to a hot substrate at test temperatures of 121°C, 177°C and 227°C, and the thermal stability of the primers and the corrosion resistance of each coating system in simulated field conditions was investigated. This work also stressed the importance of proper application of coatings, particularly significant at higher substrate temperatures where coatings can dry too quickly to form the required smooth and continuous film. The Corrosion Monitoring Technologies for Industrial Applications Symposium covered developments in the field of corrosion monitoring technology.

“New Experimental Techniques for In-situ, Real-time Corrosion Monitoring” (Igor Kosack, Honeywell Process Solutions) proposed a new corrosion monitoring method based on the application of Raman spectroscopy. The characteristics of vibrational frequencies can be used to identify the chemical composition and the structure of materials where the frequency shift of Raman lines represents the unique “fingerprint” of a material. The technique can detect in-situ, real-time corrosion rates and identify corrosive species and corrosion products found in an oil and gas production environment, including Fe$_2$O$_3$, Fe$_3$O$_4$, FeO and FeCO$_3$.

“A Biosensor for Sulphide Detection and Microbiologically Influenced Corrosion Monitoring” (Xin Pang, Canmet-Materials [CMAT]), introduced the application of carbon nanotubes in a sensor for monitoring microbially influenced corrosion (MIC). Sulphate-reducing bacteria (SRBs) are the primary causes of MIC; under anaerobic conditions the bacteria catalyses the reduction reaction of sulphates to sulphides, resulting in the production of H$_2$S. The presence of this gas can therefore be used as an indication of microbiological activity. An electrochemical sulphide detection sensor was constructed using single-walled carbon nanotubes and a conducting polymer; these materials offer a large active surface area with a high sensitivity. Experimental results indicated that this was a promising method for sensing sulphides.
“Monitoring and Inspection Options for Evaluating Corrosion in Offshore Wind Foundations” (Troels Mathiesen, FORCE Technology), discussed the relationship between degradation mechanisms, mitigation and monitoring. Offshore wind foundations present a relatively new challenge to corrosion engineers due to the occurrence of a number of different localised environments contained within a single offshore structure. Monopile wind foundations use a transition piece above the external waterline to connect to the turbine. A ‘J-tube’ is used at the base of the structure for the electric cable entry. These joints are typically grouted to provide a leak-free seal and an unflooded interior compartment. However, past experience has shown that some water ingress is inevitable and more recent designs allow the internal compartment area to be flooded with a large volume of seawater.

Internal hotspot areas for corrosion include the mud zone, the waterline of the internal compartment, weld defects at the grouting or cable entry and above the waterline where the accumulation of gases may occur, and mitigation and monitoring in this location is a current focal point of the industry. The external monopole structure employs similar corrosion prevention techniques to offshore established technology (See technical article on this subject, on pp 17-22).

A range of inspection and corrosion monitoring methods have been utilised on offshore wind foundations, and the learnings from a series of different projects were discussed. External ultrasonic testing crawlers have been used to measure wall thickness, and drop cells have been effective methods for measurement of the protection potential of CP systems.

Internally, small scale and full length corrosion coupons have been deployed, in addition to electrical resistance probes which can provide real-time measurements of corrosion rate. Sensors can be lowered into the internal water layer and used to obtain data including pH, dissolved oxygen, temperature and protection potential of CP.

A single strategy for corrosion monitoring is not practicable and, as such, each wind farm’s approach must be customised to suit the design and environmental conditions.

The presentations and discussions at the NACE Conference reinforced the importance of understanding mechanisms, mitigations and monitoring of corrosion; these are all critical elements for an effective corrosion management strategy.

The winning team for The Institute of Corrosion’s Young Engineers Competition (2016) were: Christian Bridge (BP), Na Mi (KBR), Hattie Wade (Technip) and James Warren (Saipem).

