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Happy New Year! I trust you all had a relaxing and enjoyable Christmas break. As incoming President this is my first bash at this column so please excuse me if I ramble on a bit!

For those of you who don't know me, I'm an electrochemist based at the National Physical Laboratory (NPL) in Teddington, southwest London. Over the years my involvement with the Institute has mainly been through the Corrosion Science Division, although I have picked up a reasonable understanding of the broader range of ICorr activities during my 10+ years on Council.

Our esteemed editor, Brian Goldie, was keen to include a photo of me so that you will be able to recognise me – or more likely cross to the other side of the road when you see me coming! The only thing vaguely suitable that I could find was this promotional shot taken recently by the NPL photographer. I feel I must point out that the item I am holding is a reference electrode…and not a pregnancy test as some wags have suggested.

I would like to thank our outgoing President, Sarah Vasey, for the excellent job she has done over the past two years. Sarah has worked tirelessly on behalf of the Institute to oversee a number of important initiatives, most notably the ongoing improvements to our training courses, the appointment of a new Business Development Manager, the increase in our student membership and (with significant input from Trevor Osborne) the successful purchase of our new home at Saxon Court in Northampton. All this on top of one of the busiest day jobs I have ever seen!

It is an honour to assume the role of President and I am very much looking forward to the challenge of building on the achievements of Sarah and previous Presidents. Completing the overhaul of our training course offering will obviously be a major priority. This is by no means a trivial task but is critical to our financial sustainability. Equally important will be the continued drive to recruit younger members, who after all represent the future of the Institute. As Young ICorr Chair, Chris Bridge has done an outstanding job in growing student members (over 100 at the latest count) and I will be working closely with his successor, Simon Bowcock, to maintain this upward momentum.

Right now the Institute is in pretty good shape, thanks mainly to the unstinting efforts of enthusiastic volunteers and committees. However, there is always room for improvement and we as Trustees and Council members are continually looking for new ways to enhance our offering to members. I am keen to meet as many of you as possible during my two year term to hear your views and am looking forward to attending a wide range of local branch activities and events. If you have any ideas for future initiatives I would love to hear them. The key thing is to get involved!

ICorr President,
Gareth Hinds.
Institute News

From the Editor

The 2018 ICorr AGM was once again hosted by the Midlands branch of the Institute and held in the magnificent Birmingham Town Hall.

A festive mood was added by the presence of the continental street market outside, and the attendees enjoyed lunch and networking time before the excellent technical programme organised by Midland branch and the presentation of the U.R. Evans sword to Professor Anne Neville, Leeds University, by the new President.

The AGM itself was a well attended event at a time of many changes for the Institute. A new President was elected; the Honorary Treasurer and Honorary Secretary continued in their posts, as did many of the existing Council members, all of whom will work to guide the Institute through the move into the building that we have purchased, and the many opportunities that this will allow for us to grow in 2019 and beyond.

A number of interesting and relevant questions were also raised regarding the future plans for the Institute, which were outlined to the attendees. The current fortunate financial situation regarding surplus cash was also queried and it was explained that as ICorr is a charity, the Charities Commission encourages the retention of 2-3 years running costs as cash. This provision had been made by the Honorary Treasurer.

On behalf of the Institute, I wish you a Happy New Year and a successful 2019.

Dr Jane Lomas, Honorary Secretary

2018 AGM

As usual, I would like to add my good wishes to that of the new President for a happy and prosperous new year to all members.

We start 2019 with degree of uncertainty as to the outcome of the Brexit negotiations, and how this will affect our industry. According to the British Coatings Federation (representing all the UK coating manufacturers), the industry could suffer severe disruption, a loss of millions of pounds and a drain on investment. The £4b “just-in-time” industry, has more than half of its suppliers based in the EU, and has been forced to activate “no deal” contingency planning which consists of stockpiling key raw materials and finished goods, hiring more warehouse space and setting up legal entities in the EU. Its members are also preparing to grapple with different sets of chemicals regulations, and face tariffs on both raw materials, half of which are sourced in the EU, and on finished products, costing the industry an estimated £150m.

However the European Chemicals Agency (ECHA) is offering help for coatings companies to stay in the British market while still fulfilling all necessary regulations, as not only UK companies will have to pay attention to changes after Brexit, it also affects companies in the EU-27 and EEA that are doing business with UK companies. However potentially the most prominent change will probably be that there will no longer be a REACH registration for UK-companies after Britain leaves the European Union, and thus could prevent the introduction of new materials and products to the EU.

Enough of politics and back to this issue, there are two technical articles covering corrosion protection and monitoring of oil and gas production systems, including those operating at elevated temperature. Hassan Malik discusses the use and positioning of corrosion monitoring points to ensure effective protection of assets, and Dirk Bestzig explains how coatings are tested for performance at high temperature operation.

Finally, remember this is your magazine, and I welcome comments and suggestions on the content, and submissions of news items, new products and technical articles. I can be contacted at, briancpe@aol.com

Brian Goldie, Consulting Editor

ICATS News

Following the busy end to 2018 with the launch of the new ICATS course material, 2019 promises to be another successful year for the scheme as we prepare to introduce the new website and we will shortly be announcing two additional Approved Training Centres.

We held a final Seminar in Northampton in January to introduce the new course to our Trainers. These seminars were a great success and included an overview of the ICATS development plans and a detailed look at the new programme.

A Company Trainer Course is planned for 19/20 February, at Northampton, and a Supervisor Course was held in January, and the next will be announced soon (see www.icats-training.org).

For further information on any of the above please contact the office at, correx@icorr.org or phone 01604 438222.

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

WELCOME to our 251 new members and 11 Sustaining Company Members who joined the Institute in 2018.

TOGETHER WITH THE CONGRATULATIONS of the Institute to all the following members who have attained Professional Status in 2018.

**Technician**
- Jim C Galbraith
- Muhammad Saleh
- Shokat Giteli
- Paul Spikins
- John B C Ritchie
- Muhammad Naveed Nawaz
- Palanisamy Samuthiram
- Solaimuthu Periasamy
- Venkatesh Kundalagara Rajeshkar
- Terence Marshall
- Steven Slack
- Abdel Rahman Ahmed Mohamed Hendawy
- Chandresh Ellathuvalappil
- Abdul Hakeem Olubayo Latinwo
- Neil R Brown
- Kamal Mohamed El-Sayed
- David Bailey
- Stefano Tassinari
- Dinesh Selvaraju
- Joseph Quinn
- Rahul Ashokbhai Panchal
- Intizar Hussain
- Raja Sekhar Ganti
- Bikku C John
- Muhammad Asif Siddiqui
- Robert J Allen
- Erol Dag
- Khushboo Sharma
- Firoz Ahmed Makrani
- Marco Facciotti
- Edward Hall
- Mark J Waterfield
- Mushaid Nauman
- Alan Peers
- Madjid Afshari
- Murugan Ramachandran
- Jawwad Khan
- Nagendra Mahabaleshwar Nirvaneshwar
- Awais Manzoor Malik
- John Samuel Selvaraj
- Abdul Waheed
- Arun Sudarshan Kiron Kannan
- Okwuchukwu Ejikeme Nkem Nwosu
- Vignesh Gopal
- Elayaperumal Rajamani
- Stephen Shapcott
- Mohamed Ibrahim Hegazy
- Seda Omercikoglu
- Petra Ernst
- Frederick Oritseweneye Pessu
- Jaiprakash Narain Agrawal

