Corrosion Management

Issue 144 July/August 2018

Selection of materials for handling waste waters

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The President Writes

This month has seen the long awaited ‘buried pipe’, which will allow candidates on the CP Course to carry out testing of instrumentation on a live piece of buried pipe, installed at the IMechE Training facility in Sheffield. This has been a labour of love and frustration for many over a long period of time, but it is also a symbol of what can be achieved when two organizations with some very determined people put their heads together. This will bring an enhanced learning experience for people attending CP training in Sheffield. There has also been much time and effort put in by many in recent months looking at how we can be the best in class at the training we offer.

The other wonderful news this month is that we are now in possession of our new home, 5 Saxon Court Northampton. My sincerest thanks go to Trevor Osborne for the hard and diligent work that he has put in to make this possible. It has been the wish of Council for some time to see us in a permanent location and that has now been realised. There are some changes that need to be made to the property, but we are looking at a move in date of November, and we would welcome a visit from you all.

I was lucky enough this month to have a tour of the Sir David Attenborough polar vessel just prior to the hull being launched, but the weather made it feel like a shipyard in Singapore rather than Birkenhead!

We have held productive PDTC and Council meetings, there is good progress being made in our efforts to provide up to date and interesting new courses, and you should see the results of this in coming months. Council was as ever a lively debate with good progress being seen by the Membership committee. I would like to take this opportunity to thank Bob Crundwell for his years of service to the Institute as a Past President and active role in the institute, Bob has decided to stand down from Council and we wish him all the best.

I hope you all continue to enjoy the summer.
Sarah Vasey, ICorr President

From the Editor

I hope you are all surviving this very hot weather, as certainly some of the plant facilities are not - steel surface temperatures have been in excess of 100 C and this has challenged some of the protective coatings being used. The good news is that the long period of dry weather has allowed maintenance painting to keep up to the schedules. As well as this being the main painting season, it’s also the time of editorial planning for the following year – so if there are any topics you wish to see covered in the magazine, please let me know.

Riding on the success of the CEOCOR congress, the main technical article in this issue is based on one of the plenary lectures – the selection of corrosion resistant materials for pump construction in the waste water handling plants. The second technical article looks at a failure of stainless steel pipework due to the water used for hydrostatic pressure testing.

Remember, this is your magazine, so make sure you send in any news items about your local branch, or other corrosion-related information, so that they can be shared with the others in the Institute.

Brian Goldie, Consulting Editor

New Sustaining Member

HDM Tubes Ltd

HDM Tubes Ltd., based in Cardiff, is a leading manufacturer of spirally welded LD pipes for the foundation and construction industries. The mill layout has been specially designed to roll heavy gauges up to 32 mm and long lengths up to 45 m. The Cardiff factory is equipped with shot blasting/painting, clutch/interlock welding, facilities for combi-wall applications, and also has a workshop for any other necessary attachments to meet custom-made pipe designs.

As the only spiral pipe producer of heavy gauge and long pipes in UK, HDM Tubes Ltd. is able to provide short lead times for specific projects and customer needs. Taking advantage of their base at Cardiff Docks, they are able to ship long and heavy pipes directly to vessels, barges and trucks and can serve around the UK, Ireland and Europe.

HDM Tubes Ltd is also certified with quality, health and safety and environmental management systems registered to ISO 9001, ISO 14001 and ISO 18001.
R&W provide a comprehensive range of rail, civil engineering, traffic management, environmental and plant specialist services, operating primarily in Highway and Rail environments. Their founding principle of direct employment and asset ownership ensures they can offer reliable and yet flexible services to all their clients. R&W’s aim is to be “employer and contractor of choice” – a vision which has established their capability of delivering all aspects of project life cycles (plan, design, build, refurbish and recycle). To support this R&W have a highly skilled and motivated workforce of more than 200, who embrace the company values of being safe, respectful and always delivering. This culture is the “R&W Way” and has helped them develop effective and collaborative relationships with clients, regularly being rewarded for their service and operational excellence. They have an in-house capability to train their workforce to achieve ICATS accreditation and have an in-house ICorr Paint Inspector to ensure the works are carried out to the client’s specifications. They strive to continually improve what they do and work hard at achieving recognised business standards, holding numerous accreditations (i.e. ISO 9001/18001/44001/14001).

Membership development

Can you help promote student membership of ICorr in your local university?

The activities of the Membership Development Committee are gathering pace, with the latest committee meeting taking place in June. A major initiative to grow our student membership is now underway, led by Young ICorr chair Chris Bridge, who has visited the Materials Science department at the University of Oxford to sign up students for free ICorr membership. This has proved to be a far more direct and effective way of engaging with students than email contact with individual academics.

The plan between now and September is to build a cohort of volunteers to roll this process out to other universities in the autumn. If you are willing to visit the Materials Science department of your local university (or even better, the university you attended yourself) we would love to hear from you. This would involve an hour or so of your time to give a short presentation outlining the benefits of membership to a group of students (slides will be provided) and to answer any questions they have about the Institute.