The team are extremely grateful to have been given the opportunity to attend NACE 2016 and would like to thank The Institute of Corrosion for organising the competition and BP for sponsoring the prize.
There are currently more than 800 wind generating structures in the Northern Sea and 80 in the Baltic Sea, and more than 20 wind farms, each with a large number of structures and/or towers, will open in the next few years in these areas. In planning for these wind farms, the corrosion protection of the structures to be installed has become a focus of public interest, especially their effect on the environment which is often criticized or feared. There is also a large and immediate task for corrosion specialists to formulate standards in order to protect these steel structures effectively for a period of 25 years under very corrosive conditions.

The German Federal Maritime and Hydrography Agency (BSH) has formulated “minimum requirements” (Mindestanforderungen) which describe the measures to be taken for German offshore wind energy structures concerning their integrity, i.e. ensuring their function and stability, for a lifetime of 25 years under very corrosive conditions.

The problem of corrosion of offshore wind energy structures should be resolved in the context of all questions concerning the protection of the environment. This article is focused on a number of corrosion test procedures that will be analyzed with regard to their suitability, discerning the excellent corrosion protection systems from the average ones.

DIFFERENT TYPES OF CORROSION STRESSES ON COATINGS IN MARINE ENVIRONMENTS

In prequalification tests, the commonly used standards are generally based on laboratory testing procedures and it is important to know that these test procedures cannot often determine the true corrosion prevention potential of a coating system. No overall laboratory test exists which considers all the different stresses and includes the appropriate acceleration factor, in order to relate an accurate number of hours in an accelerated test to lifetime in years in real life.

Within a structure erected in a maritime environment (sheet pile walls, oil platforms or wind energy structures), there are generally different zones with different intensities of corrosive attack: bottom or sea floor, immersion and low water zone, tidal and splash zone and last but not least, the atmospheric zone (Fig. 1). Therefore, it is necessary to consider different intensities of corrosion in any test procedure to be developed or applied.

Furthermore there is continuous mechanical stress from waves, floating matter and ice movement in winter that can attack coatings, and coatings also commonly suffer from mechanical impact during transport and erection, which can lead to localized damage and coating detachment. The wet, high-salt environment is a constant danger that leads to corrosion, especially in the areas of highest corrosive stress, for example the splash zone. Failure of a coating by osmotic blistering may be caused by condensation of water, and UV-radiation and biological growth are further phenomena that can weaken coatings by...
deterioration of the binder. Microbial-induced corrosion (MIC) due to bacteria, for example, sulphur-reducing bacteria (SRB), could be hazardous to structures, especially in the low-water zone and the sea floor regions. Then again, in the author's experience, the danger of a corrosive attack by bacteria is only evident for uncoated steel.

Often forgotten is the stress applied to coatings from the electric current produced by a combination of different metals (galvanic cell), as well as by cathodic corrosion protection systems (which should actually prevent any corrosion of the steel). Both circumstances cause an acceleration of the corrosion cell’s cathodic reaction and propagation of hydroxyl ions that eventually attack the coating binder at the steel/primer boundary. Table 1 summarizes the various stresses and equivalent laboratory testing methods. The thesis of this report is that a large part of these individual single stresses can be tested by a combination of long-term trials (LTT) in nature (and was recently proposed by members of the WG 6 of ISO preparing the update of the ISO 12944, “Paints and varnishes — Corrosion protection of steel structures by protective paint systems”) in combination with special laboratory test procedures.

Table 1: Stress of Corrosion to Coatings and Selected Test Procedures.

