Coating Thickness
Material Analysis
Microhardness
Material Testing

Microhardness determination of coatings in the micrometer range

FISCHERSCOPE ® HM2000S

• Determination of plastic and elastic parameters
• Instrumented Indentation Test
• Thin coatings measurable
• Easy to use

HELMUT FISCHER
((your address))
((street & number))
((place))
Tel.: (+00) 00 000 00 00
Fax: (+00) 00 000 00 00
info@helmutfischer.xy

New Wall Thickness Gauge
The FISCHERSCOPE® Ultrasonics UMP Series measures wall thickness of pressure vessels, boiler tubes, storage tanks and more

• Field Upgradeable
• Vibrates on Alarm
• Compact Size
• Highly Repeatable
Contents

Issue 139 September/October 2017

4 The President Writes
4 Institute News
8 Industry News
10 Technical Article
Acceptance testing for Coatings in Insulated Service
14 Technical Article
Corrosion monitoring of offshore structures using acoustic emission sensors
16 Technical Article
Development of crevice formers for curved specimens
18 Innovative Products

19 Sustaining Members
24 Diary Dates

Published on behalf of the Institute of Corrosion
Square One Advertising and Design Limited
84 Queen Street, Sheffield
S1 2DW, United Kingdom.
Publisher and Managing Editor
Debbie Hardwick
Tel: 0114 273 0132
Fax: 0114 270 0422
Email: debbie@squareone.co.uk
Consulting Editor
Brian Goldie
Email: brianpe@aol.com
Design
Square One Advertising & Design
www.squareone.co.uk
Advertizing Manager
Jonathan Phillips
Tel: 0114 273 0132
Fax: 0114 272 1713

Email: jonathan@squareone.co.uk
Editorial copy date for November/December 2017 issue is: 10th November 2017
Subscriptions
UK £70.00
Europe £80.00
Outside Europe £90.00 airmail £80.00 surface mail
Enquiries and subscriptions to the Institute of Corrosion at the address below:
The Institute of Corrosion
President
Sarah Vaery
Former President
John Fletcher
Vice President
Gareth Hinds

Hon. Secretary
Dr. Jane Lomas
Barratt House, Suite 3, Kingshorpe Road,
Northampton, NN2 6EZ
Tel: 01604 438222
Email: admin@icorr.org
Website: www.icorr.org
All rights reserved Reproduction without written permission from the Institute of Corrosion is prohibited. Views expressed in editorial text or advertising copy are the opinions of the contributors/advertisers and are not those of the Institute or the Publisher.
ISSN: 13 55 52 43
The President Writes

Last month I had the pleasure of presenting the prestigious U.R. Evans award on behalf of the Institute of Corrosion. The award this year was presented posthumously to Prof. Hugh Isaacs, a leading figure in the corrosion field and fellow of the Electrochemical Society. The award was collected by Professor Mary Ryan who gave a very interesting lecture in recognition of his work. One of the things that this reminded me of was the wonderful community we work in. We are very fortunate to be part of the corrosion community, and work with the people we do, bringing to mind the importance of continuing these working relationships and friendships.

We need to keep our community vibrant and there are various initiatives within ICorr that we are hoping will help to facilitate this. For example, the Young ICorr group are planning an event in November which will be a lecture followed by networking, and I would encourage all ‘young’ members, and also some of your younger colleagues who are not currently members, to get involved. I was also able to attend the Aberdeen Branch Corrosion Awareness Day, which was a very well attended event with almost 70 people attending, and I believe a report on this will be in the magazine. Thanks must go to the Aberdeen committee, and all the speakers, for giving up their time to make this such a successful event.

We will also be running our first “Fundamentals of Corrosion” course in October – a new training programme aimed specifically at Engineers in the industry. Full details will be published on the ICorr website. It has just been announced that this year’s AGM will be hosted by Midland Branch and initial details are given in Local Branch section.

Finally I would just like to remind members that their subscriptions for 2017/2018 were due in July.

Sarah Vasey, ICorr President

From the Editor

The summer is well and truly over and we are now entering the planning stages for next year’s projects. I hope therefore the technical articles in this issue will be of help in these exercises. There is an excellent report from researchers at the Robert Gordon University in Aberdeen on the use of Acoustic Emission technology to monitor corrosion, and Michael Melampy of PPG, discusses the acceptance criteria for coatings used under insulation. Finally there is also a report from the recipient of the first Paul McIntyre award, Ulf Kivisäkk, who describes his research into crevice corrosion of stainless steels.

The ICorr website has been re-launched and in addition to the current copy of the magazine being available under the ‘membership services’ tab, more detailed versions of technical articles published can be found there.

Brian Goldie, Consulting Editor

Young Engineers Programme (YEP)

Following on from the successes of the 2012-13 and 2014-15 young engineers programme, the Institute of Corrosion will be running the next programme in 2018, starting in January.

There will be lectures on the subjects related to Corrosion in Oil and Gas, including, basic corrosion, welding, materials, coatings, painting, fire protection and linings, cathodic protection, chemical treatments, plus presentation skills.

As before, the series of lectures will be followed by case studies, with a presentation to be given at an event around the London area.

We are currently carrying out pre-enrolment for this programme, and are looking for around 20 participants in the early stages of their career in the corrosion industry and who are looking for extra experience to set them up for their future.

The lectures will be sponsored by BP and held at the CB&I offices in Paddington, London. There is no cost for this course for the delegates, and we would like to thank the sponsor and host for allowing this.

If you are interested in this event please fill in the application form which can be obtained from, Institute of Corrosion, Barratt House, Kingsthorpe Road, Northampton, NN2 6EZ, or Email:- admin@icorr.org

The applications will be reviewed by the YEP sub-committee, and you will be notified if you are successful. Deadline for receipt of applications is 30th November 2017.
Institute News

BRANCH NEWS

Aberdeen Branch

The branch closed its very successful 2016/2017 session with its annual Corrosion Awareness Day, which was well attended with 62 registrations supported by 6 excellent speakers providing a very successful, though very intense day, with many areas of corrosion introduced. This event was only made possible by the very generous sponsorship of Sherwin Williams together with all the Aberdeen Branch Sponsors.

Professor Paul Lambert (Mott MacDonald) provided a wonderful and gripping introduction to the day’s proceedings, outlining some key areas in the evolution of materials and corrosion control methods, as a background to other more specialised areas covered by the following speakers. Dr Carol Devine (ICR Integrity) followed with an amazing insight into the world of integrity wrecking bugs and how they can be controlled and detected, with some wonderful imagery that makes highly recommended viewing (https://sites.google.com/site/icorrabz/resource-center). Dr Nigel Owen (Aberdeen Foundries) gave us the view from the ‘Front Line’, as a busy foundry manager dealing with numerous metallurgical related casting issues, supplying the complex needs of the Cathodic Protection Industries, covering both Impressed Current and Sacrificial CP requirements and differing technologies.

After a well-earned break and some delicious catering provided by Palm Court, Sarah Vasey, ICorr President opened the afternoon CAD Session with a talk on the work of the Institute and its organisation. Malcolm Morris (Sherwin Williams) then gave us the 3 excellent insights into the world of corrosion mitigation by coatings, chemicals and materials selection with a strong practical bias and highlighted many relevant standards, recommended practices and legislation, essential to ensuring successful performance.

All this fitted very nicely into the final two talks by key Corrosion Management (CM) Specialists, Hooman Takhtechian (Oceaneering) who skilfully guided us into the concepts of CM, how it is geared to best utilising available resources, providing effective communications systems and the avoidance of risk to personnel, in often High Pressure / High Temperature operating environments. Dr Muhammad Ejaz (Plant Integrity Management) then wrapped up proceedings with a fascinating introduction to the world of Corrosion Modelling, its historical development and how it can be applied successfully today, which was coupled with a supporting presentation on Intrusive Corrosion Monitoring.

All in all, it was a very comprehensive training session of immense benefit that achieved its main objective of providing a most informative event at a very reasonable cost.

The Aberdeen Branch has further strengthened its management committee for 2017/2018 session and welcomes the following new members who will undoubtedly bring a wealth of new experiences and ideas to its work. Amir Attarchi (Senior Corrosion Engineer) at Oceaneering International, Dr Philip Enegela (Corrosion Engineer) at ATKINS Energy Division, Dr Nigel Owen (Manager) of Aberdeen Foundries Ltd, and Bryn Roberts (Managing Director) at ABR Engineering Consultants Ltd.

Sponsors and exhibitors are already booking, and confirmed sponsors include, National Grid (Platinum), Cathodic Protection Co. (Gold), Corrosion Technology Services Europe (Gold), 3c Corrosion Control Company (Gold), MetriCorr (gold), Rustrol Systems (Silver), Automa SRL (Silver), Intertek P & IA (bronze), and Weilekes Elektronik GmbH (Bronze).