**Professional**
- Kumar Kolur Vadivelu
- Ali Güneyli
- Siva Prakash Kulandaivel
- Lian Ling Beh
- Marvin Sincioco
- Jeroen Joannes Maria Van der List
- Ben Magee
- Muhammad Naveed Nawaz
- Palanisamy Samuthiram
- Solaimuthu Periasamy
- Venkatesh Kundalagara Rajeshkar
- Terence Marshall
- Steven Slack
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- Stephen Shapcott
- Mohamed Ibrahim Hegazy
- Seda Omercikoglu
- Petra Ernst
- Frederick Oritseweneye Pessu
- Jaiprakash Narain Agrawal

**Fellow**
- Vikram Prabhakaran
- Christopher J Everett
- Chukwuma Candidus Onuoha
- Markus Buchler
- George William Mackenzie Hobbs
- Syed Ibtesam Hasan Abidi
- Arwind Kumar Dubey
- Ahmed Ramadan Nassar
- Ricardo Filipe
- Zeeshan Farooq Lodhi
- Muhammad Hussain
- Itoro Lucky Akrasi
- Sayee Raghunathan
- Balasubramani Bakhthavatchalu
- Kumar Kolur Vadivelu
Helvetica Technical Consulting's vision is to safeguard the environment, the assets and the safety of people, and ensure a better and sustainable future. They deliver technical consulting to industries in terms of asset management, supply chain and quality control, from corrosion management to supplier qualification.

As Benjamin Franklin once said, “The bitterness of poor quality remains long after the sweetness of low price is forgotten” and, for this reason, all their services are performed by certified, trained and qualified operators using in-house tools and covered by a liability insurance.

Coating is a technique used to prevent corrosion that creates a physical barrier to stop or slow the deterioration process. Thus, it is very important that the entire coating process is carried out following strict parameters and rules, since corrosion affects the life cycle and fitness for purposes of equipment, tools or even structures, like bridges or high voltage pylons. It has been estimated that 75% of premature coating failure is due to poor surface preparation.

With their extensive experience, they can perform inspections during initial qualification, taking care of all the aspects involved in the process, or even perform condition monitoring of the coating on existing equipment, vessel or a structure and then make decisions for re-coating.

Their experience covers a range of topics including, pipes and fittings, coating qualification process, thermal spray, concrete, galvanic protection, personnel qualification, and coating assessment surveys. They can carry out DPT measurements, surface cleanliness (Bresle test, CSN, amine blush), blasted surface profile (Testex replica tape, surface comparators, digital profiler), adhesion testing, pinhole and porosity measurement, and environmental monitoring and recording.

Equilibrant Ltd is a Belfast based independent Civil and Structural engineering consultancy established in 2009, and specialising in the detailed inspection, Non-Destructive Testing and repair & protection of reinforced concrete and steel infrastructure. The Managing Director, Dr Jim Cromie, is a Chartered Engineer and has a PhD in the electrochemical desalination of reinforced concrete, and the Technical Director, Robert Devenney, is a Chartered Engineer with a wealth of experience in the inspection, testing and repair of all types of infrastructure.

They work with Asset Managers, consultants and contractors, producing comprehensive reports with recommendations for Life Cycle Management of civil infrastructure and can accurately identify the cause, extent and significance of structural/electrochemical deterioration using specialist Non-Destructive Testing techniques, and propose remedial works strategies, considering whole life costing, to ensure clients schedule sustainable remedial interventions. They have a full range of NDT equipment in-house including half-cell potential units/linear polarisation devices/concrete resistivity meters, Proceq live ground penetrating radar unit, Schmidt hammers etc.

All types of structural infrastructure and across engineering disciplines from railway and motorway bridges, other highway infrastructure, marine structures, high rise buildings etc. have been assessed. Typically the structures are suffering from Biogenic Sulphate Corrosion, concrete carbonation + low cover to reinforcement, chloride contamination, sulphate attack, acid attack, cracking etc. They also have the in-house expertise to model chloride diffusion and rate of carbonation penetration.

They are completely materials independent and produce factual reports or interpretive reports with repair material performance specification in accordance with EN 1504. Equilibrant Ltd also offer a Part 3 HSE Surface Supplied Commercial diver, one of, if not the only practising chartered engineer dive inspection service in Ireland.

Miller Fabrications of Wishaw, Scotland, a Gold Sustaining Member, design, fabricate and install structural steel, architectural metalwork and secondary steelwork to the UK construction and rail sectors. Their 12 acre production plant includes an in-house shot-blast and paint facility.

For more information, see www.millerfabrications.com
At the November joint meeting with IOM3, Dr Ed Wade gave a presentation to an audience of over 50, on the subject of “Downhole Metallurgy and Corrosion – from the first pipe, to current challenges”, which proved a fascinating insight into the topic that had everyone glued to their seats.

Dr Wade originally trained as a metallurgist and his interest in downhole metallurgy developed during 13 years spent with Marathon Oil in Aberdeen and subsequently as an independent consultant. Since 2004, he has delivered more than 40 training courses focussed on the selection of corrosion resistant alloys for downhole applications, including ‘open’ courses promoted in Aberdeen by the Mining Institute of Scotland (a local affiliate society of IOM3).

Starting with the first use of downhole pipe, the talk progressed through subsequent developments that have remained central to current practice; recent novel HP/HT challenges were also outlined, before closing with an overview of future very challenging downhole requirements for Geothermal Energy and Carbon Storage, such as United Downs Deep Power Project in Cornwall, that will require many thousands of new deep / high performance wells to be drilled and operated under highly corrosive conditions.

It was a fascinating tour through 159 years of metallurgical advancement of tubular goods, commencing with the Drake Well in 1859, (that went on to operate for another 40 years), through to the development of modern API Specs and Coding Systems, trends and advances in North Sea CRA use for tubulars, together with an explanation of how corrosion mechanisms such as Ringworm have been eliminated through subsequent developments that have remained central to current practice; recent novel HP/HT challenges were also outlined, before closing with an overview of future very challenging downhole requirements for Geothermal Energy and Carbon Storage, such as United Downs Deep Power Project in Cornwall, that will require many thousands of new deep / high performance wells to be drilled and operated under highly corrosive conditions.

The difficulties in adequately simulating and testing for all downhole situations was highlighted along with the sometimes intermittent, and sometimes unplanned operational practices of the Oil and Gas and other Industries, which place huge demands/expectations on material performance in sometimes rapidly changing conditions.

The need for materials to withstand highly corrosive subsurface gases at very high partial pressures for extended periods, and the difficulties of successfully implementing preventative chemical treatments at immense depth were clearly explained.

It was also evident that composites have still yet to make huge in-roads into the market place for downhole use and to successfully compete with the available wide range of corrosion resistant metallics. The main problem here seems to be industry confidence in non-metallics, as being relatively new, difficult to manufacture, and not having well established test protocols for downhole scenarios.

The event generated many questions from the audience that were very well responded to by this distinguished speaker.