<table>
<thead>
<tr>
<th>REQUIREMENTS IN NATURE</th>
<th>CAUSED BY</th>
<th>TEST PROCEDURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance to osmosis tests</td>
<td>Steam or fresh water</td>
<td>Water condensation</td>
</tr>
<tr>
<td>Resistance to abrasion and impact</td>
<td>Ice, floating matter, impact (ships)</td>
<td>Abrasion test, falling weight test</td>
</tr>
<tr>
<td>Resistance to electric current with and without any coating damage</td>
<td>Cath. corr. systems, electrochemical effects of combination of carbon steel and high alloyed steel</td>
<td>Cathodic corrosion protection test under real conditions (potential and time)</td>
</tr>
<tr>
<td>Resistance to rusting in general</td>
<td>Water, oxygen, chlorine</td>
<td>Immersion in water and salt fog</td>
</tr>
<tr>
<td>Resistance to rusting after degradation due to rough conditions of use and erection</td>
<td>Damage to coatings (cuts, delamination) by transport, ice, floating matter, ships</td>
<td>Simulation of rusting conditions</td>
</tr>
<tr>
<td>Resistance to biological growth</td>
<td>Bacteria (MIC), sea weeds, mussels</td>
<td>Long term trial (LTT)</td>
</tr>
<tr>
<td>Proof of long durability</td>
<td>Time of use</td>
<td>Long term trial (LTT)</td>
</tr>
<tr>
<td>Colour</td>
<td>UV-degradation</td>
<td>Long term trials (LTT) or UV- test</td>
</tr>
</tbody>
</table>

The relatively short duration of accelerated laboratory weathering tests (ISO 20340, “Paints and varnishes — Performance requirements for protective paint systems for offshore and related structures,” ISO 9227, “Corrosion tests in artificial atmospheres — Salt spray tests” and ISO 11997, “Paints and varnishes — Determination of resistance to cyclic corrosion conditions”) may not produce significant deterioration of the coating system as a whole. Therefore, the use of selection criteria to determine best performance is often limited to the post-test determination of underlying rusting at an artificial scribe. With this method, the rusted area may be easily determined and fixed threshold values, i.e. the pass/fail criteria, can be used. Among the remaining difficulties there is, for example, the difference between rusting, delamination and creep. Then again, coating defects, deterioration of the coating or even rusting of the surface are not always found, or can be differentiated after accelerated testing. These circumstances have forced BAW to carry out LTT in different types of waters and in different zones over a long period of time (five years) to allow corrosion of coated steel to occur, as well as to expose the coated panels to multiple stresses at the same time. According to the Guidelines of Testing...
of Coatings (RPB5) from BAW, the criteria of swelling, brittleness, blistering and rusting are used to calculate a final deterioration number with a maximum of 85, and form a standard/guideline for VBG-BAW2. By far, most coating systems show a deterioration number of less than 10 (in LTT 2008-130). This means that no real damage has been observed after five years of exposure. These observations might be explained by the fact that even in LTT in nature, virtually no critical damages comparable to the ones usually caused by impact, abrasion and galvanic action, occurred to the exposed panels.

Variation diagrams are useful tools to detect dependencies between two different series of test results. In previous work some systematic positive correlations between laboratory test and field test results were found7, 8 but mostly by only comparing the immersion zone of LTT with results of aging tests (ISO 20340) or salt spray tests (ISO 9227). Hence, it could be interpreted that in laboratory test procedures, rusting at the scribe does not represent the true corrosive effect in the more relevant zones, like low water, tidal and splash zones. Correlations are seldom seen. Confirmation of the high intensity of corrosion in certain zones is shown in Figure 2. When this fact is accepted, new laboratory tests which include relevant corrosion stresses should be looked for.

RESULTS OF LTT IN NATURE – COMPARISON TO LABORATORY TEST RESULTS

BAW publishes a list of approved coating systems for application on structures in seawater twice a year based on the results of standardized corrosion test procedures in the laboratory7.