Technical committee meetings are open to all, with high level technical papers on pipeline internal and external corrosion and protection. Bookings opened at the end of last month, and the hotel is already taking discounted room bookings (mention Ceocor).

Book this week in your diary NOW. Do not miss the best pipeline corrosion conference that will have been held in the UK for decades! Full details can be found at http://www.ceocor2018.com

(Below) Aberdeen CAD Day 2017 - Photograph kindly provided by Professor Paul Lambert (Mott MacDonald).
The branch will continue to hold its technical meetings at Imperial College, Skempton Building, London. The evening starts with the presentation at 18.30, followed by refreshments and networking between 19.30 and 21.00. For details of the next meeting, see the ICorr website.

Midland Branch

The Branch half-day Event & ICorr AGM will be held on Wednesday 29th November 2017, in the Chamberlain Room & Main Chamber, Birmingham Council House, Victoria Square, Birmingham.

Following food and refreshments from 12:30pm, the meeting will start at 1.00pm with a programme of three presentations given by corrosion specialists from industry and academia, followed by panel discussions.

The day will be rounded off by the ICorr AGM from 16:45 - 18:00pm

Outside of the Council House the Birmingham German Christmas Market will be taking place and attendees normally enjoy meeting up and having some German food and drink together after the meeting.

North West Branch

After a couple of years of inactivity it was decided to be more proactive and the first meeting of the new season was held on 4th September at Leigh Rugby Union Club, Leigh, where Chris Atkins, Chairman of the Institute of Corrosion Professional Development and Training Committee, gave an entertaining talk entitled “Cathodic Protection Training News – ISO 15257”. Over twenty people attended and despite the chaotic arrangements (the caterer let us down at the last minute and we had to find a replacement and we arrived to find the venue locked) everything went smoothly. Chris began his talk by explaining why CP certification was necessary, and went on to outline how the training scheme is progressing. The CP certification means that clients can be sure that people designing testing and installing cathodic protection schemes have the correct paperwork to demonstrate competence in the correct area, not just a generic CP qualification. It also means that those installing CP systems can demonstrate to clients they have the right skills for the job, and justify why they should be included on CP tenders and they have. It also means they have the best chance of not having to repeat work and revisit sites to rectify problems caused by using unskilled, uncertificated people.

ISO 15257 has been published, which means the current BS EN 15257 will become BS EN ISO 15257. This standard extends the reach of the Cathodic Protection (CP) training and certification scheme and incorporates the existing NACE CP scheme. As a result the certification paperwork and training courses need a little tweaking (the ISO has 5 levels and the BS EN currently only has 3). Levels 1 to 3 in the current CP schemes correspond to levels 2 to 4 in the ISO scheme.

North East Branch

The next meeting of the Branch will be at the beginning of November with a presentation by Barry Turner of BS Coatings. The date and venue will be posted on the website in due course.

LONDON BRANCH EVENT

Thurs 19 October 2017, 17:30 for 18:00
From the Foundations of Electricity to Modern Corrosion Failures
Organised by SCI’s London Group and the Institute of Corrosion
SCI, 14/15 Belgrave Square, London, SW1X 8PS

1750 - Benjamin Franklin’s Electricity Experiments: Dr Fred Parrett, SCI London Group Chair & Parrett Technical Developments

Before the first batteries were invented and we could experiment with direct current, early experiments were all with static electricity. The most significant and well documented were those by Benjamin Franklin around 1750. Well known for his kite experiment with lightning, but he did so much more. This presentation will outline the Science of Benjamin Franklin and link to his life not just in the USA but the 18 years he spent living in London.

2017 - AC Corrosion on Pipelines - a serious hidden problem: Dr David Eyre, independent consultant

Corrosion is controlled on high pressure oil and gas pipelines by application of a high quality coating system, supplemented by cathodic protection (CP). AC Corrosion is a recently identified form of corrosion that can cause rapid full-wall penetration on coated pipelines by induced AC current, even with a fully functioning CP system. This can occur when the buried pipeline parallels overhead HV powerlines. This talk will describe how the AC is generated onto the pipeline, the corrosion mechanism and how the risk can be assessed and mitigated.

The event is free to attend, but please register in advance via http://bit.ly/LG191017 to avoid disappointment. The event is open to SCI, ICorr, IOM3, LMS and TWI members and guests.
Make holiday detection safer, easier and more reliable with the Elcometer 280 Holiday Detector.

www.elcometer.com

Visit the ICorr website for all the latest news

www.icorr.org
New research aims to combat corrosion in demanding environments

A new multimillion pound collaborative research project, ‘Preventing Surface Degradation in Demanding Environments’, funded by the Engineering and Physical Sciences Research Council (EPSRC), brings together world class researchers from BP, the University of Manchester, Imperial College London and the University of Cambridge, who already work together on corrosion research through the BP International Centre for Advanced Materials (BP-ICAM), plus additional expertise from the Universities of Edinburgh and Leeds.

Corrosion and wear processes have very significant societal, economic and safety implications for industry. From tools and machinery to oil pipes, platforms and refineries, many industrial assets are susceptible to these surface degradation problems. This is especially true when they’re exposed to demanding environments that the oil and gas sector encounters.

Professor Philip Withers, the University of Manchester’s Regius Professor of Materials and the Principal Investigator on the project, said: “Although there have been impressive strides in the empirical understanding of corrosion, many of the underpinning assumptions and industrial practices date back decades.”

The collaborative team have received £5m of joint funding from the EPSRC and BP to investigate the processes that cause surface degradation and to develop new strategies to mitigate them.

Dr Angelo Amorelli, BP’s Technology Vice President of Group Research said: “BP has identified surface degradation as a high priority area for future research, so we are delighted to have been awarded funding by the EPSRC to address the problems of corrosion and wear in one large collaborative project. We hope to extend the safe operational lifetimes of current materials and develop new materials which will ultimately be of great benefit to multiple industrial sectors.”

Rebar Corrosion Testing Needs a Revamp

According to researchers at ETH Zurich, it is hard to know for sure when rebar corrosion has started, because the size of concrete samples commonly taken for lab testing is simply too small.

Laboratory testing is one method of determining to what extent chlorides from road salt—which can penetrate the concrete such as bridges and cause steel rebar to rust. The researchers have come up with a formula that they say could help to make lab testing more accurate, and could also be applied to sensors on the structures themselves that serve to detect corrosion.

According to ETH professor Bernhard Elsener, the chloride concentration in the samples is calculated in the laboratory, and if the sample exceeds the critical threshold of 0.4 percent relative to cement weight, not just near the surface but in the deeper levels, the assumption to date has been that corrosion could soon set in and that repairs were required.

Typically, these samples are 5 to 20 centimetres, which allows for easy handling in the laboratory. But the downside is, according to ETH that the conclusions drawn from the studies of these samples are often incorrect.

Ueli Angst, professor at the Institute of Building Materials, explained that in the research project reinforced concrete specimens of various sizes were examined and it was discovered that corrosive chloride concentration was far more apparent in smaller samples, and subject to larger fluctuations than in larger specimens, also only the analysis of a larger specimen, say a metre long, allows for a realistic assessment of the condition. In order to address the complications presented by such a sample, ETH researchers have devised a mathematical formula that allows conversion of the critical threshold in a certain specimen to any other size. This replaces the fixed critical threshold of 0.4 percent.

Protective Coating Supplies – the “One Stop Coatings Shop”

For the Contractor, the advantage of being able to get independent advice on the different coating products and systems available for a particular project, is a major benefit.

One such “one stop shop” has now been set-up in the SE of England serving primarily, but not exclusively, the Oil & Gas Industries. “BEANNY” a stockist, importer and certified distribution centre, can supply coating products from many manufacturers including those from SPC, International, Jotun and together with the technical expertise of the staff, can make the difference to the profitability of a contract.

Further details can be obtained from, jglynn@beanny.co.uk
Corrosion performance of blended cement concrete in marine environment

Blended cement is widely used in critical structures, mainly because of its enhanced corrosion resistance, and the performance of this material in marine environment has been investigated in a study by Indian researchers. In a paper published in Construction and Building Materials, the results of the long term corrosion performance of Portland pozzolana cement (PPC) and Portland slag cement (PSC) concrete, under the three marine exposure conditions, atmospheric zone (AZ), immersion zone (IZ) and splash zone (SZ) at the Offshore Platform Marine Electrochemistry Center (OPMEC) in Tuticorin, India, are described.

The concrete cubes were exposed over the period of 10 years and their physicochemical properties such as compressive strength, alkalinity, free chloride content and sulphate content, bio-fouling attachment and electrochemical properties like, AC-impedance and potentiodynamic polarization were measured, and the results obtained were compared with Ordinary Portland Cement (OPC) concrete. It was observed that strength and alkalinity of the blended cement concretes were roughly equal to that of OPC concrete, and in addition, the pH values of the blended cement concretes were above the threshold limit recommended for depassivation, and the resistance to chloride ion penetration was significantly reduced. The electrochemical studies revealed that the blended cement concretes had higher corrosion resistance in all three exposure zones. From the results it was concluded that the blended cement concretes are highly recommended for aggressive marine environments rather than OPC concrete.