The branch 2018/19 session continues on 26 February, with a special coatings technical event. Ajith Varghese of International Paint will talk on ‘A Novel Approach to Combating CUI’ and Michael Baraky (RMB Products) and Rob Mackie (United Pipeline Systems), will discuss ‘MIC-Resistant HDPE Linings for Seawater Applications’. 

Dr Ed Wade’s paper can be found on: https://drive.google.com/file/d/1N2Cqy1MutsU0QjAjSxPaFeHoRe1gLip/view?usp=drive_web and all past Aberdeen ICorr Presentations can be found on: https://sites.google.com/site/icorrabz/resource-center

Full details of future events can be found on the diary page of the magazine and on the website, or contact: ICorrABZ@gmail.com

London Branch

The January talk by Dr Patricia Conder, Sonomatic Ltd, was on “Pipework Corrosion: Prediction and Reality”, and how differences in the spatial pattern of internal pipework corrosion, be it patchy or more uniform, impacts on the effectiveness of inspection, and how this can be used to improve understanding of the underlying corrosion behaviour. Patricia discussed how extensive corrosion is easy to find and measure, but in instances where wall loss occurs more randomly, the challenges of matching inspection strategy to the corrosion coverage increase. She discussed how thinking of inspection as a statistical sampling process helps both inspection strategy and analysis. The audience were challenged to spot the difference between a corroding and non-corroding circuit within a second. This was successfully achieved by means of a graphical overview of the whole circuit inspection history.

This overview presented a route to mine into the data, to examine “groupings” based on corrosion mechanisms, for example testing to see if the bends really are corroding faster than the straights. She also discussed the use of integrity driven corrosion rates, based on how the overall wall loss of the circuit is changing, rather than focussing on per inspection location corrosion rates, which can exaggerate measurement variability. Although historically inspection has been based on manual ultrasonic thickness measurements and radiography, these techniques have only covered relatively small areas overall. Developments for pipework inspection offer everything from screening to more detailed high accuracy mapping. The challenges being to incorporate all these results into a database in a meaningful way to get added value from a change in inspection approach. Patricia finished the talk by reminding us to think corrosion: think spatial.
Bill: In 1997, I joined BP as a corrosion engineer and found myself in a team led by Don Harrop, a highly respected engineer, who has since become a good friend and mentor to myself in a team (led by Don Harrop), a highly respected engineer, who has since become a good friend and mentor to me. I became a Team Leader which relates to another key passion of mine – working with, and developing people. It was a fantastic role which allowed me to travel to many interesting parts of the world and gave me my first overseas assignment for 2 years in Houston, Texas, USA, as the worldwide group leader for corrosion technology.

CM: Do you have any specific career advice or learnings to share?
Bill: Yes. Career tip #1 – If anyone offers you a paid job as a corrosion engineer on a Caribbean island – take it!

Career tip #2: If all the above sounds like I've been very

In a new occasional series about our industry leaders, Corrosion Management (CM) interviewed Bill Hedges, who has worked in corrosion and integrity management for over 30 years, and was recently promoted to the role of Chief Engineer for the Materials Group at BP. We asked him to describe his career path, and to reflect on the future of the corrosion industry.

CM: Bill, can you tell us about how you came to be a corrosion professional?
Bill: My first role was to run the corrosion laboratory which is an amazing role which allowed me to travel to many interesting places and meet many interesting people. It was also where I first became a Team Leader which relates to another key passion of mine – working with, and developing people. It was a fantastic role which allowed me to travel to many interesting parts of the world and gave me my first overseas assignment for 2 years in Houston, Texas, USA, as the worldwide group leader for corrosion technology.

CM: Ultimately you stuck with O&G, can you tell us about your career with BP?
Bill: In 1997, I joined BP as a corrosion engineer and found myself in a team led by Don Harrop, a highly respected engineer, who has since become a good friend and mentor to me. I became a Team Leader which relates to another key passion of mine – working with, and developing people. It was a fantastic role which allowed me to travel to many interesting parts of the world and gave me my first overseas assignment for 2 years in Houston, Texas, USA, as the worldwide group leader for corrosion technology.

After 3 years, I moved to their operation in Trinidad and Tobago, initially as a corrosion engineer. There I was promoted to the role of Integrity Manager which allowed me to expand my experience to include corrosion, inspection and production design. The Tundra. Living and working through this incident and its impact, whilst dealing with lawyers, consultants, politicians and the media was life changing and, in the end, very rewarding.

In 2012, I returned to the UK to become the Corrosion Authority for a much larger team and business. This gave me an experience I learnt greatly from, because shortly after I arrived we had a corrosion leak that resulted in an oil spill covering two acres on the Tundra. Living and working through this incident and its impact, whilst dealing with lawyers, consultants, politicians, and the media was life changing and, in the end, very rewarding.

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fortunate you would be right. However, it omits the numerous job applications I was rejected for and the frustrations that it brings. So, if you are passionate about what you do but cannot seem to find the right career path my advice is to keep working hard, persevere and look for alternative pathways. It is my experience that opportunities usually appear – although not always at the most convenient time!

I have continued to try and learn and broaden my experiences and have been privileged to be recognised for my work with several accreditations and honours, FRSC, CChem., C.Sci., FNACE, FICorr. and C.Eng. I love to work with, and encourage younger engineers, as well as the broader corrosion community, and I am a strong supporter of both the ICorr and NACE student / Young Engineer Programmes. I’m also a strong advocate for getting more women into our industry and have supported the NACE “Women in Corrosion” initiatives.

So, what have I learned? Firstly, corrosion is a brilliant, fun and rewarding role. We don’t often think about it, but it is also a very responsible role, keeping people and the environment safe. As a colleague and good friend once said to me “corrosion is not simple” – it’s a complicated, multi-disciplinary subject where it’s rare for one person to have all the answers, which means team work is essential. As Corrosion Engineers we have made many advances, and it’s my belief that we do a great service to the industry in general, and the communities we work in.

CM: What are your thoughts about the future as a corrosion professional?

Bill: I think the future is very exciting. I believe we will see more automation with sensors, robots, drones and crawlers collecting key data for us, which also reduces the risk to people. It will be impossible for a single engineer to analyse all the data, so the use of data analytics and artificial intelligence will become critical to convert it into useful information that can help us control corrosion more efficiently than today. Don’t be frightened by this – we will always need corrosion engineers – we’ll just be using new skills to complement what we already have. Finally, I believe materials are an important part of our future, non-corrosive (if there is such a thing!), light-weight materials that can be used where appropriate.

I’m looking forward to it.

CM: Thank you Bill, so are we!

Industry News

Oilfield Corrosion Science & Engineering – short course, University of Leeds, 21-22 May 2019

This 2-day course will provide an overview of the main corrosion threats to production and processing facilities, with academic and industrial presentations, demonstrations, theory, and real industrial case studies covered by well renowned guest speakers.

The course is suitable for Oil and Gas owners and operators, managers of operations, engineering and maintenance functions, asset integrity engineers; engineers and scientists working in oilfield industries both in downhole systems or aboveground storage tanks and production pipelines; design and maintenance engineers or technical staff involved in both offshore and onshore oil and gas activities. It is also suitable for scientists or chemical engineers who would value a deeper understanding of how corrosion science and theory can be applied to better understand and solve real industrial corrosion problems; and engineers or designers involved in the supply of metals and alloys which are subject to oilfield corrosion degradations.