Student membership of ICorr is free and the main barrier to signing up new members is simply lack of opportunities for contact. By reaching out to relatively large numbers of students in this way we should be able to increase uptake of membership significantly – and if we can retain even a fraction of these in the longer term it will make a massive contribution to the sustainability of the Institute.

If this sounds like something you would help with, please contact Chris, at bridge.christian@gmail.com.

Other ongoing membership development activities include refreshing the Institute brand and website, simplifying procedures for applying for membership and upgrades, establishing a policy on subscriptions for retired members, and developing the concept of Corporate Membership. More information on these and other initiatives will follow in future issues of Corrosion Management.

ICATS approved Training Centres are situated in convenient locations around the country, and are appointed to provide training for ICATS registered companies. In the North West, the provider is Offshore Painting Services. Established in Liverpool in 2010, Offshore Painting Services (OPS) has grown to become a leading provider of complete corrosion protective solutions, and composite blade inspection and repair services, to the renewable energy sector, in particular specialising in high specification coatings and rope-access blade repairs, along with rope-access solutions within facilities management, as part of the operations and maintenance function of a windfarm, both on- and offshore.

Over the years OPS have built a reputation within the industry for quality, service and safety, supported by an in-house quality assurance process independently verified and accredited to ISO 9001 and 14001, and in 2016, OPS Training was created to provide an extensive range of industry-wide vocational training courses at their Liverpool-based bespoke training centre, which includes rope-access (IRATA), offshore safety (GWO) and specialist painting and spraying (ICATS). The addition of these training services complements the already successful operations function, and provides a unique perspective to OPS and those seeking employment within the sector, allowing existing technicians to refresh their skills and qualifications while opening career opportunities for newly qualified technicians, ensuring each technician is fully competent and confident in their chosen discipline. Training is now an integral part of the OPS business model, with more certification and accreditation bodies and courses being added to the training syllabus, alongside the creation of four additional classrooms bringing the capacity to offer up to nine different courses daily. The facility provides delegates with a safe environment in which they can gain new skills and knowledge within classroom-based academic lessons, supplemented by practical exercises simulating real-life scenarios replicating a typical work-related day.

As the renewable energy sector continues to develop and expand, the need for a competent, skilled workforce is ever more prevalent, and OPS are able to meet this requirement, providing relevant and industry-recognised qualifications to technicians, many of whom are able to export their skills across the UK and beyond. Increasingly, the need for specialist qualifications is necessary to ensure the delivery of a quality service, and OPS are at the forefront with such qualifications as ICATS and IRATA, responding to the ever-changing and evolving industry of renewable energy, and adapting and innovating to meet the challenges of the future.

Visit the ICATS website
www.icats-training.org
Young Engineer Programme

The June presentation was on the subject of hydrocarbon fire protection and fire engineering, given by Philip Hollyman MSc AIFireE MSFPE. Hydrocarbon Fire Protection is a complex subject but Philip focussed on the important topics that a young Engineer needs to know, namely; what is fire protection, and why is it needed, what are the different types of fire, how are PFP coatings tested, what is structural fire design and what are the factors affecting the loading?

There was good interaction from the floor with discussion on how engineers could best approach fire protection to meet their current project requirements to save weight and costs.

An up-date on the Case Study which the participants will study, and which involves looking at an offshore heat exchanger corrosion failure, was given by George Winning. The young engineers will examine the problem and review the heat exchanger design/operating data and propose credible root causes for the degradation of the 1st stage tube sheet. Each team's conclusions, should define the potential failure scenarios for the degradation, describe a testing scope to confirm the root cause of the corrosion damage, and explain how they would perform a corrosion risk assessment to help the Installation's management team determine if the unit can be restarted. They will also consider what mitigation options could be applied to prolong the service life of the heat exchanger, and using the design and operating data provided, also present alternative materials of construction for a replacement heat exchanger and describe the basis for their selection. The results of each team's study will be presented at the London branch evening meeting in November.

The evening closed with a networking dinner hosted by the Institute of Corrosion and AkzoNobel, and as always thanks go to those who gave up their free time to come and assist with the YEP programme, and in particular Philip Hollyman from AkzoNobel.

Alan Denney

A member of the Institute, Alan Denney, has been given an award from the Corrosion Institute of Southern Africa, relating to the external corrosion management of the refined products pipeline which goes from the port of Beira in Mozambique to the tank farm at Feruka in Zimbabwe.

The award acknowledges the long-term external corrosion management of the line over many years. Michael Brett and Partners in RSA performed work on the pipeline in the 1980s, and John Brown E&C Ltd designed and carried out construction management for an extensive rehabilitation of the line in 1990-1993. The CP system maintenance and upgrading was continued by Corrolec Corrosion Services in RSA and subsequently by ACEL and Isinyithi Cathodic Protection (Pty) Ltd. Whilst the work has involved many engineers and specialists throughout approximately 40 years, the cathodic protection work had been conducted to a very significant extent by Neil Webb who worked for these companies. The award was given to acknowledge all the companies involved, and that for John Brown was (unexpectedly) sent to Alan, as the head of the materials, corrosion and welding engineering department in John Brown in London at the time of the pipeline rehabilitation in 1990-1993.