Over the last decade, a trend was observed — an increasing number of corrosion-inhibiting, primer-free coating systems have passed the salt spray test (ISO 9227; 1,440 hours, with rusting less than 1.0 mm). It seems that primers such as zinc-rich can be substituted by these new systems — mainly one- or two-coat systems based on epoxy resins. According to the BAW guidelines2 a LTT test in nature must follow any accelerated test in order to be fully conforming. After the evaluation of the LTT test results, a huge discrepancy was found — more than half of the approved coating systems did not confirm the good performance of the laboratory test. This poor result was due to the very high values of rusting seen at the scribe within the tidal and splash zones after the more relevant stresses in the field test (Kiel, Baltic Sea). Figure 3 shows a test panel with rusting at the scribe after the five-year field test. While in the laboratory test (salt spray test ISO 9227) the panels showed a mean rusting value of less than 1.0 mm (identical to the threshold value in ISO 9227 and BAW), the panel in this figure shows a rusting at the scribe of 25 mm after natural exposure. This is far above the required threshold value of 6 mm after natural weathering. In Figure 4 the lower half of the panel has a large rusted area along the scribe while in the upper half corrosion is virtually negligible because of the zinc-rich primer. The calculation of the average rusting values after the five-year exposure in nature gives results which confirm the observation of single coat systems (Table 2).

The results indicate that in the immersion zone all the different coating systems show little corrosion at the scribe. In contrast to that, in the tidal zone there is a lot more corrosion and the values allow for a degree of discrimination between systems, as can also be seen in the splash zone. The clear tendency is that coating systems without specially formulated inhibitive primers (single- and two-coat systems) tend to fail in the most corrosive zones in LTT. The explanation of this phenomenon is at first simple: the rusting of the surface along an artificial scribe is prevented by the zinc rich primer systems. Zinc-rich primers are able to avoid chloride-induced corrosion, and by that underlying rusting, independent of the generic type of binder of the primer. Their action is twofold: sacrificial as mentioned above; and secondly, binding of OH− and Cl− ions, decreasing the primer’s “porosity” and increasing its barrier protection.

The calculated corrosion rates (µm/h) of the rusting at the scribe in the previously described test procedures are listed in Table 3, in relation to the threshold values of different standards and guidelines. It can be seen that the salt spray test (ISO 9227) has practically the same corrosion rate value as the aging test (ISO 20340) with the most stress cycles. It is concluded that the threshold value of 3.0 mm is too high a claim and this value should be raised to 4.0 mm.

When the corrosion rates of the different test procedures are compared, one can calculate the acceleration factors, for example, the aging test against the immersion zone in nature: 0.71/0.06 = 12. The corrosion rates of threshold values of the LTT are always between the very good (zinc-rich systems) and the average systems (single and two-coat systems) (Table 3).

To check the validity of laboratory test results a comparison must be made with the results of rusting in LTT in nature. A number of coating pairs (results from two different
test procedures) may be checked for any dependencies by a variation diagram. To avoid disadvantages due to application effects, the couples/pairs of the statistical population must be prepared in the same manner. In this way, statistical dependencies can be checked for by calculating a correlation coefficient (r), which shows the confidence level depending on the number of pairs, as presented in Figure 5.

The statistical probability that field test results of rusting in the tidal zone and the salt spray test are dependent on each other is higher than 99 percent. Therefore, when one compares the threshold values in the correlation curve, there is a point of intersection at 9 mm (LTT) and 1 mm (salt spray) which is virtually identical to the respective threshold values there. The dependency shown in Figure 5 is the only one found between rusting in laboratory test results (ISO 20340 aging test and ISO 9227 salt spray test) and LTT tests in various zones. It means that both of the common laboratory test procedures are unable to mirror results obtained in the immersion and splash zone in nature. Heavy deterioration at the surface and other signs of damage are not found and are therefore almost negligible in all test series. The generic types of binder don’t show any clear influences, although polyurethane (PUR, single pack) shows slightly better results than epoxy coatings.

As a result of these tests and further experiences of protecting hydraulic steel structures in both sea water and the atmosphere, Table 4 presents some proposals of suitable and common coating systems for low water, tidal and splash water zones (Im2/CS, zone 2), according to BAW, as well as proposals for the atmospheric zone (CS/CX; zone 3) which should be introduced for structures in German windfarms in the Northern as well as the Baltic Sea.