The venue for the course will be the School of Electronic and Electrical Engineering, University of Leeds, Leeds LS2 9JT. The fees, which are VAT exempt and include the cost of tuition, course materials, lunches, light refreshments and the course dinner are £750. Delegates are responsible for their own accommodation, if required, and a list of hotels close to the University will be sent out with the delegate joining instructions.

Booking for this course should be completed through the University secure online store using debit or credit card. For online booking queries and for all other enquiries please contact:

CPD Course co-ordinator, Conference & Events Unit Faculty of Engineering, School of Chemical and Process Engineering 3.11 University of Leeds, Leeds, LS2 9JT UK, Telephone, +44 (0)113 343 2494/8104, or email, cpdengineering.leeds.ac.uk

General information on the course and the detailed programme can be found at www.engineering.leeds.ac.uk/short-courses/

COST OF BRIDGE MAINTENANCE INCREASES

According to the RAC Foundation, the cost of repairing substandard local authority bridges in Great Britain has risen by 34% in the past year alone, to £6.7bn. The study looked what it would cost to carry out repair work required on the tens of thousands of local authority bridges (defined as structures over 1.5 metres in span).

It was based on information supplied by 200 councils across England, Scotland and Wales, who between are responsible for 71,652 bridges, of which 3,177 are categorised as ‘substandard’, meaning unable to carry the heaviest vehicles now seen on our roads.

Bridge safety is an important criterion particularly in the wake the Morandi Bridge collapse in Genoa, Italy last August, killing 43 people. Although no UK local authority manages bridges directly technically comparable, they do have are a number of similarly post-tensioned (PT) bridges with hidden cables, which require intrusive inspections (post-tensioned special inspections) that can cost £100,000 a time.

There are 605 PT bridges, of which 199 had special inspections in last 18 years, and which the Foundation has estimated would cost £21.4 M alone.

More details can be found at, www.rafoundation.org
**Global Paints and Coatings Market Survey**

This is the third time Ceresana has analysed the global market for paints and coatings, which accounted for about 42 million tons in 2017.

Currently, almost half of all paints and coatings consumed in 2017 were used in the construction industry. This market is primarily supported by the rising demand for living space in densely populated countries but also by major projects in infrastructure and commercial construction which is increasingly adopting innovative products for various uses. The Asia-Pacific region is likely to further expand its leading position on the world market where today, more than 50% of revenue is generated. The second largest consumer of paints and coatings in 2017 was North America.

The current market report also analyses demand for individual product types, ranging from those based on acrylics, vinyls, alkyd, epoxy, and polyurethane, etc. Acrylic paints were by far the most used type in 2017 and demand for acrylic paints was highest in Asia-Pacific and North America, followed by Western Europe and South America.

Environmentally friendly water-based paints are gaining momentum due to their lower VOC levels and, in some applications, the possibility to be recycled are a great advantage. These and other advantages will help water-based paints and coatings to account for the highest average growth rate of the upcoming eight years.

The first chapter gives the description and analysis of the global paints and coatings market, including forecasts up to 2025 and the development of revenues, demand, and production for each region of the world. In addition, this is split by applications, product types, and technologies. The regional markets are analysed in detail including applications in construction, transportation, industry products. In addition, demand for paints and coatings – split by the types acrylics, vinyl, alkyd, epoxy, polyurethane, polyester, other polymers, and other products – is examined.

Chapter 2 offers a detailed analysis of demand, export, import, output, and turnover of 16 countries, including application areas, and market data is divided into individual paint types and technologies for each country. The final chapter has a useful directory of the 113 most important producers of paints and coatings, clearly arranged according to contact details, revenues, profit, product range, production sites, and profile summary.

More information can be found at, https://www.ceresana.com/en/market-studies/industry/paints-coatings-world/

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**Jotun Coatings protect Norway suspension bridge**

The Arctic Circle’s longest suspension bridge, the Hålogaland Bridge, located in Narvik, Norway, has been protected by Jotun paints. The bridge, completed in the middle of December, has taken five years to build. The structure was built in 30 sections, with 7,000 tons of bridge deck, according to Jotun who supplied their Jotamastic steel coating for corrosion protection.

Hege Karset Bjorgum, Global Concept Director Infrastructure for the company, explained that Jotun had executed a training programme with the main contractors, while providing quality control oversight of surface application and finishing, and which involved stringent technical inspections in China, as well as delivering on-site expertise during the actual installation process in Narvik.

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**SPECIALIST COATINGS COMPANY BECOMES EMPLOYEE OWNED**

Chemco International in Coatbridge near Glasgow, one of the market leaders in the design and manufacture of specialist protective coatings, became the latest company in Scotland to become 100% employee owned.

The move to employee ownership comes as the company is going through one of the most successful spells in its history and plans further expansion with the creation of additional jobs.

Founded in 1990 by Manny Khorasani, Chemco traces its origins back to the original Glassflake Company, the inventors of glassflake technology in the 1960s. Manny joined Glassflake as a production supervisor in 1982 and after quickly rising through the management ranks, he bought the company in 1990, renaming it Chemco International. Commenting on the decision to become employee-owned, Manny said: “Around eighteen months ago I started thinking about taking a back seat in the business. I looked at a number of different options, including selling the business, but my concern was that due to the nature of the business, a trade buyer would most likely relocate the company. None of the options I explored delivered the business continuity I wanted for our customers and employees and this is when the employee ownership became an attractive option”.

An Employee Ownership Trust has been formed which will hold 100% of the shares on behalf of the employees, and the transition to employee ownership was supported by Co-operative Development Scotland (CDS) with support from legal and accountancy companies.

The management team, from the bottom of the stairs, Manny Khorasani, Colin Wade, Alistair Neil, Masoud Goodarzi, Ian Gold, and Nuno Barreiros.
Jotun extends coatings alliance with Kansai Paint

Norwegian paints and coatings manufacturer Jotun (Sandefjord) has recently announced the further development of an alliance with Kansai Paint, a coating supplier in Japan. Working together, Jotun and Kansai will be looking to replicate their marine coatings success in the protective coatings market.

Jotun and NOF Kansai Marine Coatings originally formed the SeaStar Alliance in 2002, in which they developed a range of antifouling brands. According to Jotun, they see the extension of this relationship as a natural evolutionary step as the collaborative approach to the marine market has paid huge dividends by sharing knowledge and using one another’s innovation and industry expertise to access opportunities and build a product portfolio. This alliance will allow further expansion into the global market concluded Jotun.

Latest Literature

Identifying defect levels in organic coatings

A recent report describes research aimed at developing a field corrosion detection method for identifying the defect levels in organic coatings by using electrochemical noise (EN) measured in Singe Cell (SC) mode. An electrochemical sensor was used for defect identification and the results indicated that, as the defect levels rise, the amplitudes of the electrochemical current noise (ECN) increase.

Further data analysis based on power spectral density (PSD), and discrete wavelet analysis confirmed that white noise level, and wavelet energy distribution can successfully discriminate the levels of protectivity of the organic coating.