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

TO ADVERTISE IN CORROSION MANAGEMENT please contact Jonathan Phillips or Debbie Hardwick at: Square One +44 (0)114 273 0132 enquiries@squareone.co.uk
Many of you will know that in May 2018, CEOCOR held its Annual Congress in Stratford upon Avon. A significant number of those in ICorr with interests in buried pipelines, their internal and external corrosion mitigation, coatings and cathodic protection, attended the Congress. This was the first time in the 62 years since the formation of CEOCOR that the Congress had been held in the UK. For those of you who would like to know about the history of CEOCOR, you should visit the CEOCOR web site http://ceocor.lu and read the “50 years of CEOCOR” under the Bibliography tab.

ICorr and Correx Ltd were responsible for organising the venue, the exhibition and the social programme for both delegates and partners. CEOCOR were responsible for the technical programme. An organising committee chaired by Steve Barke and comprising Sarah Vasey (President), John Fletcher (Immediate Past President), Ross Fielding (Midlands Branch), Brian Goldie (Editor, Corrosion Management) and Brian Wyatt (ICorr and CEOCOR) were responsible for the planning and operation of the Congress. Linda Wyatt was responsible for the Partners’ Programme and two of her ex work colleagues assisted with the registrations and enquires throughout the Congress. All the bookings were administered by the ICorr/Correx Ltd Office staff, and I thank them all for their tireless work over many months. There was a dedicated web site for the event for which thanks go to Debbie Hardwick at Square One. The ICorr President opened the Congress, and John Fletcher and Steve Barke were there all the time working to keep it all running smoothly. Thanks are also due to ICorr Council for their support from when this was just an idea, and one that might have cost ICorr a lot of money.

The technical programme was managed by the CEOCOR Secretary General René Gregoor from Belgium and the Presidents of the two Commissions within CEOCOR, Markus Büchner from Switzerland and Tom Levy from Luxembourg; the Key Note Speakers were organised by ICorr. Again, sincere thanks are due to all concerned.

There were a further 29 technical papers covering topics including:

- Pipeline coatings
- Pipeline cathodic protection criteria
- Pipeline cathodic protection measurement techniques
- Innovative pipeline inspection systems
- Innovative coating assessment systems
- Corrosion in drinking water systems
- Issues with casings and isolating joints
- DC and AC Interaction to pipelines and structures

My assessment of the quality of the papers was, as is always the case with CEOCOR, first rate and that the delivery of them was excellent. Attendees were presented with these in hard copy and electronic formats. They are not available to non-CEOCOR Members for 12 months but will be publicly available on the CEOCOR website next year (however to receive them now, join CEOCOR, it is only Euro 150).

Before and after the 2-day Technical Paper sessions were the Work Group meetings. These deal with technical issues of interest to the members, and most of the European Standards related to cathodic protection of buried pipelines have been developed as pre-standards within these Work Groups, and their completed documents are on the CEOCOR web site. Current work includes CP criteria, reference electrodes, internal corrosion, casings and OFF potential measurements. Members and non members are welcome to participate in these Groups, there are typically 2 or 3 meetings per year with electronic working between times.
Sponsors and Exhibition
The Platinum Sponsor was National Grid. There were 6 Gold, 8 Silver and 5 Bronze Sponsors who also exhibited, a further 4 exhibitors, and a number of companies also sponsored other elements. All told there were 23 exhibitors, a record for CEOCOR. My thanks go to all of the sponsors and exhibitors without whose support the Congress would not have been possible.

Those exhibitors that I have spoken to directly have all said that this was a great success for them. This was not like one of the larger trade `shows' - it was an opportunity to highlight their company and talk to some of the most senior technical authorities in buried pipeline corrosion in Europe.

Social and General
Although the prime reason for attendance was work, there was fantastic Gala Dinner with hilarious entertainment from the Shakespeare Birthplace Trust, and from some attendees who were prepared to enter into the spirit of Shakespeare and corrosion engineers! The BBQ/ hog roast/ jaz trio evening provided a great networking opportunity. The partners enjoyed visits all around Stratford and a private tour of Ragley Hall.

In total there were over 150 participants, again a record for CEOCOR. But we measure success by the quality and not the quantity - it was a great success! Those of you who were unable to come missed something really special, and those of you whose companies didn't exhibit, now know what they missed ... but we had no more room!

What Next
I hope for more UK individual and corporate members of CEOCOR. The next Congress is in Copenhagen, see http://www.ceocor2019.com. I know that the organising team of Lars Nielsen and Thomas Larsen will be striving to do even better than we managed to do; they are a good team and it is a good venue ... but they will have to work very hard to do better than 2018!

Finally, this was a hugely successful meeting, the best that I have been to for decades. It did not happen without a huge amount of work. I thank ICorr and CORREX Ltd for their confidence in financially supporting this, and the Committee as detailed above, who worked tirelessly and effectively.