CATHODIC CORROSION PROTECTION TEST

The Cathodic Corrosion Protection (CCP) method by impressed current is a common system for protecting structures in seawater against corrosion. Generally, this method is to be preferred over galvanic anodes as it doesn’t release dangerous metals like zinc or aluminum into the maritime environment.

Nevertheless, both methods cause stress to the coating due to the protection current delivering electrons which may form hydroxyl ions at the boundary of the steel surface and the primer. This in turn attacks the polymer, finally forming blisters or even causing disbondment. A very important quality of a coating under these conditions is the potential to incorporate, or neutralize, the propagated harmful hydroxyl ions.

The cathodic disbondment test (ISO 15711) is proposed for testing according to ISO 20340 and NORSOK M501 in the tidal and immersion zones. The intention is not fully clear — is it a pure disbondment test under accelerated conditions, or a test to check the compatibility of a coating system with the electric current of a cathodic corrosion protection system? If the latter is the case, we should recognize that six months of test duration (ISO 15711) is far less than the time necessary to obtain trustworthy results for the proposed protection system consisting of a combination of coating and CCP. A lot of changes can happen after a period of six months. It is better to monitor the required electric current per test panel versus time as a way to observe and control the protective efficiency of the system.

<table>
<thead>
<tr>
<th>ZONE COATING SYSTEM</th>
<th>IMMERSION ZONE (LM2)</th>
<th>TIDAL ZONE</th>
<th>TEST PROCEDURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zn-rich primer (n=20)</td>
<td>1.4 mm</td>
<td>9.8 mm</td>
<td>4.7 mm</td>
</tr>
<tr>
<td>Zn-free. primer (n=7)</td>
<td>1.4 mm</td>
<td>10.4 mm</td>
<td>5.7 mm</td>
</tr>
<tr>
<td>Single/two-coat(s) (n=10)</td>
<td>2.3 mm</td>
<td>16.1 mm</td>
<td>22.3 mm</td>
</tr>
<tr>
<td>Recommended values 1)</td>
<td>2.5 mm</td>
<td>10 mm</td>
<td>6 mm</td>
</tr>
</tbody>
</table>

Table 2: Average Rusting Values at the Scribe After Five Years of Exposure (LTT) for Various Coating Systems.

Table 3: Corrosion Rates [µm/h] of Different Standards and Test Results.

![Figure 5: Long-term trials variation diagram of underlying rusting in water changing zone and salt spray test.](image)
variation or degradation of a coating system under electric current stress, in contrast to counting the blistering after six (ISO 15711) or only 15 months. There is a need to observe the behavior of a coating and check for the development of blisters, or the increase the protection current at field conditions (- 950 mV versus Ag/AgCl- electrode in sea water) for at least 15 months.

Most of the coatings have a limited capability to resist the propagating of hydroxyl at areas in the cathodic regime. In addition, when the testing time is limited to 15 months it is recommended to introduce a current density of about 2.2 mA/m² for the whole area of the panel (150 x 150 mm of coated area including holiday area), which results in a maximum current of 50 µA. Using this parameter in addition to blistering or disbondment is a better assessment as a whole. According to the experiences of BAW (more than 300 CCP-tests in the last decade), only well-formulated coating systems especially designed with an appropriate primer system (for example, zinc rich) may show the ability to resist a load by electric current for 25 years. The results of decades of measurements show a clear result — Zn-primer-based coating systems can bear or withstand hydroxyl attack and this way disbondment and blistering of the coating can be avoided.

FURTHER LABORATORY TESTS

As mentioned earlier, there are many applied stresses to be considered when (carbon) steel has to be protected in sea water, especially in offshore regions. Some tests listed in Table 1 meet practical demands and may be carried out in laboratory. In addition to the long term trials in nature, there is also a need to know the resistance of a coating to abrasion. In combination with the falling weight test this enables a good characterization of the mechanical quality, i.e. attributes of a coating system such as hardness and elasticity. These attributes can help to avoid disbondment or the effect of impact which would result in the rusting of surfaces.