The Global Market for Advanced Paints & Coatings to 2025

The Global Market for Advanced Paints & Coatings to 2025 addresses the current solutions the paints and coatings industry is finding to meet new challenges and the materials and processes they are using to develop advanced and novel paints and coatings with excellent and sustainable performance, multi-functionality and long service life. The report includes an in-depth analysis of the global advanced paints and coatings market broken down by applications, revenues and market growth forecasts to 2025. The key challenges for the global advanced paints and coatings market, and a market by market assessment by coatings type are also described together with profiles of 325 advanced paints and coatings companies.

SSPC, The Society for Protective Coatings

A new publication, SSPC Guide 23, describes five common field methods of determining moisture content in substrates including painted and unpainted concrete and masonry walls (including concrete masonry units, brick, stone, poured-in-place, pre-cast and tilt-up). The new guide includes generic descriptions of equipment used in measuring moisture content, conditions necessary to perform testing, test procedures and other considerations affecting test results. SSPC Paint 41, Moisture-Cured Polyurethane Primer or Intermediate Coat, Micaeous Iron Oxide Reinforced, Performance-Based, has been revised. This standard provides lab testing benchmarks and acceptance criteria for the generic coating type in its title. The revision involves an expansion of the scope of the standard, which now allows for the moisture-cured polyurethane primer to be used either as a direct-to-steel coating or as an intermediate coat over a compatible primer. Paint 41 has also been revised in relation to standard testing conditions, requirements of liquid coating, laboratory testing of applied coatings and scribe evaluation.

Standards

ISO

Final draft International Standards that have been submitted to the ISO member bodies for formal approval by the date shown.


New standards issued:

ISO/TR 20436, Buildings and civil engineering works — Sealants — Paintability and paint compatibility of sealants.

CEN

New standards issued over the last two months.

EN ISO 15257, Cathodic protection - Competence levels of cathodic protection persons - Basis for certification scheme (ISO 15257:2017).


EN 13523, Coil coated metals - Test methods - Part 21, Evaluation of outdoor exposed panels; Part 24, Resistance to blocking and pressure marking; Part 8, Resistance to salt spray (fog).
Corrosion under Insulation (CUI) is accelerated corrosion that takes place under insulation that is typically used to conserve energy, help with process control and protect workers from temperature extremes. CUI is an issue for facility owners in many industries that use heat or cold in their industrial processes including chemical processing, refining, fertilizer manufacturing and power generation. Insulation used in these applications is generally mechanically attached to the substrate vessel or pipeline and is usually covered with cladding. Cladding is most often made of metal or plastic and is applied to protect the insulation from physical damage and to keep water away from the insulation and substrate. Eventually, water and entrained contaminants can leak through the cladding and get in to the insulation, creating a cooling effect when it comes into contact with the carbon- or stainless-steel substrate. It is widely accepted that corrosion happens more quickly at higher temperatures approaching 100°C [1] when a corrosion cell exists, and it is also understood that the electrolytic concentration created by the evaporation of contaminated water in the insulation assembly can lead to accelerated corrosion. Further, process shutdowns, both planned and unplanned, allow for accelerated CUI corrosion. CUI can result in substantial section loss of substrate materials that can lead to perforation of the piping system of operating equipment. Depending on what is flowing through the equipment, a perforation may result in a high-pressure steam leak or a hydrocarbon liquid or gas leak, which can lead to fires (pool fires and jet fires) and explosions. These leaks can cause significant damage, personal injury, environmental contamination, lost production time and a poor perception of ownership by the public. All of this equates to a substantial cost to the owners and stakeholders of businesses affected.

Prevention
CUI can be prevented with the proper selection of substrate materials, coating materials, insulation materials and cladding materials. The best way to prevent CUI is to limit it by not insulating equipment unless it is necessary to save energy, improve the manufacturing process or avoid personal injury. Uninsulated equipment must still have corrosion protection, however; it is much easier to maintain in the long term. The overarching issue is the cost related to having a good design life versus the initial cost. Speciality alloys and other construction materials can be used to prevent CUI. In some cases, these materials are used if the risk of failure is too high, or if maintenance and repair are too difficult. Although many of these alloys can be expensive, they can eliminate the need for corrosion protection and future maintenance.

Most often, an owner and engineer will rely on coatings, combined with proper insulation and cladding. These three components can be thought of as a three-legged approach to CUI prevention. The three legs being, weatherproofing, insulation material, and the protective coatings system. This article will focus on protective coatings, and explore coatings selection and use, based on generic coating types, and application needs.

Coatings are most often the last line of defense against CUI. The owner and engineer should select the best coating from a first cost and/or lifecycle cost analysis, with cost versus performance weighed over differing specific temperature ranges.

Coating Selection
Many insulated surfaces operate under 150°C and at these temperatures insulation very rarely dries out completely. For environments operating under this temperature, a coating system for CUI should be able to sustain full-time immersion service and of course boiling water. For environments operating at temperatures above 150°C, the coating material will have to survive boiling water and intermittent immersion service. All CUI coating systems should be able to withstand thermal shock and thermal cycling over the operating temperature range. It is very important for the owner and engineer to know the specific thermal issues for a process unit. Usually coating selection is made based on the maximum design temperature. The design temperature should take into account the maximum temperature of a process, including upset temperatures and/or the result of high-pressure steam cleaning of pipe and vessel interiors during shutdowns. The owner and engineer must ensure that the design temperatures are accurate and not under or overstated. There are many coatings that can be used to prevent or reduce the development of a corrosion cell. Various formulations can provide different levels of performance including hardness, ability to flow, wetting, film creation, adhesion, permeability and chemical resistance. A coating can be modified to resist higher temperatures, but only to a certain degree given the resin binder system. Organic coatings usually have lower temperature limits, compared to inorganic systems — at higher temperatures organic materials can thermally degrade.

The owner and engineer should consult with the operations staff about the actual operating conditions including any peak temperature excursions as a result of process upset conditions, or other operational activity. For example, the operations staff would know that high-pressure steam cleaning of the production lines and vessels occurs as needed to ensure product flow and efficiency and to allow for site inspection. The high-pressure steam (and resultant temperature) will typically be based on the available steam source within the facility, and this is often up to 230°C and for 24 to 48 hours, thus exposing any coatings to these peak temperatures. As shutdown time must be limited from a business perspective, the refinery or petrochemical facility may choose to use nitrogen to flush the condensed water out of the process lines, subjecting the pipelines to significant thermal shock. This and other upset conditions should be evaluated with the operations staff before making a coating system selection.

Another important aspect of coating system selection includes the filler or pigments used. Some fillers are ceramic; others may be metallic. Metallic pigments such as zinc and aluminium can offer sacrificial corrosion protection for carbon steel but are consumed if a corrosion cell is present. Ceramic fillers such as micaceous iron oxide and glass flake can help provide barrier protection and these materials will not be consumed in the corrosion process. Barrier protection is increased because the filler flakes provide a laminar matrix which helps to reduce the permeability of the coating materials. Many coatings include corrosion inhibitors in the coating system to help reduce corrosion.

Coatings used for CUI
For many years, owners and engineers believed that for typical continuous service temperature operations above 120°C coating protection was not needed. The belief was that at these, and higher temperatures, corrosion could not begin because there would be no water present and therefore a corrosion cell could not develop. However, production lines needed to be shut down on a somewhat regular basis for planned and unplanned maintenance and as a result, the temperature would drop to below 100°C and with water present from leakage or condensation, corrosion would begin. Further, the insulation used was prone to soaking up and holding water — often with enough water to cool down the production line even during operation — to the point that corrosion could begin.
Additionally, the cladding material would become damaged from workers or by other means and result in even more water entering the insulation and cladding system. As a result, much more corrosion developed than was ever anticipated.

Even today, some companies still do not coat pipelines and vessels and others do not provide corrosion protection for operating conditions over 175°C. In some cases, owners may choose to replace pipes on a regular basis.

**CUI Environments**

NACE SP0198, “Control of Corrosion Under Thermal Insulation and Fireproofing Materials — A Systems Approach” [2] provides guidance as to the use of generic coating systems in several temperature ranges. Table 1 provides a summary of generic coating systems with guideline recommendations for maximum temperatures.