Brian Wyatt, President of CEOCOR

Institute members take part in the Race Across America (RAAM), 2018
The four cyclists, from left to right, Nick Buys, Ian Patterson, John Sibley and Lee Spoor.

For 36 years RAAM has been challenging ultra-cyclists from around the globe to push their physical and mental limits to the farthest reaches. The route traverses three major mountain ranges (Sierra, Rocky and Appalachian), crosses four of America's longest rivers (Colorado, Mississippi, Missouri and Ohio), the Great Plains, and also passes through such iconic American landmarks as the Mojave and Sonoran Deserts, Monument Valley, and Gettysburg. It is open to amateur and professional racers, in solo, 2-, 4- and 8-person relay teams, and has become a huge platform for racers to raise awareness and money for charities of their choice. The racers have raised a total of over $2 million per year, for the past 5 years.

The Team New Forest from Hampshire is a 4 man relay team, and 2 of the racers were professional members of the Institute, Ian Patterson and Lee Spoor. The other two cyclists were John Sibley and Nick Buys. There was also an 11 strong supporting crew, and again two of which were also professional members of the Institute, Andrew Patterson and David Horrocks.

In total the team raised over £7,500 (+£1200 in gift aid) for their chosen charity, Cancer Research UK.
The 5th branch event of 2018 took place on Tuesday 29th May 2018 with 46 attendees. The evening opened with a short AGM and election of a new committee for 2018-2019 season. In terms of the committee members, the branch has secured continued commitment from all the existing 2017/2018 members, and in addition a new committee member, Ms. Zahra Lothi (MiCorr, CEng) was elected to serve for the 2018/2019 season. Also the branch welcomed back a former committee member, Dr. Muhammad Ejaz, who took a sabbatical year in the 2017/2018 session and has returned for the 2018/2019 season.

The May meeting was a very informative Industrial Visit to Sonomatic, which included several presentations and showcased their specialist equipment and facilities for overcoming / identifying corrosion and integrity challenges. It was a great opportunity to witness so many different inspection technologies on display together, and which was well received by all who came along. It was also very interesting to hear about the links between Industrial NDT as used extensively in the Oil and Gas Industry, and Medical applications of these advanced techniques.

The applicability of the use of Non-Intrusive Inspection (NII) and its possible time savings, was explained and a wide range of NII verification methods were demonstrated, along with discussion of Non-Intrusive Codes such as DNVGL-RP-G103 as further developed by HOIS Joint Industry Project and others, ie

- Type A – No Corrosion likely and Minimum Inspection Requirements / Coverage.
- Type B – Predictable Corrosion Locations / Moderate Rates and Medium Inspection Requirements / Coverage.
- Type C – Unpredictable Corrosion Locations / High Rates and 100% Inspection Requirements / Coverage.

The need for close working co-operation between inspection teams and corrosion engineers was stressed, together with the importance of post inspection analysis / data review and statistical analysis. When correctly calibrated and deployed, these specialist techniques provide an extremely useful 3-dimensional record of the completed inspection with all high risk areas highlighted / colour coded according to depth of corrosion penetration / pitting.

The use of Long range Ultrasonic Testing (LRUT) as an effective screening tool was explained in detail to the audience. Weld locations may clearly visualised as high amplitude peaks, and when used properly, LRUT flags up areas showing corrosion activity which require further investigation. This does not necessarily stop at the specific location(s) of the indication(s) detected, but it triggers the operator to perform a higher level of investigation. For instance, if defect indications are detected in sections of straight pipe, adjacent elbows or other fittings may warrant inspection using a complementary NDT technique, e.g. CHIME®, which is a semi-quantitative tool used to inspect pipe material located between two UT probes, which can be up to 1 metre apart. This is an ideal method for pipe supports, as LRUT indicates only where there is an indication, but CHIME® classifies indications into categories of, (a) No corrosion, (b) < 10% wall loss, (c) 10% to 40% wall loss, and (d) >40% wall loss.

Later in the evening the Dynamic Response Spectroscopy (DRS) demonstration showed how modern composite coatings / wraps such as neoprene and multi-layer polypropylene, could be effectively inspected, highlighting variations in thickness, and the ability to detect internal pitting to +/- 0.5mm and any significant coating defects. DRS uses lower test frequencies to deal with these thicker type coatings.

At the end of the evening, a vote of thanks was given to all the Sonomatic staff, who contributed to this very successful event. Throughout the evening, wide range of questions followed the very comprehensive presentations and all the presenters’ slides are available at, https://sites.google.com/site/icorrabz/resource-center

Other event photos are available at: https://photos.google.com/share/

Next year’s Technical Meetings will be held at a new venue – The Robert Gordon University, and for more information about all forthcoming Aberdeen branch activities, please check the diary page, or the website or contact, Dr Yunnan Gao, ICorrABZ@gmail.com. To sign up to the branch mailing list, go to https://sites.google.com/site/icorrabz/home

The current Aberdeen Chair (Dr. Yunnan Gao), with Sonomatic staff – Dr Alison Craigon, Dr Patricia Conder, Dr Susan Osbeck and Graham Marshall, together with Stephen Tate (branch Publicity Secretary).