Anticorrosion performances of modified polymeric coatings on E32 naval steel

Recently published research compares the corrosion resistance of E32 low alloy steel with and without a protective coating. The systems studied were primer only, primer with epoxy topcoat and primer with TiO2 nanoparticles, and all the samples were exposed in seawater collected from the Black Sea, Năvodari oil terminal. The purpose of the study was to determine if there was an improvement in the protection properties of the coating by adding dispersed inert ceramic nanoparticles, in this case titanium oxide with an average diameter of 200 nm. The corrosion properties were studied by electrochemical methods (evolution in time of the open-circuit potential, polarisation curves and electrochemical impedance spectroscopy), and the results indicated that the nanoparticles of TiO2, mixed in the primer as a nanocomposite coating had significantly improved the anticorrosive performances of E32 steel compared to the steel coated with primer alone.

The study was published in: Progress in Organic Coatings Volume 123, October 2018, Pages 120-127.
**Standards issued in the last two months:**

- **EN 358:2018** Personal protective equipment for work positioning and prevention of falls from a height - Belts and lanyards for work positioning or restraint
- **EN 363:2018** Personal fall protection equipment - Personal fall protection systems

**ISO 19277:2018** Petroleum, petrochemical and natural gas industries - Qualification testing and acceptance criteria for protective coating systems under insulation.

This standard describes the various corrosion under insulation (CUI) environments, in refineries and other related industries and environments, and establishes CUI environmental categories including operating temperature ranges from -45 C to 204 C for topside and aboveground service only. It specifies both established and other test methods for the assessment of coatings used for prevention of CUI and also provides acceptance criteria for each CUI environment.

As a note, the test results and acceptance criteria can be considered an aid in the selection of suitable coating systems, and for service or peak temperatures below -45 C an optional cryogenic test can be incorporated, and for over 204 C testing acceptance criteria can be agreed between interested parties. Additional or other test and acceptance measures are possible, but require particular agreement between the interested parties. The standard covers spray-applied coatings applied over new carbon and austenitic stainless but does not cover testing of sacrificial coatings, such as inorganic zinc, as these coatings can be consumed quickly in wet environments. Non-through porosity thermal spray aluminum coatings with greater than 250 µm dry film thickness can be tested and qualified in accordance with this standard but it does not cover tape and sheet applied products for use in preventing CUI. In addition, the standard does not deal with other aspects of coating degradation, such as those caused by abrasion, erosion, ultraviolet degradation or other methods that can exist given specific environment and construction methods.

- **ISO EN 2812-2:2018** Paints and varnishes - Determination of resistance to liquids - Part 2: Water immersion method

This specifies a method for determining the resistance of an individual-layer or multi-layer system of coating materials to the effects of water by partial or full immersion, which enables the determination of the effects of water on the coating and, if necessary, the assessment of the damage to the substrate. This standard describes the various corrosion under insulation (CUI) environments, in refineries and other related industries and environments.

- **EN ISO 19277:2018** Petroleum, petrochemical and natural gas industries - Qualification testing and acceptance criteria for protective coating systems under insulation.

**New standards issues within the last two months:**

- **ISO 4623-1:2018** Paints and varnishes - Determination of resistance to filiform corrosion - Part 1: Steel substrates
- **ISO/DIS 21809-11** Petroleum and natural gas industries — External coatings for buried or submerged pipelines used in pipeline transportation systems — Part 11: Coatings for in-field application, coating repairs and rehabilitation

**New and recently revised standards**

- **SSPC-P A 2 (revised November 18)** Requirements Determining Compliance to Dry Coating Thickness
- **SSPC-Paint 42 (revised January 19)** Epoxy Polyamide Primer for Steel Surfaces, Performance-based
- **SSPC-CTS 1 (new standard, January 19)** Classification of Concrete Coating Finish Textures (with tactile texture comparator coupons)
- **SSPC-Paint 42 (revised January 19)** Epoxy Polyamide Primer for Steel Surfaces, Performance-based
- **SSPC-PA 2 (revised November 18)** Determining Compliance to Dry Coating Thickness Requirements
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The process of corrosion is rarely constant and can be more accurately described as a dynamic process, and is typically influenced by process variables that vary with time [1]. Consequently corrosion monitoring becomes a critical operation in order to assess its impact, and apply effective and efficient mitigation methods. Gaps in the recording of process parameters, long time intervals in taking off-line corrosion rates, and lack of monitoring in important locations, can lead to increased risk of failure, which may result in lost production and costly repairs. Hence the implementation of a well appraised corrosion monitoring programme can help manage industrial processes and related corrosion prevention treatments, minimize corrosion failures, and maximize the availability of the assets.

There are many reasons for corrosion monitoring in oil and gas systems, and include diagnoses of corrosion problems, monitoring of corrosion control methods used, prediction of corrosion damage, determination of inspection schedules, and estimation of the useful service life of an asset [2]. Corrosion assessment can be complex since industrial process operations provide a wide variety of dynamic environments and service conditions and no single method will necessarily work or provide optimum results in all applications. In some cases, multiple technologies may be needed in combination to provide accurate and reliable corrosion monitoring information that can be used with confidence to make engineering decisions.

An important part of controlling corrosion is by the use of various mitigation methods, and the mitigation applied would then depend on a corrosion risk assessment of, for example, offshore piping and equipment being carried out. In this case, the purpose of the corrosion risk assessment is to rank the static equipment and piping and identify options to mitigate or manage the risks [3]. If the risks can't be eradicated through design, then the corrosion threat has to either be mitigated or managed. Mitigation can be attained through correct materials selection, coatings, cathodic protection and chemical inhibition. Knowing the level of risk is important and can be gauged though corrosion monitoring and inspection programmes generated from Risk Based Inspection (RBI) software. Corrosion monitoring needs to be carried out at sites in the process system subjected to the highest risk of failure, and where the consequence of failure is significant, and this can be through the use of corrosion probes and coupons, fluid sampling points and bio-probes. In conjunction, engineers should have considered a set of mitigation procedures that can be applied to control high levels of corrosion so that the rates can be reduced to those specified in Key Performance Indicators (KPI) to achieve the lifetime of the asset.

This article describes a model, or methodology, which has been developed for corrosion monitoring and which can be used to add or remove monitoring points in an existing system. Examples of using the principles applied to piping and equipment on an offshore structure are given.

Offshore oil and gas processing equipment
A general description of the methodology developed for corrosion monitoring and mitigation in an offshore oil and gas process unit is outlined in Figure 1.

This involves collection and study of documents such as mitigation strategies, materials selection report, initial location of monitoring points as cited in a Corrosion Design Basis Memorandum (CDBM), and RBI report. If the RBI report is not
available at the Front End Engineering Design (FEED) stage, monitoring points can still be identified, but these may have to be revised at a later date, once this report becomes available. Based on these reports the risk can be identified and monitoring points placed in the most high risk areas of the process, as well as any additional monitoring. Results from monitoring and inspection would give the latest risk, and if this risk is unacceptable, the mitigation strategy may have to be revised as well as the location and number of monitoring points, such as corrosion coupons, electrical resistance probes and water sampling.

A more detailed explanation of the methodology for piping is given in figure 2, which shows how the model can be used to make this type of assessment and revision to the corrosion monitoring strategy, based on criticality data.