With this information and with experience in the field, a potential classification of CUI environments might be developed as depicted in Table 2. Note that the maximum temperature in this table is 450°C as there are not many situations where coatings are used above this temperature, and it is best for the manufacturer and the owner to have an agreement as to the specific testing requirements. This table provides temperatures for both continuous and cyclic peak temperature ranges. The operating condition of the equipment will dictate the CUI environmental classification based on the maximum temperature of the substrate during operations, upset and/or maintenance operations, such as steam cleaning. Further, these environmental classifications focus on peak temperature ranges as opposed to an overall temperature range. This is important as experience dictates that coatings that can meet the performance requirements for very hot conditions may not perform as well as other coatings in situations where the temperature never gets too high. As such, a coating designed and tested for use at 350°C may have a shorter life and fail quickly at 90°C, while a coating such as an epoxy phenolic may perform very well at 110°C, but could fail at 350°C.

**Testing**

Coatings for CUI must withstand all the challenges associated with higher temperatures, thermal cycling, thermal shock, continuous high temperature, and when approaching 100°C, boiling water. The proposed testing methods are not designed for sacrificial coatings such as inorganic zinc or the porosity

<table>
<thead>
<tr>
<th>System</th>
<th>Type</th>
<th>Surface Preparation</th>
<th>Temperature</th>
<th>No of coats/ DFT (µm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS-1</td>
<td>HB Epoxy</td>
<td>Sa2½</td>
<td>-45 to 60°C</td>
<td>2/250</td>
</tr>
<tr>
<td>CS-2</td>
<td>FB Epoxy</td>
<td>Sa2½</td>
<td>-45 to 60°C</td>
<td>1/300</td>
</tr>
<tr>
<td>CS-3</td>
<td>Epoxy Phenolic</td>
<td>Sa2½</td>
<td>-45 to 150°C</td>
<td>2/250</td>
</tr>
<tr>
<td>CS-4</td>
<td>Epoxy Novalac</td>
<td>Sa2½</td>
<td>-45 to 205°C</td>
<td>2/300</td>
</tr>
<tr>
<td>CS-5</td>
<td>TSA</td>
<td>Sa3</td>
<td>-45 to 700°C</td>
<td>-/300</td>
</tr>
<tr>
<td>CS-6</td>
<td>Inorganic Copolymer, Inert Multi Polymer Matrix</td>
<td>Sa2½</td>
<td>45 to 50°C</td>
<td>2/250</td>
</tr>
<tr>
<td>CS-7</td>
<td>Thin film Petroleum or Tape</td>
<td>Sa2½</td>
<td>-45 to 60°C</td>
<td></td>
</tr>
<tr>
<td>CS-8</td>
<td>Bulk or Shop Primed IOZ with topcoat</td>
<td>NA</td>
<td>-45 to 400°C</td>
<td>/ various</td>
</tr>
</tbody>
</table>

Table 1: NACE SP0198, Summary of Table 2.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Minimum Temperature</th>
<th>Peak Temperature Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>CUI-1</td>
<td>-45°C</td>
<td>-45 to 60°C</td>
</tr>
<tr>
<td>CUI-2</td>
<td>-45°C</td>
<td>60 to 150°C</td>
</tr>
<tr>
<td>CUI-3</td>
<td>-45°C</td>
<td>150 to 205°C</td>
</tr>
<tr>
<td>CUI-4</td>
<td>-45°C</td>
<td>205 to 450°C</td>
</tr>
</tbody>
</table>

Table 2: CUI Environmental Classifications
associated with thermal spray aluminium coatings (typically under 200 microns), which can be very susceptible to corrosion in wet environments, nor is it appropriate for tape wraps, which may require specialised testing.

**Standard Weathering Testing**

Weathering testing is critical as it is well understood that coatings may be applied to new construction equipment and that these pipes, spools and/or vessels may not be put into service for a considerable period of time. In addition, weathering testing must be done to evaluate how a coating will perform after it has been heated for a period, such as during an outage and/or mothballing of the facility.

Panels can be prepared for testing, for both as-applied and conditioned, as well as applied, conditioned and then heat conditioned. Heat conditioning of panels involves heating the panel to its maximum temperature for 20 hours, followed by air cooling for four hours, repeated ten times for a total of 200 hours of exposure to the maximum temperature of the CUI classification (Table 3).

These panels can then be tested in accordance with the acceptance criteria described in Table 4. Moreover, in keeping with 12944-6(1998) [3], pre- and post-adhesion tests are required per ISO 2409 [4] and/or ISO 4624 [5], with acceptance criteria as a 0-2 or 5 MPa (other conditions may apply).

**CUI Test Method**

A coating for thermal service above 100°C must also demonstrate that it can survive cyclic boiling water, steam and dry conditions with considerable time in intermittent immersion service. The multiphase CUI cyclic corrosion test is a practical and easy-to-understand test method that can help determine minimum requirements. This test method duplicates situations that can occur in facilities. In general, the test procedure consists of the components depicted schematically in Figure 1a.

**Thermal Cycling Testing**

A CUI coating should be able to withstand any thermal cycling within its temperature classification. This test includes heating the panel until it reaches the maximum temperature of the classification and then dipping it into ice water until the steel temperature is lowered to the minimum temperature (Table 5).
A square pipe is used with a closed-loop oil heater. Surface temperature is typically at 150 or 175°C. The coatings to be tested are applied to the outside of the pipe on all four sides. Several coatings can be tested at once. There are 15 cycles consisting of four hours in a hot and dry environment, four hours in a hot and wet environment, 48 hours in an ambient (cool) environment during a week, with the entire cycle repeated a total of six times. The wet cycle uses a 5 percent NaCl water solution pumped into a surrounding chamber so that the lower half of the square tube test cell is immersed in the solution which then boils until it is completely dried (approximately 3.5 hours). This test is only appropriate for CUI environments above 100°C and therefore only appropriate for CUI-2, CUI-3 and CUI-4 classifications. For testing CUI-2, the hot oil heater would be set at 150°C and for testing CUI-3 and CUI-4 the hot oil heater would be set at 175°C. It has been demonstrated that 175°C provides the best test for challenging a coating for CUI. Hotter and cooler temperatures result in less coating degradation. Evaluation of the test panel is completed at the end of the six-week test with acceptance criteria as defined in Table 6.

Optional Testing
Testing for cryogenic service would include thermal cycling from -195°C to the maximum of the CUI environmental classification several times to ensure the coating's ability to withstand the relevant thermal expansion and contraction. Other testing can be required as agreed upon per the interested parties.

Conclusions
In developing four CUI environmental classifications based on peak temperature ranges, and in keeping with NACE SP0198, manufacturers, engineers, constructors and owners can begin to speak the same language about requirements for coatings in insulated service. The interested parties can then develop a testing regime and acceptance criteria based on specific temperature ranges.

Currently, owners must choose coatings for CUI service based on individual manufacturers test results or develop their testing protocol based on their experiences. This proposed testing regime allows for third-party testing laboratories to provide certifications as to a coating’s compliance with these test methods and would enable owners to choose between coatings that meet minimum requirements. Adoption of these test methods as an acceptance tool, with an eye to improve these testing methods in the future, is key to lowering owner costs and improving the performance of CUI coatings in the field.

References
(4) ISO 2409:2013, “Paints and varnishes – Cross-cut test”.

Editors Note: This article was originally published in the Journal of Protective Coatings & Linings, March 2017.
Corrosion monitoring of offshore structures using acoustic emission sensors

N. H. Faisal, M. G. Droubi, J. A. Steel, School of Engineering, Robert Gordon University, Aberdeen, UK

Corrosion of metals is a major threat to the integrity of assets throughout their life because it can cause deterioration of materials during operation, which may lead to leakages, failures and harm to operators and the environment. In the specific case of offshore facilities, highly corrosion resistant steel components (CRAs) are being increasingly used (e.g. drilling and production technology, infrastructure, risers, storage tanks and wind turbines, etc.) to give longer component life times. All materials have their limitations however, and for all facilities, early detection of deterioration by means of non-destructive testing (NDT) is crucial to maintain operational success, safety and security.

Corrosion can be defined as the degradation of a material due to a reaction with its environment and the effects of corrosion can potentially damage every component to varying degrees, according to its operating environment. Over the years, several companies have developed in-house corrosion testing methods, procedures and best practices that reflect the best of the company’s technical knowledge on methods of design, operation, maintenance and construction of hydrocarbon processing facilities and other industrial or marine facilities, along with all other supporting assets and equipment adapted to suit various corrosive environments. Some of the monitoring techniques include electrochemical noise, hydrogen permeating and electrochemical impedance spectroscopy techniques, electrical resistance probes, linear polarization resistance probes, process stream monitoring (composition, flow, pressure and temperature), ultrasonic thickness measurement weight loss coupons, and zero resistance ammetry. One developing method that can be used to monitor corrosion is by Acoustic Emission (AE), which refers to the generation of transient elastic waves produced by a sudden redistribution of stress in a material.