The first meeting of the new season will be held as usual at Imperial College, on 11th October. The topic will be, “Advanced cathodic protection; protection design by finite method”, by Paolo Marcassoli from Cescor. More details will be available on the Branch page of the Institute website nearer the time.

The second branch joint meeting with the Society of Chemical Industry will be held at SCI, 14 Belgrave Square, London SW1X 6PS, on 25th October 2018 and entitled “A Fighting Ship and Fighting Corrosion” The Speakers will be, Dr Eleanor Schofield – Mary Rose Trust and Jim Glynn – ICorr and Beanny Ltd. The presentations will describe the conservation strategies developed during the restoration of the Mary Rose, and the dynamic duo of coatings and cathodic protection.

The starting time is 17.30 for 18.00, and a net-working drinks reception will follow 19.30. This event is free to attend, but please register in advance to help with catering at, http://bit.ly/2k6CXUR. Registration can also be made through John O’Shea at, johno.shea@btinternet.com. Further details are available on both ICorr and SCI websites.
### North West Branch AGM

The branch AGM and Golf Day was held on 12 July at Heyrose Golf Club Knutsford.

Due to ongoing issues with GDPR, advance notice of the Golf was not circulated, but notice of the AGM, which is a legal requirement, was. This resulted in a select few enjoying an afternoon of golf in beautiful weather, on what was agreed is a very nice golf course. The trophy was yet again taken by Ken Dykes, fitting reward for organising the event. OCCA’s golfers were invited to join in, but, due to the short notice none were able to attend, however, the branch golfers expressed an interest in raising a team to compete in OCCA Manchester Section Golf Day on 20 September at Whitefield Golf Club.

Andy Bradley in his Chairman’s report expressed concern over the misunderstandings regarding GDPR, which was echoed by Chris Atkins who had tabled an official AOB question regarding the subject. Andy also said that he had not been able to make contact with the current Vice-Chairman so would like to seek a replacement. Omniflex have joined as a sustaining member company, with himself and Ian Sutherton as designated members.

It was great to see Chris Atkins back on his feet again and able to take a more active part in ICorr proceedings again following his devastating accident.

The existing committee and officers were re-elected and a vote of thanks was given to Barry Windsor for all his years of dedicated service.

A general discussion took place and a programme of events was planned for the following season.

These include a presentation on CP by Omniflex in September, a resurrection of the “Lean Conference” in Salford, a Christmas meal on 6th December and the 50th AGM and Golf Day on 23 May 2019.

### Midland Branch

Many thanks from the Midland Branch to Trevor Box for his chairmanship, with the branch growing in strength during his period at the reins. Thanks also to the branch committee and all members for their support.

The branch held an informal committee meeting on 24th July, specifically to arrange the branch meeting programme for the next 12+ month period. The following preliminary schedule has been arranged, this year a September evening event is proposed along with the December Branch meeting and ICorr AGM. For the December meeting we have chosen a theme of Pipelines with presentations from across the industry on the integrity of pipeline systems.

A one day Branch event is proposed for June next year, full details to be provided in due course. Provisional plans have been made for a steam train corrosion related meeting, and possible train ride + food, again more details to be published in due course.

The branch is looking to have the coatings industry of the midlands better represented, and those interested please make contact Bill Whittaker, at bwhittaker@cathodicengineering.co.uk, plus willing speakers are also invited to make contact so we can include them within our upcoming events programme.

### North West Branch

The traditional North West branch joint meeting with OCCA was held once again in February and consisted of a factory visit to Elcometer Limited. Around 30 people attended the meeting which started with a presentation in the Rolls room about the company and its range of products specifically developed to meet the needs of the coatings industry.

After the presentation the attendees were free to wander around the room inspecting the array of instruments displayed, before being split into three groups for the factory tour. The very comprehensive tour took in the manufacture of all the products, from the raw materials to the finished product. The tour finished with introductions to all the sales and admin staff.

Thanks are due to Elcometer for allowing the visit and to John Fletcher for organising it.
Industry News

Corrosion Science Symposium

This 59th Corrosion Science Symposium will be held at the University of Leeds on 9-11 September 2018. The cost of corrosion is still estimated to be 4% GDP for most developed nations although this has increased to 6.2% in the USA as per the latest NACE Corrosion cost study in 2016. This confirms that better mitigation techniques are still required and new approaches need to be explored. Managing corrosion is a pertinent challenge for industry and academia across many industrial applications (e.g. oil and gas, automotive, biomedical, energy, space exploration). This Symposium will aim to discuss the exciting and recent advances in corrosion science and engineering, the application of these principles to engineering systems, and present the exciting developments across a wide range of application areas.