Figure 2 depicts a typical corrosion assessment loop. If monitoring is available, but the criticality from the RBI report is less than or equal to medium, then monitoring could be discarded, leading to a more cost effective system. Otherwise the monitoring remains as shown in the figure. In the case of a process system constructed of carbon steel with CI injection, then monitoring is needed to check the efficiency of the inhibitor. However if there is no CI injection and the criticality is greater than medium, then monitoring should still be installed. The same applies to stainless steel with criticality greater than medium. Many oil and gas production systems have an Integrity Operating Window (IOW) and this involves measurement of pressure and temperature. This data, along with fluid chemistry data, can be used to assess the risk of the applicable damage mechanisms (DM). Again where the criticality greater or equal to medium, monitoring should be carried out with the installation of pressure and temperature sensors and fluid sampling points. If there is a high risk of scaling, this should also prompt the installation of water sampling or scaling coupons. The monitoring carried out should be to determine corrosion rate by probes and coupons, fluid sampling to assess fluid corrosivity and microbiology, bioprobes for MIC, and sensors to collect pressure and temperature data. This data can be used to assess IOW conformance and risk of particular damage mechanisms. If the risk reaches medium then revision of the monitoring strategy may be needed.

Figure 3 shows how the corrosion monitoring of equipment, which has a similar pattern to piping, can be improved once an RBI report is produced. This involves a requirement for fluid sampling and sensors to monitor pressure and temperature to calculate the risk of the possible damage mechanisms.
For any set of piping or process equipment, the possible damage mechanisms can be identified, the risk of them occurring then depends on the collected monitoring data. Thus identifying the high risk locations and monitoring those locations is critical to asset integrity. The monitoring system should be set up so that alarms or red flags are triggered if the risk from any given damage mechanism is greater or equal to medium. For example if carbon steel piping has a 3mm corrosion allowance, and the life of the asset is 30 years then the corrosion rate should not exceed 0.1mm/year. However if the corrosion rate gets close to this figure, then the alarm should be set to be triggered at, say 70% of the maximum rate, and if this happens then the mitigation plan needs to be re-assessed.

The general strategy for monitoring to determine mitigation methods is given in Figure 4, where the work flow for a system can be followed. Initially, when the alarm is triggered and the asset identified, which could be piping, equipment or a pipeline, the damage mechanism causing the alarm needs to be found. A mitigation work flow system for that particular asset should already have been developed and this is referred to “Mitigation Work Flow of Asset” in Figure 4. The next step as shown in the figure is to work through the selected mitigation programme and determine the cause of the alarm. This stage is designated as “Use Mitigation Work Flow to Determine Cause of Alarm”. Next, corrective action needs to be taken and finally the system is monitored over a number of months to ensure it conforms to the IOW.

Following is an example of how the mitigation methodology system works if the asset is damaged as a result of scaling. From Figure 4, an alarm would be triggered as a result of scaling, and the asset identified. In the box “Mitigation Work Flow of Asset” mitigation for scaling would be selected, and as a result the methodology shown in Figure 5 would appear. This would be used to determine the last 3 stages shown in Figure 4, (cause of alarm, corrective action and IOW compliance). If scaling is confirmed to be a threat, then a scaling inhibitor would be injected into the system, to ensure that this is controlled.

Excessive scaling can be identified through the use of scaling coupons, and the possible reasons for this are outlined in Figure 5. Once scaling is found, the pump status should be checked as this could be due to incorrect injection rate set on pump, failure of pump to work, pump blockage or non-availability of scaling inhibitor as a result of inventory issues. Scaling may have also occurred due to changes in fluid chemistry which would then require an increase in the injection rate and once this had been done the system should be monitored to prove the system is back within the IOW. Another cause for unexpected scaling may be due to an increase in operating temperature, and once this had
been readjusted, the system would be re-monitored to confirm reduced or no scaling and conformance to the IOW. If none of the procedures outlined in Figure 5 are found to be suitable, then a more detailed study would be required, as well as consulting the supplier of the scaling inhibitor.

Another typical example is corrosion during gas dehydration at a rich glycol inlet filter (glycol containing high water content which has been removed from the gas). The rich glycol is a threat to piping and equipment as it is regenerated back into lean glycol. In one particular system, the RBI report for this equipment on an offshore platform was designated as “High” and the material of construction was carbon steel with a 3mm corrosion allowance. To get the correct mitigation method, the damage mechanisms should be known as well as monitoring the necessary parameters to assess overall threat level.

The process fluid was found to contain CO$_2$, H$_2$S, CO$_3^{2-}$ all in the presence of oil and water. The possible damage mechanisms cited were CO$_2$ corrosion, acid sour water corrosion, hydrogen induced cracking, carbonate cracking and MIC. To determine what threat these damage mechanisms actually pose requires monitoring. For example CO$_2$ corrosion depends on the partial pressure of CO$_2$. The actual level of CO$_2$ may be high, but if the operating pressure is low, which would give a low partial pressure of CO$_2$, then corrosion would not be an expected threat. Thus monitoring the CO$_2$ content of the fluid and operating pressure is important. Similar intricacies would apply to the other damage mechanisms mentioned above. Engineers should therefore know at what temperature, pressure and fluid composition combinations a particular damage mechanism becomes a threat. In the design for this section of the process, gas dehydration (glycol filter), a fluid sampling point should be present to monitor the CO$_2$ content, water content, H$_2$S content, pH, CO$_3^{2-}$ and bacteria analysis. Pressure and temperature sensors also need to be present in the correct locations. Based on all the data gathered can accurate assessment of the threat level can be made and an increase or decrease in mitigation applied to keep the system within the IOW.

Conclusions

- An RBI report should be used for new projects to produce a more efficient, cost effective and better managed monitoring system to be used.
- For many oil and gas projects an RBI report may not be available at the initial stage of production. Once such a report is made available the monitoring and mitigation systems should be re-assessed.
- To confirm particular damage mechanisms and conformance to the IOW, monitoring should include pressure, temperature and water sampling data. Devices should be installed in the correct locations to collect such data, and this should ideally be done at the design stage after assessment of all reports.
- Whenever an RBI report is updated, the monitoring and mitigation plans should also be considered for possible revision.
- The experience gained from this work can be used to improve the planning and integrity of future projects.

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Testing CUI Coating Performance

Dik Betzig, PPG PMC Hi-Temp Coatings

Engineers and designers of equipment and piping operating at elevated temperature have a wide choice of testing standards for qualifying and selecting coating systems for protection against hot cyclic corrosion of carbon and stainless steel under insulation.

Coating specifiers for major oil and refining companies have yet to develop a consensus as to what the physical performance guidelines should be for high temperature coatings and their degree of chemical resistance.

An important obstacle to predicting corrosion is the array of varying corrosive environments and operating temperatures, which greatly affect the expected service life of any coating system. Another variable is the degree of corrosion derived from the leachable chemistries of four common insulation materials used in the oil and gas industry: Calcium Silicate, Rockwool, Aerogel blanket and Perlite insulation.