Corrosion monitoring is expedient when considering offshore structures such as subsea pipelines or wind turbine structures. This is because the marine environment which combines the effects of saline water, salt laden air, rain, dew, condensation, localised high temperatures and the effects of combustion gasses; is one of the most corrosive environments that cause materials to corrode more rapidly. To prevent the problems mentioned above, it is crucial to monitor materials in these corrosive environments so that replacements or repairs can be carried out at planned intervals / maintenance periods. This can be done in several ways, however downtime is a major factor to consider when monitoring equipment for corrosion and this has resulted in the resurgence of NDT methods which allow for inspection with minimum or non-existent downtime requirements.

This article summarises the AE based technique to monitor corrosion process of metals in corrosive conditions.

**AE Instrumentation and measurement**

AE is a non-destructive sensor based technique which detects and measures the conversion of high frequency (up to 1 MHz) elastic waves generated by the rapid release of energy, to electrical waves produced by AE sensors producing a frequency response between 100 kHz and 1 MHz. The sensors are held onto the flat test specimen surface using masking tape or custom made magnetic clamps (Fig. 1a). To obtain good transmission of the AE signal, the surface is kept smooth and clean and silicone high vacuum grease is used as coupling fluid to fill any gaps caused by surface roughness and to eliminate air which might otherwise impair wave transmission. Before every test, the sensitivity of the sensor is checked by breaking a lead pencil close to it, to ensure signal detection. Preamplifiers are used to amplify the AE signal to a level that can be carried by appropriate cables and converted by an analogue to digital converter (ADC). Multi-channel acquisition appropriate software for controlling the acquisition and storage of data. The AE sensors, mainly made from lead zirconate titanate (PZT), are generally broadband differential AE sensors producing a frequency response between 100 kHz and 1 MHz. The sensors are held onto the flat test specimen surface using masking tape or custom made magnetic clamps (Fig. 1a).

Figure 1: Scheme of corrosion monitoring using AE sensor on plate-like offshore structures: (a) single AE sensor method on a carbon steel plate with corrosion source distances shown by arrows at grids, and (b) three AE sensors mounted on a carbon steel plate, to determine the corrosion source location. (In method (b), three sensors can be mounted on an infinite plane and are used to simplify the situation, and the velocity of the wave in the material, V, is assumed constant. Time difference parameters can be obtained by thresholding techniques. Solving the set of equations gives the location of the source in a polar form (R,θ). D1 and D3 are the time difference between sensors 1 and 2, and 1 and 3, respectively (Fig 1b) adapted from ref. 6)
of raw AE signals requires high performance data sampling and compatible computer systems, so an appropriate data acquisition card (DAQ) must be used.

Analysis and interpretation of AE signals in practice (recording and signal processing) from corrosion monitoring is a complex area and thus the AE must be regarded as representing an accumulation of many events within a given time window and so only an averaged energy can be obtained. For the purposes of assessing the correlation between AE and corrosion events, one characteristic of the energy associated with the significant AE is approximately proportional to the area of new corrosion crack surface formed.

It is important to note that the AE from corrosion usually releases much less energy than emission from crack growth, and so is more difficult to detect in a noisy offshore field environment. For AE sensor(s) to detect corrosion, the corrosion needs to be active, however the presence of inactive corrosion may be missed due to any scale to fracture by changing the strain sufficiently on the base material. A more detailed description of AE measurement can be found in references [1,6].

**Corrosion monitoring of metals using AE sensors**

There are numerous literature references, and practices, related to corrosion monitoring using an AE sensor, and nearly all presented an equivalent conclusion that such sensors can detect corrosion efficiently. A variety of corrosion types including uniform corrosion, pitting corrosion, crevice corrosion, stress corrosion cracking, abrasion corrosion and IG-SCC corrosion have been considered and found to be correlated with AE [1]. The advantages in using AE to study stress corrosion cracking (SCC) and pitting have been clearly evidenced in some of the recent work. For example, Calabrese et al. [2] used AE to evaluate the corrosion behaviour of 13% Cr martensitic stainless steel under tensile load in an acidified chloride solution. They claimed that AE monitoring allowed them to distinguish and identify different damage mechanisms and found to be correlated with AE [1]. The advantages in using AE to study stress corrosion cracking (SCC) and pitting have been clearly evidenced in some of the recent work. For example, Calabrese et al. [2] used AE to evaluate the corrosion behaviour of 13% Cr martensitic stainless steel under tensile load in an acidified chloride solution. They claimed that AE monitoring allowed them to distinguish and identify different damage mechanisms and found to be correlated with AE [1].

In another study, Alvarez et al. [4] compared the AE signals generated by the trans-granular stress corrosion cracking (TG-SCC) of Ag–10Au single crystals and those originated by the intergranular stress corrosion cracking (IG-SCC) of a polycrystalline silver–gold alloy under the same experimental conditions. The AE signals measured during both TG-SCC and IG-SCC propagations in three different alloys such as a-brass, AISI 304 SS and Ag–10% Au, showed similar AE parameters and similar amplitude distribution. Such similarity might indicate that, whatever the SCC mechanism acting, the AE signals originated from the same process which may be a valuable contribution to the detection and monitoring of SCC cracks by AE. In more applied study, Kovac et al. [5] have proposed the use of AE burst time and power spectra features for automatic detection of SCC for stainless steel material. They have claimed that the sizes of ductile fracture areas can be estimated based on a relative comparison of the energies of the detected AE bursts. However, no significant difference in AE characteristics was observed between crack propagation and specimen failure.

AE techniques have also been used (e.g. by Jomdecha et al. [6]) to evaluate initiation and propagation steps in pitting corrosion of austenitic stainless steels. In their investigation during early stage of pitting initiation, the AE events were not related to the corrosion process itself but to the more acoustical active mechanism of hydrogen evolution mainly because of bubble friction along pit walls. Short range crack propagation (due to high stress intensity at nucleated SCC crack tip) and long range crack propagation (assisted by anodic dissolution at the crack tip) have also been successfully identified by AE technique [6]. In one of the related investigations, Wu et al. [7] used the AE sensor to monitor the pitting corrosion on vertically positioned 304 stainless steel specimens. AE activities were detected within a very short period of pitting commencement, and these activities increased as the pitting continued. Wu et al. [7] proposed a relationship between AE energy and pitting progress by monitoring low and high energy AE signals, and claimed that the low-energy signals were believed to originate from the hydrogen-bubble evolution inside the pits, while the high-energy signals were attributed to the rupturing of the pit covers during the pit growth.

**Standardisation of AE based corrosion monitoring**

If monitoring methodologies can be developed for various offshore structures; AE should be able to monitor corrosion inexpensively, without stopping any operations (e.g. pipeline flow or storage) in inaccessible areas. There may still be challenges in predicting the exact location of the corrosion in large structures, but this signal should provide data so that a reasonable assumption can be made of what area is affected. The strength of the energy in the signal can also provide data on the extent of the damage caused by corrosion. In terms of standardisation of instrumentation and measurement schemes, BS EN 15856:2010 is the only standard which directly provides a general principle of AE testing for the detection of corrosion within liquid-filled metallic vessels. ASTM STP 908-1986 summarises the general principles of AE testing for the detection of corrosion.

**Conclusions**

It is undeniable that offshore structures have grown profoundly in importance and their contribution to industries such as those involved in oil and gas and new green energy production will continue to rise in the forthcoming years. While corrosion is a real threat to the operational and structural integrity of offshore structures, there is a necessity for an improved understanding of operational conditions coupled with efficient condition monitoring capabilities (both wired and wireless for remote access) and knowledge of the materials and damage mechanisms associated with different types of corrosion that might be encountered in harsh offshore environments. While there are certain limitations in the application of AE technique, such as corrosion source not calibrated so that trending is commonly used, and that usually some form of calibration is also needed. Monitoring corrosion using an AE sensor (for monitoring localised corrosion and inaccessible locations) has the potential to allow the identification of significant cost savings through loss control, prioritising of maintenance based on quantitative information and effective operations and maintenance troubleshooting. Types of analysis can...
Development of crevice formers for curved specimens

The Paul McIntyre award is presented to a senior corrosion engineer, who, as well as being a leading practitioner in his field, has advanced European collaboration and international standards development (in keeping with Paul’s areas of interest). The recipient of the inaugural award was Ulf Kivisäkk from AB Sandvik Materials Technology R&D in Sweden.

The award was presented at the recent CED working day (see May/June Corrosion Management), and acknowledged Ulf’s work on developing an ISO standard test method for assessing crevice corrosion of stainless steels.

The following article describes his work in more detail.

It is well known that crevice corrosion is an important factor for stainless steels in seawater, and in many cases the onset of crevice corrosion regulates the maximum service temperature. For more than two decades crevice corrosion testing was an important activity within the EPC working party Marine Corrosion, and several test programs were initiated. In the first two test programmes for crevice corrosion in natural seawater, the results did not correlate to the service experience, and in addition, the reproducibility was poor and large scatter was present in the results both between different laboratories, and within one laboratory. For instance, the standard austenitic grade Type 316L did not suffer from crevice corrosion after six months of exposure.