Further details can be found at, https://tinyurl.com/corrosion-science-symposium

CEPE Annual Conference and General Assembly

The Annual CEPE Conference and General Assembly takes place in Belgrade, Serbia, from 28 to 30 September 2018. This year's conference will focus on what life will be like in 20 years from now, including market trends and changes to legislation

Further details, and registration form can be found at, www.european-coatings.com/Events/CEPE-Annual-Conference-General.

CEPE and BCF agree joint position on Brexit

The British Coatings Federation (BCF) and CEPE have pledged to continue their close working relationship beyond Brexit. The UK and EU industries’ supply chains are heavily interconnected, and because of this close working relationship, the industry has grown exponentially over the years, as well as seen the development of innovative technologies as a result of close collaboration between the EU 28. The UK’s intended departure from the EU has created uncertainty on both sides of the Channel. Europe is a key market for the UK paints, coatings and printing inks industry, which comprises over 60% of UK exports, whilst 80% of paint and ink imports to the UK are from the EU. 50% of BCF members are British, with the rest predominantly owned by European, American and Japanese parent companies, the vast majority having UK manufacturing facilities.

Both the BCF and CEPE welcomed the UK Prime Minister’s announcement that the UK has the ambition to stay within the European Chemicals Agency. If the UK chemical facilities. Both the BCF and CEPE have pledged to continue their close working relationship beyond Brexit. The UK and EU industries’ supply chains are heavily interconnected, and because of this close working relationship, the industry has grown exponentially over the years, as well as seen the development of innovative technologies as a result of close collaboration between the EU 28. The UK’s intended departure from the EU has created uncertainty on both sides of the Channel. Europe is a key market for the UK paints, coatings and printing inks industry, which comprises over 60% of UK exports, whilst 80% of paint and ink imports to the UK are from the EU. 50% of BCF members are British, with the rest predominantly owned by European, American and Japanese parent companies, the vast majority having UK manufacturing facilities. Both the BCF and CEPE welcomed the UK Prime Minister’s announcement that the UK has the ambition to stay within the European Chemicals Agency. If the UK chemical regulations were to deviate from those on the continent, this would result in severe disruption for the industry.

Record-breaking attraction coated by AkzoNobel

Visitors to the Middle East will soon be able to experience the largest and highest Ferris wheel in the world - Ain Dubai (the Dubai Eye) - which is being protected by coatings from AkzoNobel. Modelled after the London Eye, Ain Dubai will provide 360-degree views of the city and the Arabian Gulf. It has 48 passenger capsules, with a maximum capacity of 1,400 people, and a full rotation will take 48 minutes.

At 210 metre high, the spectacular attraction features more than 9,000 tons of steel (almost 25% more than the Eiffel Tower in Paris), and AkzoNobel is the sole supplier of protective coatings for the massive structure, which is expected to be completed later this year.

The high performance system of International products being applied to the structure includes Interzinc 52 primer; Intergard 475SHS (a high build epoxy providing protection against corrosion); Interthane 990 (a high build epoxy finish coating); and Interfine 979 polysiloxane topcoat.

“Given the harsh local climate and Ain Dubai’s proximity to the water, it was important to specify a system which provides both corrosion and UV resistance,” stated Andrea Meconcelli, AkzoNobel’s Performance Coatings Director for the Middle East. “The specification is designed to deliver maximum protection, as well as offering outstanding colour and gloss retention.”

CEPE and BCF agree joint position on Brexit

The British Coatings Federation (BCF) and CEPE have pledged to continue their close working relationship beyond Brexit. The UK and EU industries’ supply chains are heavily interconnected, and because of this close working relationship, the industry has grown exponentially over the years, as well as seen the development of innovative technologies as a result of close collaboration between the EU 28. The UK’s intended departure from the EU has created uncertainty on both sides of the Channel. Europe is a key market for the UK paints, coatings and printing inks industry, which comprises over 60% of UK exports, whilst 80% of paint and ink imports to the UK are from the EU. 50% of BCF members are British, with the rest predominantly owned by European, American and Japanese parent companies, the vast majority having UK manufacturing facilities. Both the BCF and CEPE welcomed the UK Prime Minister’s announcement that the UK has the ambition to stay within the European Chemicals Agency. If the UK chemical regulations were to deviate from those on the continent, this would result in severe disruption for the industry.

Record-breaking attraction coated by AkzoNobel

Visitors to the Middle East will soon be able to experience the largest and highest Ferris wheel in the world - Ain Dubai (the Dubai Eye) - which is being protected by coatings from AkzoNobel. Modelled after the London Eye, Ain Dubai will provide 360-degree views of the city and the Arabian Gulf. It has 48 passenger capsules, with a maximum capacity of 1,400 people, and a full rotation will take 48 minutes.

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CEPE Annual Conference and General Assembly

The Annual CEPE Conference and General Assembly takes place in Belgrade, Serbia, from 28 to 30 September 2018. This year’s conference will focus on what life will be like in 20 years from now, including market trends and changes to legislation

Further details, and registration form can be found at, www.european-coatings.com/Events/CEPE-Annual-Conference-General.