It is often argued that high adhesion values of a coating help to prevent corrosion. But the reason why high pull-off values are advantageous hasn’t yet been proven. Within the guidelines of NORSOK M501 and ISO 20340, there are different threshold values which correspond to the coating system. To shorten the discussion of this aspect it should be recognized that zinc-rich primer systems generally produce almost the same (high) pull-off values as single- or two-coat systems without primers. Furthermore, even very high pull-off values don’t protect coating systems against rusting at the scribe or osmosis. The osmotic pressure is always much higher than the coating strength. Also high adhesion values do not prevent underlying rusting — the opposite seems to be the case.

Table 4: Examples of Recommended Coating Systems in Different Zones.

<table>
<thead>
<tr>
<th>ZONE / SYSTEM NO.</th>
<th>PRIMER</th>
<th>INTERMEDIATE-/TOP-COATING</th>
<th>PAINT SYSTEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/1-3</td>
<td>2K-EP-Zn(R)</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>2/4</td>
<td>2K-EP-diverse</td>
<td>1</td>
<td>50-100</td>
</tr>
<tr>
<td>2/8</td>
<td>1K-PUR-Zn(R)</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>3/1-3</td>
<td>2K-EP-Zn(R)</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>3/5</td>
<td>1K-PUR-Zn(R)</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>3/6</td>
<td>TS</td>
<td>1</td>
<td>80-100</td>
</tr>
</tbody>
</table>

*top coating 2p-PUR according RAL 1003; TS = thermal sprayed Zn-alloy.
Corrosion management is essential for protecting steel structures in seawater. Sensitive to falling weight tests than primer-based coating systems and show significant failure after the test and weathering stress in a salt spray chamber. If a coating system shows signs of damage, there is a high demand for self-protection of the surface against rusting. This can be achieved with specially formulated primer systems as proven in laboratory and LTT tests, as well as on existing structures.

Cathodic protection (CP) by impressed current is a well-known method of protecting structures in seawater against corrosion. For meaningful results, our studies have shown that the cathodic disbondment test (ISO 15711, "Paints and varnishes — Determination of resistance to cathodic disbonding of coatings exposed to sea water") must be carried out for a duration of 15 months in order to ensure the resistance of coatings to the cathodic protection current generated. At the same time it is advantageous also to measure the current demand because this allows signs of weakness in coatings to be seen when the test panel requires a higher protection current. Within the immersion zone, the difference of underlying rusting of primer-based systems and single- or two-coat systems is low. Generally very little corrosion will happen there, but at the same time, this is the zone where CP works and this means that due to cathodic polarization, hydroxyl ions are produced by delivering electrons to the cathode in order to protect the steel in sea water. Decades of measurement have shown a constant result: zinc-rich primer based coating systems can bear or withstand hydroxyl attack, and this way disbondment and blistering of the coating can be avoided.

Ultimately the results of a long-time exposure in nature should determine how a system can work in avoiding corrosion under extreme circumstances and conditions on site. Existing laboratory test procedures are useful to a certain extent — for example, as a pre-qualification test for the protection quality of coatings.