It is known that the influence of environmental parameters such as temperature, crevice geometry, type of seawater, oxygen content and the confinement, affect the crevice corrosion resistance of stainless steel. Therefore, an EU funded project ‘Crevcorr’ was initiated by the working party, in which a reproducible specimen set-up was developed for both flat and curved specimens. In the same project, parallel work with a new bio-synthetic seawater, as well as procedures for field exposures and electrochemical testing, were established.

Disc spring set-up

One major disadvantage with the standard bolt and nut fastened polymer crevice former used is that the clamping force is not constant with time and temperature. The clamping force determines the crevice gap, which alongside the crevice depth, are important parameters for the initiation of crevice corrosion as demonstrated by modelling. One way to maintain a constant clamping force is to use disc springs and in the ‘Crevcorr’ project, a disc spring controlled set up was developed (figure 1). For testing in natural seawater without electrochemical control, the dimensions of the specimen were defined as 10x10 cm in order to have enough cathodic area. For crevice formers, PVDF was chosen since it has stable mechanical properties within the testing temperature range of up to 90°C, and therefore the loss of clamping force that was typical for PTFE crevice formers at temperatures higher than ambient can be avoided. Together with an improved test procedure, reproducible results from both laboratory testing and field exposures were achieved. After field exposure at six laboratories for six months, all Type 316L samples experienced crevice corrosion. This was a major improvement compared to two of the earlier test programs carried out by the working party, in which 45% and 50% of the specimens surprisingly passed 6 months laboratory testing in natural seawater.

Curved Specimens

In order to achieve similar crevice conditions on a tube as for flat specimens, finite element modelling (FEM) was used. During the modelling the clamping force of the crevice former on the specimen for tube, as for flat specimen, was determined for several tube dimensions. By adjusting the clamping force, it was possible to achieve similar conditions inside a crevice. Due to the curvature of the tubes and therefore the crevice formers, pressure along the crevice gap is not constant. However, the results of the FEM modelling in figure 2, showed that for a small diameter tube the distribution of the surface pressure is greater than for a larger diameter tube. It also shows that the distribution is in the radial direction. Therefore, the grey area (in figure 2) representing the same clamping force as for flat specimens has a similar size in both configurations.

As an outcome of the modelling, a calibration curve of the clamping force versus the tube diameter was made (figure 3). The curve represents a new method where the maximum clamping force is similar to that in flat specimens. For a standard duplex stainless steel, UNS S31803, crevice corrosion testing was carried out on tubes with clamping forces according to the calibration curve, and the results were compared to results from plate crevices in synthetic seawater in a Round-Robin test programme. For two laboratories, crevice corrosion was found to be initiated at 30°C for curved specimens, which is similar to that observed for testing plate material of the same grade.
at six laboratories. It should be noted that the crevice gap in the axial direction is the same as for flat specimens. Hence, it seems that an area of similar clamping force in the radial direction is enough to achieve corresponding results to flat specimens.

Instead of defining the specimen size, the specimen areas are defined for curved specimens. In this work a specimen with an outer surface area of 100 cm² was proposed to be used for testing. The inner surface will also act as a cathode area and therefore the total area will be about 200 cm², the same area as for both sides of flat specimens. Using a potentiostat for testing, no cathode area is needed since the potentiostat simulates an infinite cathode area.

Design curves for UNS S33207 in seawater

Design curves are valuable tools for demonstrating the localized corrosion resistance in chloride environments by using the developed disc spring technology. Flat specimens were employed and a clamping force of 0.9 kN was used for pressing the crevice formers to the specimen. Crevice corrosion potential measurements were performed using polarization curves, and critical crevice corrosion potentials were obtained. The test solution was 3% sodium chloride, and purged with nitrogen. The specimens were conditioned at -100 mVSCe for 10 minutes, and then the potential was anodically polarized with a scan rate of 0.17 mV/s reaching 1000 mVSCe, or a total current larger than 1 mA. The criteria for onset of crevice corrosion was a current density of 100 μA/cm² and visual examination. Triplicate specimens were used.

In figure 4 the potential where crevice corrosion was observed is plotted versus the temperature. The design curve demonstrates the clear difference of the crevice corrosion resistance between the hyperduplex UNS S33207 and the superduplex UNS S32750. The section, where the onset of crevice corrosion is independent of potential, is at a higher temperature. In addition, at temperatures above the potential independent range the potential level for onset of crevice corrosion is higher for UNS S33207 than UNS S32750.

Conclusions

Reproducible crevice corrosion test procedures have been developed and consistent results between laboratory testing and field testing have been achieved. Specimen design was developed using a disc spring set-up for flat and curved specimens resulting giving comparable results. The design has been standardised in ISO 10870 and can be used for generating design curves.

References


Acknowledgment

The past and current members of EFC working party Marine Corrosion and members of project 'Crevcorr' are acknowledged. The collaboration with Mr. Bård Espelid and Professor Damen Feron with the EFC publication, and the development of curvature specimens are acknowledged. The support from AB Sandvik Material Technology and co-workers are greatly acknowledged and the author thanks Mr. Pasi Kangas and Mr. Fredrik Sandberg for their contributions.

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 September/October 2017 17
Innovative Products

Fast-Dry Epoxy Made for Industrial Sector

Hempel has introduced a new high-build epoxy coating for industrial and infrastructure applications which is intended to provide longer service life for industrial assets, Hempaprime Multi 500. According to Hempel, it features faster drying times and shorter minimum overcoat intervals for the oil and gas, infrastructure and power-generation sectors. The coating, which has been specifically designed to dry quickly, increases productivity by shortening the man-hours needed for application, the company says. The new coating allows for three coats to be applied in 20 percent less time than current products.

Hempel’s latest coating can be used as a primer, intermediate or topcoat. According to the company, it can also be used for minor repairs, and due to its long service life for heavy industrial applications, maintenance requirements are minimal. Hempaprime Multi 500 meets ISO 12944 C5-High, and is pre-qualified to NORSOK’s M-501, Ed. 6, system 1, concluded the company.

Hardness Tester Removes Human Element

According to Elcometer, their new hardness tester is designed to provide fully automated testing of coating hardness, removing the potential for human error from the process.

The Elcometer 3045 can be used for Persoz or König pendulum hardness testing, with no human intervention, which the company says allows for accuracy and repeatability.

The features include a dual-axis bubble-level indicator to help ensure correct alignment, and a full calibration routine, automatically adjusting to meet the specified standard. The machine includes batch memory that stores all test data for output to a computer using Elcometer’s proprietary data management software.

The tester can be used in accordance with ASTM D 4366, BS 3900 E5, DIN 53157, ISO 1522 and NF T30-016, the company says.

Samples up to 7.85 by 4.33 by 0.55 inches can be tested using the new Elcometer 3045.

Katex now offer Novotest Hardness Testers

Katex Ltd, a specialist supplier of NDT and inspection equipment to the offshore / underwater, marine and industrial market is now promoting the Novotest range of hardness testers to the UK market.

This range of hardness testers uses either the UCI or Leeb method of measurement, or a combination of both for complete versatility. The ultrasonic contact impedance (UCI) probe is used for measuring the hardness of small items, objects with a thin wall, complex forms and to measure the hardness of surface hardened layers. Whilst the Leeb method is used for measuring the hardness of non-ferrous metals, cast iron, coarse-grained materials and larger products.

The latest models in the range consist of the T-D3 for just Leeb measurement, the T-U3 for UCI measurement and the T-U/D3 for measurement using both methods, and all gauges have a full colour screen, datalogging and an integral camera to capture images of the test piece, concluded the company.

Visit the ICorr website for all the latest company news

www.icorr.org
CORRPRO COMPANIES EUROPE LTD (GOLD MEMBER)
Adam Street, Bowesfield Lane, Stockton On Tees, Cleveland
Tel: 44(0) 1642 644 106  Fax: +44(0) 1642 644 150
Email: cer@corrpro.co.uk  www.corrpro.co.uk

DUNIVE LTD
Sturmer Road, Haverhill, Suffolk, UK, CB9 7UU
Tel: X +44 (0)1440 766777  Fax: +44 (0)1440 762810
Email: sales@dunive.dunive.co.uk  www.dunive.co.uk

HCL FASTENERS LTD
Clamping House, 1st Avenue, Westfield Ind. Est., Radstock, Bath BA3 4BS
Tel: 01761 417714  Email: sales@hcl-clamping.co.uk

IMPALLOY LTD
Bloxwich, Walsall, West Midlands, WS3 2XN
Tel: 01922 714400  Fax: 01922 714411  Email: sales@impalloy.com

MGDUFF INTERNATIONAL LIMITED (GOLD MEMBER)
1 Timberline Estate, Gravel Lane, Quarry Lane, Chichester, West Sussex, PO19 2FJ
Tel: +44 (0) 1243 533336  Fax: +44 (0) 1234 533422
Email: sales@mgduff.co.uk  www.mgduff.co.uk