Coating evaluation procedures fall into several general classes:

1. Characterisation
2. Screening
3. Simulated environmental tests (accelerated performance testing)

Characterisation tests are those that measure basic characteristics of a coating and/or the coating-substrate composite. This would include the measurement of such properties as hardness, thickness, density, melting point, emittance, thermal conductivity, tensile and creep strength, elastic modulus, and fatigue strength. Some of these can be part of the quality control tests for the product or the application. For many of these, procedures are described in ISO and/or ASTM standards.

Screening tests are generally designed to provide a preliminary evaluation of the capability and potential of a coating system for a given application. Usually the data derived from such tests are of a comparative correlative nature. The test environment ordinarily includes only one or two independent variables and is geared for high rate/high volume, rather than environmental simulation. Screening tests normally involve a minimum of equipment. However, some facilities, notably those which are used to screen expensive process equipment, may represent capital investments exceeding $50,000. Perhaps the most common screening test for high temperature coatings is the so-called cyclic oxidation test, in which small coated steel coupons are subjected to a series of increasing isothermal air exposures until all the specimens have failed. Like other screening tests, this test can be quite effective in eliminating ineffective coatings from further consideration, thereby minimizing the number of candidate coatings that must be carried into advance proof testing.

Simulated environmental tests are those in which the actual exposure environment is simulated in the laboratory. This description is somewhat of a misnomer since most environmental exposures are too long in duration to be realistically modeled. This is the reason why attempts are made to develop accelerated testing methods.

An elusive factor which complicates inter-laboratory data comparison is failure criteria. The appearance of substrate oxide has been generally regarded as evidence of coating failure. However, the amount of oxide that accumulates to constitute a failure is a subjective quantity and can vary from laboratory to laboratory. Moreover, this failure criterion is strictly artificial and may have no relevance to what would constitute a service failure.

The first step towards the elimination of the current confusion in evaluating coatings would be the establishment of meaningful test standards. An attempt at this was the subject of earlier studies [1]. The establishment of test standards for high temperature protective coatings is currently being investigated by ASTM committee C-22. The initial test procedures proposed have received only limited acceptance, and the progress of ASTM C-22 has been relatively slow.

Meanwhile, the recently released ISO 19277-2018 is gaining recognition as a standard CUI test method.

The confusion and inefficiencies caused by the current lack of test uniformity can only worsen as higher operating temperatures, longer service life, and greater reliability will be demanded of future coatings. With coating requirements becoming more stringent, improved measurement techniques, refined reliability analyses, and more effective NDT must be developed.

This article describes the different factors to take into account when selecting high temperature and more specifically CUI coating systems. It discusses several methods and standard currently in use to test the different performance parameters of such systems.

Heat Resistance of Organic Coatings

When organic coatings are exposed to elevated temperatures, the initial effect is usually softening, followed by hardening, embrittlement, and degradation of the coating. The rate of response and the extent of degradation depend on coating composition, temperature, and length of exposure. Both thermal and heat resistance relate not only to occasional heating, but also to resistance to change from exposure to a (constant) heat influence over months or years.

Organic coatings can be specifically formulated to provide thermal resistance to protect steel surfaces exposed to elevated temperature during service life. These include, phenolic or novolac epoxies as well as vinyl esters, which can offer good long-term corrosion protection. However, most are over rated in terms of temperature and lose mass in the order of 20-30% with prolonged exposure above 150C. Thermoset epoxy’s and baked enamels have an upper temperature range of 200C unless they are hybrids with higher temperature resistance.

High temperature coatings are needed to protect distillation columns (the coating is not visible as the column has been insulated after application).
Table 1: Properties of typical Organic & Inorganic High Temperature Coatings.

<table>
<thead>
<tr>
<th></th>
<th>Traditional Silicones</th>
<th>Multi-Co polymer</th>
<th>Phenolic Novalac</th>
<th>Inorganic Zinc</th>
<th>IMPM &amp; Hybrid Siloxane</th>
<th>Thermal Spray Aluminum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contains sacrificial anodic metal</td>
<td>Yes (Aluminum)</td>
<td>Yes (Aluminum)</td>
<td>No</td>
<td>Yes (Zinc)</td>
<td>No</td>
<td>Yes (Aluminum)</td>
</tr>
<tr>
<td>Withstands intermittent immersion</td>
<td>Fails</td>
<td>Not Recommended</td>
<td>Yes</td>
<td>Fails</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>In-service application, substrate T °C</td>
<td>Yes 93 °C</td>
<td>Yes 120 °C</td>
<td>Yes 120 °C</td>
<td>No</td>
<td>Yes at 260 °C</td>
<td>Yes</td>
</tr>
<tr>
<td>Surface tolerant</td>
<td>No</td>
<td>No</td>
<td>Some</td>
<td>No</td>
<td>No (SSPC SP-15)</td>
<td>No</td>
</tr>
</tbody>
</table>

**Heat Resistance of Inorganic Coatings**

In general, inorganic/ceramic coatings exhibit better heat resistance than organic coatings. Traditional thin film silicones and aluminum silicones perform best in dry isothermal conditions, but will not tolerate intermittent immersion.

Zinc silicates react under warm and wet insulation in a cyclic environment and as such are not the product of choice for CUI applications. Most of the current inorganic coatings including thermal spray aluminum (TSA) have a high degree of porosity and perform best under steady state thermal conditions, but are affected by salt spray or other wet cyclic conditions. Inert Multipolymeric Matrix (IMPM) technology has proven to deal with some of these drawbacks of other technologies.

Constructability and ease of repairs with open re-coat window after erection and welding or bolting up of the equipment, are also desirable properties. Not all technologies have these attributes, so specifiers should familiarise themselves with each product’s technical data sheet. For example, not all new products develop a hardness level that allows for post fabrication, and painting, handling, erection and fitting. The specifier should be very careful to ascertain this physical property characteristic of the newly applied coating.

For elevated temperature CUI service, newer technology systems which can be applied in a fabrication facility and allow for transportation and erection with little damage, are available. These technologies can be used to overcoat inorganic zines or – preferably- can easily replace inorganic zines. These new technology coatings become hard and resist damage, do not require a heat cure, and are self-healing to develop corrosion preventative properties.

**Surface Preparation & Inspection**

Surface preparation is of course one of the most important parts of the coating system performance. It is generally a more costly component of the work and can involve not only hazardous waste generation, but can require health and safety precautions. In many cases the choice of surface preparation method can become a limiting factor in evaluation of projects and engineers’ estimates.

Its performance on different grades of surface preparation may be an important practical and economical decision making factor when selecting any coating system.

Some of the new technology CUI coating systems do not require the typical white metal clean surface preparation, and can work well even with a less then optimum application.

Another critical success factor is ensuring that the coating system applied is installed in accordance with the owner’s specification and the suppliers product data sheet. With the overall cost of doing this work, it is extremely important that the coating system works as well as possible to maximise durability. Life cycle thought processes are important in choosing the coating system and by ensuring a proper application, realisation of these expectations can be achieved.

**Test Methods for Evaluation of Heat Resistance**

Evaluation of heat resistance is carried out on coated specimens exposed to selected temperatures representative of service conditions, and later subjected to other exposure conditions to determine susceptibility to loss of protective function. Typical of this kind of testing is ASTM Test Methods for Evaluating Coatings for High Temperature Service (D2485). A test set-up for evaluating corrosion under insulation is described in ASTM Method G189: Standard Guide for Laboratory Simulation of Corrosion Under Insulation.