Therefore, the threshold values should be aimed at the performance and should not prefer certain systems. For the aging test of ISO 20340 (4,200 hours), a threshold value of 7.6 MPa is recommended while for the salt spray test, 1 mm (1,440 hours, ISO 9227) could be kept as a threshold value. To get an idea of the corrosion rates one can compare the acceleration factor of artificial aging with the rusting in nature. To improve the validity of laboratory test procedures, their results must be compared systematically with the results of realistic testing procedures like LTT in nature. The results of LTT may imply that there is no special need for high-performance pigmented coatings within the immersion zone because of the low through rusting values in general. But, more attention should be paid to the behavior of coatings in combination with the CP electric current in this zone, which induces stress on the coating by the propagation of hydroxyl ions. Here, as well as in the laboratory and field test, special primer systems are available which show good and acceptable results. According to the experiences of BAW (test of more than 400 systems from suppliers worldwide in the last decades), well-functioning primer systems are available from producers worldwide. Finally, guidelines for corrosion protection should help to figure out the best systems available by defining proper threshold values in test procedures, although this practice doesn’t necessary help with corrosion protection under such difficult conditions as an offshore climate. Laboratory test methods should include further chemical test procedures such as abrasion and falling weight tests. Contrary to that, pull-off values may show differences in adhesion between the coating layers but are not able to predict the anticorrosive potential of a coating system. This article was originally published in the Journal of Protective Coatings & Linings, and is reproduced here with permission.
HEMPEL LAUNCHES RANGE OF LININGS RANGE FOR TOUGH INDUSTRIAL APPLICATIONS

Hempel has announced the launch of its new Hempaline Defend Vinyl Ester range of linings, designed specifically for challenging applications where heavy-duty performance is critical to reducing corrosion and maximising production uptime.

The Hempaline Defend Vinyl Ester range for the power generation and oil & gas markets includes glass and mineral-flake filled coatings and fibreglass-reinforced linings.

In the power generation industry, the linings are used to protect the internal surfaces of flue gas desulphurisation units, ductwork and stacks in wet and dry environments. In both the power generation and the oil & gas industries, the new range of coatings can be used as tank linings, as well as to protect concrete surfaces, such as secondary containment structures, from aggressive cargos.

EPOXY COATING FOR MARINE NEWBUILDINGS

Hempel has also announced the launch of Hempadur Quattro XO 17820 in Canada, the US and Mexico, which completes the global availability of the Quattro coatings range. This high performance two-component pure epoxy PSPC compliant coating has been developed for the marine newbuilding sector. According to the company, Quattro XO 17820 was developed for water ballast tanks in new vessels, however it can also be used as a universal primer for most vessel areas – above and below the waterline – providing high quality performance and peace of mind for customers.

It was created specifically to suit the working methods of shipbuilders in the USA and as such has shorter re-coat intervals and reduced maintenance costs. Additionally, its higher (80%) volume solids content means less volatile organic compounds (VOCs) are released into the atmosphere, which is preferred in North America.

PPG LAUNCHES NEW CARGO HOLD COATING

PPG’s protective and marine coatings business has unveiled a new protective coating system that is reported to maximize performance for new builds and in maintenance.

NEW FAST CURING TANK LINING

Sherwin-Williams, Protective/EMEA has launched FASTCLAD™ ER tank lining, a high performance, fast return to service solvent free epoxy.

Independent testing has shown that the lining has superior flexibility, excellent edge retention and high-build properties. It is designed for single coat application by plural-component spray and offers a return to service of 24 hours or less depending on temperature, and in fabrication shops it will be cured to handle in about 3 hours allowing foot traffic and faster inspection.

One version of the lining is available with Opti-Check™, Optically Activated Pigments technology, for easier and more thorough inspection for pinholes, holidays and low film thickness.

The heavily cross linked amine curing system, provides high chemical resistance, flexibility and excellent barrier properties, which together deliver a high durability solution for long term service, concluded the company.

NEW INNOVATIVE PRODUCTS

visit the new ICorr website www.icorr.org
Corrosion Damage Repair

Subsea Industries has launched a new product for filling and building up a corroded and pitted steel surface to its original form prior to recoating. According to the company, Ecofix® is as tough as the steel itself, machinable, and can be used to repair most pitting or corrosion damage on rudders, stabilizer fins, thrusters and other underwater gear.

Ecofix is used in combination with Ecoshield coating to provide total protection, and is an effective alternative to metal facing or very expensive alternative fillers, concluded the company.