PRA Training Courses

The timetable of training courses for the second half of 2018 includes a Paint Technology training course on 29th October to 1st November. This course is designed for newcomers to the industry who need a firm foundation in the technology of surface coatings. The comprehensive and intensive four day course contains an overview of the raw materials used in surface coatings and their contribution to the final properties of the coatings. The study of coating systems emphasises the changes taking place in modern technology. The fee for this course £1760 ex V AT per person

The Paint & Coating Basic course will be held on 4 September, this also is designed for newcomers to paint related fields, and to those with less scientific backgrounds. It will be particularly useful to sales and marketing personnel. The course provides an introduction to paint technology, covering how and why paints are used; the different types of paint and their properties; how they are made and the raw materials used; and paint performance and testing. There is also an overview of the major paint markets and their drivers. Places still available for this one day course, at a cost of £560 ex V AT per person.

For further details, or to book a place on either course, email coatings@pra-world.com or call +44 (0)1664 501212.

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Steel Coating Innovation Wins German Award

Researchers at Fraunhofer Institute for Laser Technology (ILT) in Aachen, Germany, recently won second prize in the Steel Innovation Prize programme, presented every three years by the German steel industry, for their innovative approach to the deposition of thin-film coatings on steel.

The Fraunhofer ILT team’s ultra-high-speed laser deposition process, known by its German acronym, EHLA, was first announced last year and won a 2017 Joseph von Fraunhofer Prize, honoring research by Fraunhofer-Gesellschaft staff. EHLA is meant to take the place of processes such as chrome plating, and creates a thin layer (25-250 µm), with a stronger, less porous bond with the substrate in comparison with other approaches such as thermal spray coating. The new process was developed in partnership with the Digital Additive Production programme at RWTH Aachen University.

Sensor project to tackle hidden corrosion

A university spin-out and a Scottish Innovation Centre are joining forces to tackle a huge challenge for the oil & gas, nuclear, renewables, and construction sectors - how to detect corrosion that’s hidden under insulation.

According to the press release, for the oil & gas industry alone, the cost of monitoring so-called Corrosion under Insulation (CUI), in assets such as pipelines, is estimated at around £3.3bn annually. Current practice relies on periodic removal of insulation in selected areas to check visually for corrosion.

This new project will explore the use of remote sensors to monitor corrosion continually without the need to physically remove insulation. The 12-month project involves CorrosionRADAR Ltd, a spin-out from Cranfield University, and Scotland’s Innovation Centre for Sensor and Imaging Systems (CENSIS), and funding for the £89,000 project includes a £69,000 grant from Innovate UK, under its recent “Innovation in UK Infrastructure Systems” funding round.

As well as cutting the financial costs associated with manual corrosion monitoring (which may involve assets being shut down), CorrosionRADAR and CENSIS want to reduce the need for people to work in challenging conditions to remove insulation. The project could also open the way for a predictive maintenance regime, based on Internet of Things (IoT) infrastructure and cloud-based data analytics.

In this project, CENSIS will help CorrosionRADAR to integrate its corrosion and moisture sensors with IoT infrastructure, including long-life, battery-powered wireless data logging using industry protocols such as LPWAN, and cloud-based analytics. This will enable data from the sensors to be delivered cost-effectively to end-users as actionable information – even from areas that are currently off-grid in terms of power provision and connectedness.

New e-tool launched to assess and manage the risks of dangerous substances

The European Agency for Safety and Health at Work (EU-OSHA) has launched an interactive tool to make sure employers are fully aware of their legal obligation. The dangerous substances e-tool can provide employers with the support and advice they need to effectively manage dangerous substances and chemical products in the workplace.

With a focus on small and medium-sized enterprises and companies without specific knowledge of dangerous substances, this interactive web-based guide provides tailored and easy-to-understand background and good practice information on risks, labelling, legislation, prevention measures and much more. It is based on a questionnaire, and can generate a report adapted to each individual business situation on the management of dangerous substances, including recommendations for improvement. Based on the input, it provides tailored and easy-to-understand background and good practice information, for example on risks, labelling, legislation, prevention measures and much more.

The Dangerous Substances e-tool can be accessed at, https://esguides.osha.europa.eu/dangerous-substances/

Researchers Develop Pipe Lining to Combat Hydrates

According to a report from Southwest Research Institute (SWRI), researchers there have developed a way to protect pipeline internals with a superhydrophobic coating that they believe will prevent the collection of hydrate crystals inside subsea pipelines. The SwRI's Lotus family of coatings can be applied in a specialized shop using a plasma deposition process.

Hydrates can form in high pressure, low-temperature pipelines when water combines with certain gases, forming ice-like crystals that can remain solid above the freezing point of water. They pose a problem in pipeline internals when they form blockages, requiring expensive interventions to eliminate them. Currently, hydrates are commonly prevented by chemical addition which can prove costly, and SwRI is working with an energy services firm to commercialize the Lotus coating process for use in pipeline construction.

A high-throughput coating facility specifically for the Lotus coating technology is being constructed which will eventually provide sufficient production capacity to meet the needs of customers in the oil and gas industry.