Other standards describing tests that have a place in reviewing high temperature coating properties include ASTM Method E2402: Standard Test Method for Mass Loss and Residue Measurement Validation of Thermogravimetric Analyzers.

**ASTM Method D 2485**

This method provides an accelerated means of determining performance when coatings are exposed to high temperatures. In Method A, for interior service coatings, coated steel panels are heated for 24 hours in a muffle furnace at the selected temperature. One panel is plunged immediately into water for thermal shock, while another is cooled and then subjected to a bend test.

In Method B, for exterior service coatings, coated steel panels are heated in a muffle furnace in increasing steps of temperature from 205 to 425°C. One panel is subjected to salt spray for 24h, while another is exposed outdoors for twelve months. When these test exposures are completed, the panels are examined and evaluated for film degradation, including rust formation, blistering, loss of adhesion, dulling and chalking.

**ASTM Method G189**

This guide covers the simulation of corrosion under insulation (CUI), including both general and localized attack, on insulated specimens cut from pipe sections exposed to a corrosive environment usually at elevated temperature. It describes a CUI exposure test apparatus (hereinafter referred to as a CUI-Cell), preparation of specimens, simulation procedures for isothermal or cyclic temperature, or both, and wet/dry conditions, which are parameters that need to be monitored during the simulation and the classification of systems.

The application of this guide is broad and can incorporate a range of materials, environments and conditions that are beyond the scope of a single test method. The apparatus and procedures described are principally directed at establishing acceptable procedures for CUI simulation for the purposes of evaluating the corrosivity of CUI environments on carbon and low alloy pipe steels, and may possibly be applicable to other materials as well. However, the same or similar procedures can also be utilised for the evaluation of:

- CUI on other metals or alloys
- Anti-corrosive treatments on metal surfaces, and
The potential contribution of thermal insulation and its constituents on CUI.

The only requirements are that the test samples can be machined, formed or incorporated into the CUI-Cell pipe configuration as described.

It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

**ASTM Method E2402**

Mass is the primary dependent parameter, and temperature is the primary independent parameter measured by TGA. Mass loss and residue measurements are validated by their direct measurement using thermo-gravimetric apparatus over a specified temperature range using reference materials of known volatility.

**Modified Houston Pipe Test**

The original Houston pipe test was developed to study high temperature coatings exposed to atmospheric conditions. This test method was also valuable in looking at colour stability using a temperature gradient and simulating a stack/flare environment.

Recently this method has been modified to include insulation surrounding the pipe and introducing saline water by injection between the pipe and insulation.

In the current version of the Houston pipe, the pipe is insulated and jacketed with aluminum sheet metal. The purpose of this version is to simulate corrosion under insulation. The temperature of the hot plate is set and thermocouples are placed along the along the pipe and the temperature recorded for future reference. At a pre-determined time interval the insulation is saturated with water and the test allowed to continue until it has dried out, therefore testing for both wet and dry conditions. However this test does not account for elbows and horizontal piping conditions that are present in all plants that will trap water and create intermittent immersion conditions.

The Houston pipe test is economically reasonable to set up and run. However, temperature control, fluid injection and repeatability are difficult to control. This test is not a good environmental representation for CUI.

**ISO 19277-2018**

Originally a (PPG) Hi-Temp Coatings in-house method, the environmental chamber test was modeled using three major test methods, ASTM G189, ASTM B-117 and Prohesion. The best of these test attributes are taken into consideration in ISO 19277: automated control, uniform heat, accelerated results and repeatability.

Figure 1: ASTM G-189 cross section of test cell.

Figure 2: determination of mass loss for medium mass loss material.

Figure 3: picture of Houston pipe test assembly.

Figure 4: Heat Exchanger/ CUI Test Chamber.
This test cell can maintain the set temperature with a minimum temperature fluctuation and even heat distribution due to an internal oil circulation system. The key parts of the environmental test are the Heat Exchanger (A) and, cell and chamber (B). The cell is a carbon or stainless steel 4” x 4” square pipe section 24 inches long with a ¼ inch wall thickness. The cell is placed horizontally in the chamber as shown in figure 5, in a closed loop system. Hot oil from a heat exchanger is circulated through the cell and the temperature is controlled from ambient to 250 C. No insulation is used for this test allowing the flexibility for immersion and changing the electrolyte testing.

The test cell is square allowing for flat, vertical and radius geometries. This condition allows the test medium to condense on the top surface and retain moisture during the entire cyclic duration; see Figure 4.

The bottom portion of the cell is under continuous immersion for the duration of the wet cycle. The test protocol is set for alternating wet and dry 4 hour cycles. The vertical surface is scribed to the substrate for undercut corrosion evaluation (Figures 6 & 7).

**Summery & Conclusion**

It is very difficult to rely on one test method to quantify high temperature coatings. Accordingly several distinct methods to determine performance of high temperature CUI coatings are in use for screening by product developers and can be used to qualify CUI coatings.

- ASTM 2485 is the first bench mark method that ensures adhesion and matched coefficient of expansion covering the range of temperature and thermal shock performance.
- ASTM 2402 determines weight-loss which is critical for long term corrosion performance of high temperature coatings.
- Finally an accelerated cyclic test comprising dry/thermal shock/immersion/ASTM B-117 salt spray to determine the important attributes required by ISO 19277

**References**

7. ASTM 106/A 106M Specification for Seamless Carbon Steel Pipe for High-Temperature Service
8. ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2059, United States
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1800—2100
Venue: Skempton Building, Imperial College, London, SW7 2BB
Past, present and future of corrosion
Speaker: Bijan Kermani, Keytech

26th February 2019
Aberdeen Branch
1800 - 2100
Venue: Room N242, Sir Ian Wood Building, Robert Gordon University, Aberdeen, AB10 7GJ
A novel approach to combating CUI, and MIC-resistant HDPE linings for seawater applications
Speakers: George Sykes, International Paint, and Michael Barakay, RMB Products, Rob Mackie, United Pipeline Systems

11th - 15th March 2019
Fundamentals of Corrosion for Engineers Course
1800—2100
Venue: Northampton
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Speaker: Gareth Hinds

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Venue: Room N242, Sir Ian Wood Building, Robert Gordon University, Aberdeen, AB10 7GJ
Industrial Visit, ICR
Venue: Aberdeen Energy Park, Claymore drive, Bridge of Don, Aberdeen, AB23 8GW

30th April 2019
Aberdeen Branch
5:30 - 8:00
Venue: Room N242, Sir Ian Wood Building, Robert Gordon University, Aberdeen, AB10 7GJ
Corrosion Inhibitor Screening: Impact of Test Approaches
Speaker: Dr. Ian Carpenter of Scaled Solutions

28th May 2019
Aberdeen Branch
6:00 - 8:00
Venue: 3 Commercial Park, Venture Dr, Westhill, Aberdeen, AB32 8FQ

NACE Presentation and Demo (Material Loss from Surface Preparation) and Evaluating the Effect of Surface Preparation Standard on Zinc Rich Epoxy Primers
Speakers: AIS Training - NACE Presentation and Demo & Simon Daly of Hempel on Evaluating the effect of surface Preparation Standard on Zinc Rich Epoxy Primers

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