Metallisation Launched Sprayseal Range

Metallisation Ltd has launched Sprayseal, a new range of high performance capillary action penetrating sealers which are ideal for engineering and anti-corrosion thermal sprayed coatings, and some are safe to use in food and drinking water processes.

Typically engineering coatings and high performance corrosion coatings are sealed with deep penetrating sealers, which are usually difficult to apply or cure and have a short shelf life. According to the company, the Sprayseal range of sealers are generally easy to apply, cure and have a useful long shelf life.

There are four products available in the range, all are clear, transparent products specially formulated to give full permeation into all voids and cracks in thermally sprayed coatings, and can be applied by brushing, rolling, spraying or dipping.

Sprayseal-F - the most commonly applied, general use sealer, suitable for fine cavities of pore sizes from 0-0.1mm and is touch dry in six minutes.

Sprayseal-C - a similar formulation to Sprayseal-F and is suitable for larger pores from 0.1-0.5mm, and is touch dry in eight minutes.

Sprayseal-HT – offers temperature resistance up to 500°. And requires curing within one hour of application, suitable for pore sizes 0-0.1mm

Sprayseal-E – for maximum corrosion and solvent resistance, suitable for pore sizes 0-0.5mm. This flexible sealer can accommodate movement and expansion, is touch dry in 20 hours and can be machined in 36 hours.

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DIARY DATES 2016

Thursday 13th October
London Branch Meeting
Joint Meeting with LMS
Venue: Imperial College, Skempton Building, London SW7 2BB
Description: Corrosion of hip replacements – is it a problem?
-Refreshments provided, 21.00 Finish
For further information please contact: icorrabz@gmail.com or
jglynn@beanny.co.uk

Thursday 9th March 2017
London Branch Meeting - AGM
Details to be announced.

Thursday 8th December 2016
London Branch Christmas Lunch
To be held at ROSL, London, SW1A
1LR, (The Royal Overseas League Club is situated behind the Ritz).
Details to be announced.

Monday 5th - Tuesday 6th September 2016
57th Corrosion Science Symposium (organised by CSD)
Venue: University of Swaziland
Description: Further details including abstract submission will appear here in due course.

Wednesday 26th October 2016
Marine Corrosion Forum meeting
Venue: Lloyd's Register, London
Description: Topics covered include, new corrosion test methods, asset integrity management and law, MIC of Cu-Ni tube marine coolers, use of polymers to help limit corrosion and properties of CuNiCr for salt water applications.
Website: www.marinecorrosionforum.org

Tuesday 1st November - Thursday 3rd November
Institute of Corrosion Advanced Cathodic Protection Course
Venue: Holiday Inn, Stratford Upon Avon, CV37 6YR
Presented by Dr. Markus Büchler Director of the Swiss Society for Corrosion Protection.
Description: The course will cover the basics of chemistry and electrochemistry and introduce new insights into the mechanisms of CP.

The presentations will be interspersed with practical exercise, including CP design and measurement.
The Course is intended for senior cathodic protection engineers active in the design, specification and performance assessment of cathodic protection systems, and will be limited to 20 attendees.
For further details, and a registration form go to: www.icor.org.

Wednesday 30th November 2016
EC Seminar – Anticorrosive Coatings
Venue: Amsterdam, the Netherlands
Topics:
• How does corrosion occur?
• What surface preparation is necessary for an endurable coating?
• Which ingredients does a coating comprise and what are their roles?
• What are the current trends in corrosion protection coatings?
• What distinguishes water-borne from solvent-borne systems?
• How do self-healing coatings work?
Website: www.european-coatings.com/Events/European-Coatings-seminars-2016/Anticorrosive-coatings
Contact: Kristin Heuer – Kristin.heuer@vincentz.net
T: +49 511 99 10 272

London Branch publish a monthly Newsletter; to be included on the circulation list please contact Sarah Vasey sarah.vasey@sherwin.com

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