MME GROUP
Materiaal Metingen Europe B.V, Rietdekkerstraat 16, PO Box 4222, 2980 GE Ridderkerk, The Netherlands
Tel: +31 (0) 180 482 828  Fax: +31 (0) 180 462 240
Email: info@mme-group.com  www.mme-group.com

NORTH EAST CORROSION ENGINEERS LTD
West Pitmillan Business Centre Foveran, Ellon, Aberdeenshire
Tel: +44 (0) 1358 788116  Fax: +44 (0) 1358 789828
Email: sales@neceltd.com  www.neceltd.com

SILVION LIMITED
The Brambles, Grantham Road, Old Somerby, Grantham, Lincs, NG33 4AB, UK
Tel: 01476 596932  Fax: 07872 857310 Email: sales@silvion.co.uk
rbritton@silvion.co.uk  www.silvion.co.uk

VECTOR CORROSION TECHNOLOGIES
27a Upper High Street, Cradley Heath, Birmingham, B64 5HX
Tel: 01384 671400  Email: davidv@vector-corrosion.com

VOLKERLASER
The Lodge, Blackpole Road, Worcester, WR4 6FH
Tel: 0800 0328210 and 0191 2606200

DENHOLM INDUSTRIAL SERVICES
200 Carmichael Street, Glasgow, G51 2QU
Tel: +44 (0)41 445 3039 Email: Damian.O’Brien@denholm-industrial.com

DYER & BUTLER LTD
Mead House, Station Road, Nursling, Southampton, Hampshire, SO16 0AH
Tel: 02380 742222  Fax: 02380 742200
Email: enquiries@dyerandbutler.co.uk  www.dyerandbutler.co.uk

F A CLOVER & SON LTD
Bardolph Road, Richmond, TW9 2LH
Tel: 020 89486321  Fax: 020 89487307 Email: ian@cloverpainting.com

FIRESAFE SERVICES (NE) LIMITED
Unit 28A Spencer Road, Blyth Riverside Business Park, Blyth, Northumberland, NE24 5TG
Tel: 01670 351666  Fax: 01670 352666
Email: info@firesafelimited.com

FOUNTAINS (PART OF THE OCS GROUP)
Blenheim Court, George Street, Banbury, OX16 5BH
Tel: 07807556197  Email: Donovan.gosher@fountainsgroup.co.uk

GABRE (UK) LTD
12 Church Street, Onagb, Co Tyrone, BT78 3BX
Tel: 028 82240391  Email: info@gabrielhughes.com

GULF COATINGS & PAINTING SERVICES
Zone-1, Dahat, Lagonoy, Camarines Sur, 4425, Philippines
Tel: +63 (0) 917 5425631  Email: gcps2016@yahoo.com

HANKINSON GROUP
Cotton Place, 2 Ivy Street, Birkenhead, Wirral CH41 5EF
Tel: 0870 7892020  Email: Stephen.hankinson@hankinson.co.uk

HERINGTON INDUSTRIAL SERVICES LTD
Crown Works, Crown Road, Low Southwick, Sunderland, Tyne & Wear, SR5 2BS
Tel: 0191 510 2654  Fax: 0191 548 1553
Email: herringtonltd@gmail.com  www.herringtonltd.co.uk

JACK TIGHE LTD
Redbourne Mere, Kirton Lindsey, Gainsborough, Lincolnshire, DN21 4NW
Tel: 01652 640003  Email: sales@jactighe.com

R & R Corrosion Ltd.
Brombiesburn Industrial Estate, Ellon, Aberdeen AB41 9RD
Tel: 01358 729644  Fax: 01358 729655
Email: info@rrcorrosion.com  www.rrcorrosion.co.uk

Corrosion Engineering and Cathodic Protection Field Services
Contact: Brendan Kelly
01912606224  b.kelly@penspen.com
or Lee Jones  Email: l.jones@penspen.com
Tel. 0800 0328210 and 0191 2606200
Sustaining Members

CAN
Hareness Road, Altens, Aberdeen, AB12 3LE
Tel: 01224 870100  Fax: 01224 870101 Email: info@cangroup.net
www.cangroup.net

CORROSION MANAGEMENT LTD
Engineering Consultants, Rugby, CV22 6HL, United Kingdom
Email: cox@corr-man.demon.co.uk
www.cangroup.net

EXOVA
Rosewell house, 2A(IF) Harvest Drive, Newbridge,
Midlothian EH28 8QJ
Tel: 03302220632 Email: europe@exova.com www.exova.com

HYDROSAVE UK LTD
Swallow Court, Kettering Pkwy, Kettering,
Northamptonshire NN15 6XH
Tel: +44 (0) 1536 515110 Fax: + 44 (0) 1536 515119
www.hydrosave.co.uk

INDEPENDENT PROTECTIVE COATINGS SERVICES LTD
Unit 14, Hedgend Industrial Estate, Shuart Lane, St Nicholas-At-Wade,
Kent, CT7 0NB
Tel: 01843 845472 Fax: 01843 847722

INTECSEA
Lansbury Estate, 102 Lower Guildford Road, Knaphill
Woking, GU21 2EP
Tel: 01483 795300 Email: andy.taylor@intecsea.com

LUX ASSURE LIMITED
Unit 5.3 Heriot Watt Research Park, Research Park South,
Edinburgh EH14 4AP
Tel: 0131 5167290 Email: contact@luxassure.com
www.luxassure.co.uk

MISTRAS GROUP LTD
Norman Way Industrial Estate, Over, Cambridge, CB24 5QE
Tel: 01954 231612 www.mistrasgroup.co.uk

MOTT MACDONALD (GOLD MEMBER)
Materials & Corrosion Engineering, Spring Bank House, 33 Stamford
Street, Altrincham, Cheshire WA14 1ES
Tel: 0161 926 4000 Fax: 0161 926 4103
Email: paul.lambert@mottmac.com www.mottmac.com

OCEANEERING INTERNATIONAL SERVICES LTD
Oceaneering House, Pitmedden Road, Dyce, Aberdeen, AB21 0DP
Tel: 01224 758500

PAINT INSPECTION LIMITED
61 High Street, Fareham, PO16 7BG
Tel: 0845 4383880 Email: ian@paint-inspection.co.uk
www.paint-inspection.co.uk

PIPELINE TECHNIQUE (GOLD MEMBER)
Deveronside Works, Steven Road, Huntly, Aberdeenshire, AB54 4PS
Tel: 01466 795888 Email: coatingsenquiries@pipeline-technique.com

PLANT INTEGRITY MANAGEMENT LTD
1st Floor Office, Woodburn House, Woodburn Road,
Blackburn AB21 0RX
Tel: 01224 798870 Email: info@pim-ltd.com
www.pim-ltd.com

SAFINAH LTD
5 Keel Row, The Watermark, Gateshead, Tyne & Wear, NE11 9SZ
Tel: 0191 570 9800 Email: enquiries@safinah.co.uk
www.safinah.com

SCALED SOLUTIONS LTD
6 Nettlehill Road, Houston Industrial Estate, Livingston, EH54 5DL
Email: enquiries@scaledsolutions.co.uk www.scaledsolutions.co.uk

SGK
Technoparkstr 1, Zurich 8005, Switzerland
Tel: +41 44 213 50 00 Email: sgk@sgk.ch

SONOMATIC LTD
Dornoch House, The Links, Kelvin Close, Birchwood,
Warrington WA3 7PB
Tel: 01925 414000 Email: info@sonomatic.com
Web: www.sonomatic.com

STEEL PROTECTION CONSULTANCY LTD
PO Box 6386, Leighton Buzzard, Beds. LU7 6BX
Tel: 01525 852500 Fax: 01525 852502
Email: Wil.deacon@steel-protection.co.uk
www.steel-protection.co.uk

TOPLINE LIMITED
40 Birabi Street, GRA Phase 1, Port Harcourt, Rivers State, Nigeria
Tel: 084 463238 Email: info@toplinelimited.net
www.toplinelimited.net

SPECIFIERS

SSE LTD
Grampian House, 200 Dunkeld Road, Perth, PH1 3GH
Tel: 01738 456000 Fax: 01738 456947

SUPPLIERS COATINGS

CARBOLINE
UK Office & Warehouse: Unit 26, Craftsmans Way, East Goscote
Industrial Estate, East Goscote, Leicestershire LE7 3XJ
Tel: +44 (0) 116 269 7777 www.carboline.com
Aberdeen Office: 23 Rubislaw Den North, Aberdeen AB15 4AL
Tel: +44 (0) 1224 329 098 www.carboline.com

CHEMCO INTERNATIONAL LTD
Innovative rust & wet-tolerant, Solvent-free Coatings
East Shawhead Industrial Estate, Coatbridge, Scotland, UK
Tel: 01236 606060 Fax: 01236 606070 Email: sales@chemcoint.com
www.chemcoint.com

HEMPEL UK LTD (GOLD MEMBER)
Berwyn House, The Pavilions, Cwmbran, Torfaen, South Wales,
NP44 3FD, United Kingdom
Tel: 01633 874024 Fax: 01633 489012 Email: sales@hempel.co.uk
www.hempel.com

INDEPENDENT PROTECTIVE COATINGS SERVICES LTD
Unit 14, Hedgend Industrial Estate, Shuart Lane, St Nicholas-At-Wade,
Kent CT7 0NB
Tel: 01843 845472 Fax: 01843 847722

INTECSEA
Lansbury Estate, 102 Lower Guildford Road, Knaphill
Woking, GU21 2EP
Tel: 01483 795300 Email: andy.taylor@intecsea.com

LUX ASSURE LIMITED
Unit 5.3 Heriot Watt Research Park, Research Park South,
Edinburgh EH14 4AP
Tel: 0131 5167290 Email: contact@luxassure.com
www.luxassure.co.uk

MISTRAS GROUP LTD
Norman Way Industrial Estate, Over, Cambridge, CB24 5QE
Tel: 01954 231612 www.mistrasgroup.co.uk

MOTT MACDONALD (GOLD MEMBER)
Materials & Corrosion Engineering, Spring Bank House, 33 Stamford
Street, Altrincham, Cheshire WA14 1ES
Tel: 0161 926 4000 Fax: 0161 926 4103
Email: paul.lambert@mottmac.com www.mottmac.com

OCEANEERING INTERNATIONAL SERVICES LTD
Oceaneering House, Pitmedden Road, Dyce, Aberdeen, AB21 0DP
Tel: 01224 758500

PAINT INSPECTION LIMITED
61 High Street, Fareham, PO16 7BG
Tel: 0845 4383880 Email: ian@paint-inspection.co.uk
www.paint-inspection.co.uk

PIPELINE TECHNIQUE (GOLD MEMBER)
Deveronside Works, Steven Road, Huntly, Aberdeenshire, AB54 4PS
Tel: 01466 795888 Email: coatingsenquiries@pipeline-technique.com

PLANT INTEGRITY MANAGEMENT LTD
1st Floor Office, Woodburn House, Woodburn Road,
Blackburn AB21 0RX
Tel: 01224 798870 Email: info@pim-ltd.com
www.pim-ltd.com

SAFINAH LTD
5 Keel Row, The Watermark, Gateshead, Tyne & Wear, NE11 9SZ
Tel: 0191 570 9800 Email: enquiries@safinah.co.uk
www.safinah.com

SCALED SOLUTIONS LTD
6 Nettlehill Road, Houston Industrial Estate, Livingston, EH54 5DL
Email: enquiries@scaledsolutions.co.uk www.scaledsolutions.co.uk

SGK
Technoparkstr 1, Zurich 8005, Switzerland
Tel: +41 44 213 50 00 Email: sgk@sgk.ch

SONOMATIC LTD
Dornoch House, The Links, Kelvin Close, Birchwood,
Warrington WA3 7PB
Tel: 01925 414000 Email: info@sonomatic.com
Web: www.sonomatic.com

STEEL PROTECTION CONSULTANCY LTD
PO Box 6386, Leighton Buzzard, Beds. LU7 6BX
Tel: 01525 852500 Fax: 01525 852502
Email: Wil.deacon@steel-protection.co.uk
www.steel-protection.co.uk

TOPLINE LIMITED
40 Birabi Street, GRA Phase 1, Port Harcourt, Rivers State, Nigeria
Tel: 084 463238 Email: info@toplinelimited.net
www.toplinelimited.net

WINN & COALES (DENSO) LTD
Denso House, Chapel Road, London SE27 OTR
Tel: 0208 761 2456 Email: mail@denso.net
Web: www.denso.net

HEMPEL UK LTD (GOLD MEMBER)
Barwyn House, The Pavilions, Cwmbran, Torfaen, South Wales,
NP44 3PD, United Kingdom
Tel: 01633 874024 Fax: 01633 489012 Email: sales@hempeUK.com
www.hempeUK.com

INDEPENDENT PROTECTIVE COATINGS SERVICES LTD
Unit 14, Hedgend Industrial Estate, Shuart Lane, St Nicholas-At-Wade,
Kent CT7 0NB
Tel: 01843 845472 Fax: 01843 847722

LONG-TERM SOLUTIONS FOR CORROSION CONTROL

A MEMBER OF WINN & COALES INTERNATIONAL

Winn & Coales (Denso) LTD
Denso House, Chapel Road, London SE27 OTR
Tel: 0208 761 2456 Email: mail@denso.net
Web: www.denso.net

HEMPEL UK LTD (GOLD MEMBER)
Barwyn House, The Pavilions, Cwmbran, Torfaen, South Wales,
NP44 3PD, United Kingdom
Tel: 01633 874024 Fax: 01633 489012 Email: sales@hempeUK.com
www.hempeUK.com

INDEPENDENT PROTECTIVE COATINGS SERVICES LTD
Unit 14, Hedgend Industrial Estate, Shuart Lane, St Nicholas-At-Wade,
Kent CT7 0NB
Tel: 01843 845472 Fax: 01843 847722
Institute Events

DIARY DATES 2017

BRANCH CONTACT

DIRECTORY

ABERDEEN:
Yunnan Gao (Chairman)
01224 283415
Email: icorrabz@gmail.com

LONDON:
David Mobbs (Chairman)
Tel: 0121 3039300
Email: trevor.box@acivico.co.uk

YORKSHIRE:
Brenda Peters, Analysis Scientific
Tel: 01706 871700
Email: brenda.peters@analysis-scientific.co.uk

NORTH WEST:
Alex Sandilands (Secretary)
Marie Halliday (Vice Chair)
Neil Wilds (Chair)

NORTH EAST:
Tel: 01224 263415
Email: icorrabz@gmail.com

CED DIVISION:
Julian Wharton
julianawharton@gmail.com

CSD DIVISION:
Nick Smart
Tel: 01635 280385

BRANCH DATES

19th October 2017
London Branch joint meeting with Society of Chemical Institute
Venue: SCI, Belgrave Square, London, SW1X 8PS
Topic: From the Foundations of Electricity to Modern Corrosion Failures
Speakers: Dr F Parrett, SCI and Dr D Eyre, ICorr
This event includes two presentations, the first on the historical background of electricity, the second a report on the recent problems of AC Corrosion on pipelines. A networking drinks reception will follow the talks at 19:30.

31st October 2017
Aberdeen Branch Special Event
(Composite Wraps)
Venue: Palm Court Hotel, 81 Seaford Road, Aberdeen, AB15 7YX
Presentation to start 6.30pm
Further details can be obtained from Aberdeen Branch

9th November 2017
London Branch
Venue: Imperial College, Skempton Building, London SW7 2BB
For further details, see website or email icorrondon@gmail.com

28th November 2017
Aberdeen Branch – IOM3/ICorr Joint Technical Meeting sponsored by the Mining Institute of Scotland
Presentation to start at 6.30pm
Topic: Composite Engineering in 2017
Venue: Palm Court Hotel, 81 Seaford Road, Aberdeen, AB15 7YX
Further details can be obtained from Aberdeen Branch

29th November 2017
ICorr AGM Meetings 2017
The Institute of Corrosion Annual General Meeting 2017 will take place on Wednesday, 29th of November at the Council Chamber Birmingham.

7th December 2017
London Branch 29th Annual Christmas Luncheon
Royal Over-Seas League, Over-Seas House, Park Place, St James's Street, London, SW1A 1LR
Event Details: 11.30 Pre-Lunch Drinks 13.00. 4-Course Lunch Bar after 16.00
Entertainment Presentations, Raffle.
For enquiries contact Paul Brooks on email: pbrooks@ctscp.com or telephone 07880791087

30th January 2018
Aberdeen Branch – Special Event
(Cathodic Protection)
Further details can be obtained from Aberdeen Branch

27th March 2018
Aberdeen Branch Industrial Visit
Element Materials Technology Industrial Visit to Element’s New H2S/Sour Service Lab in Aberdeen Visit to start from 6.30pm
Venue: Hareness Circle, Hareness Circle, Alten Industrial Estate, Aberdeen, AB12 3LY United Kingdom

ADDITIONAL DIARY DATES

13-15 November 2017
PDA Europe Conference
Further information can be obtained at http://pdaeuropeconference.com

16-18th November 2017
ICorr Pipeline Coating Inspector
Venue: Johor Bahru, Malaysia
For further information on any of the above contact either sarah@icorrinternational.org or r_green@imeche.org or trainingsolutions@imeche.org

15th May 2018
CEOCOR 2018 International Congress and Technical Exhibition
ICorr will host the 2018 CEOCOR Congress in Stratford-upon-Avon. For further details see www.ceocor2018.com

Visit the ICorr website for all the latest news
www.icorr.org

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