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Degradation of fusion bonded epoxy pipeline coatings

In a new report, the effect of direct current (DC) interference on properties and performance of fusion bonded epoxy (FBE) pipeline coatings, in a simulated soil solution, was studied by measuring water permeation and by electrochemical impedance spectroscopy, as well as characterisation by scanning electron microscopy and Fourier transform infrared spectroscopy.

The results demonstrated that the presence of DC interference increases the water permeation into the coating, and decreases the resistance of the coating for corrosion protection. In addition, the DC changes the molecular structure of the coating material. In general, an FBE coating located in the cathodic zone suffers more serious degradation than that in the anodic area, due to the opposite direction of the DC induced electric fields in the two zones, which affect the diffusion and accumulation of water molecules and chemical ions.

The study is published in: Progress in Organic Coatings Volume 120, July 2018, Pages 79-87.

New accelerated cyclic corrosion test (CCT)

A recently published work discusses the measurement of the water diffusion coefficients and the activation energies of three anti-corrosion urethane/epoxy coatings at 20–60°C. In addition, the water absorption/desorption behaviour of the coatings in several different CCTs, including the new test, were simulated and it was found that the desorption diffusion coefficients of the coatings were much higher than their absorption diffusion coefficients. The authors considered that water molecules might need to ‘expand the mesh’ of the molecular network to penetrate the coatings during water absorption, but that they might not need to do so during water desorption.

The new CCT has a shorter drying step and a higher temperature than in the salt fog step and humidity steps, which means that drying is much faster than wetting. By minimizing the time in the dry step, the corrosion rate of steel and zinc is accelerated more than in existing CCTs whilst reproducing the water absorption/desorption as in an outdoor environment.

The study is published in: Progress in Organic Coatings Volume 120, July 2018, Pages 71-78.

SURCON - OCCA Centenary Conference

The OCCA Centenary Conference will be held on the 12th and 13th September 2018 at the Parkinson Building, University of Leeds, LS2 9JT.

The Conference will provide a forum and networking for scientists, engineers and technologists from academia, government laboratories and industry. Industrialists searching for the key scientific discovery to enable manufacture of differentiated coatings should attend. The Conference typically attracts over 100 attendees and covers 16 oral sessions over two days.

The Keynote speakers are, Professor Dr Doris Vollmer, Physics Department, Johannes Gutenberg, University Mainz; Graham Armstrong, Secretary General, The Institute of Materials Finishing; Professor Sophie Duquesne, Department for Materials and Transformations, University Lille; and Professor Stuart Clarke, BP Institute and Department of Chemistry, University of Cambridge.

More information can be obtained from, conference@occa.org.uk

PDA Europe Annual Conference

The 12th Annual Conference will be held on 12-14 November in Bucharest, Romania. The conference will feature case studies, new products and innovations, surface preparation, testing and regulations. There will also be PDA Europe internal meetings for members and educational courses.

PDA Europe is the official trade association for the European Polyurea industry. It promotes the highest possible standards for polyurea and offers best practice information on areas of environmental consideration and safety, and provides an established networking forum for key industry players to discuss the future of the polyurea market.

The preliminary programme is available on the website, www.pda-europe.org, and further information can be obtained from, info@pda-europe.org

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Standards up-date

ISO

The following documents are currently under consideration by the technical committees:

ISO/CD 8501-4 Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 4: Initial surface conditions, preparation grades and flash rust grades in connection with high-pressure water jetting


ISO/DTR 23770 Preparation of steel substrates before application of paints and related products — Analytical colorimetry method to support visual assessment of surface preparation grades

ISO/CD 23052 Anodizing of aluminium and its alloy — Test methods of chemical resistance of anodic oxidation coatings on aluminium and its alloys using electromotive force apparatus

ISO/CD 8407 Corrosion of metals and alloys — Removal of corrosion products from corrosion test specimens

The following documents have obtained substantial support within the appropriate ISO technical committee and have either been submitted to the ISO member bodies for formal approval or for voting:


ISO/FDIS 20728 Corrosion of metal and alloys — Determination of resistance of magnesium alloys to stress corrosion cracking

New International Standards published since the previous issue

ISO 9443:2018 Surface quality classes for hot-rolled bars and wire rod

ISO 19203:2018 Hot-dip galvanized and zinc-aluminium coated high tensile steel wire for bridge cables — Specifications

ISO 3183:2012/Amd 1:2017 Petroleum and natural gas industries — Steel pipe for pipeline transportation systems - Amendment 1


ISO/FDIS 21809-1 Petroleum and natural gas industries — External coatings for buried or submerged pipelines used in pipeline transportation systems — Part 1: Polyolefin coatings (3-layer PE and 3-layer PP). Revision of ISO 21809-1:2011

ISO/FDIS 20728 Corrosion of metal and alloys — Determination of resistance of magnesium alloys to stress corrosion cracking

EN ISO 14918 Thermal spraying - Qualification testing of thermal spray processes

This standard specifies procedural instructions for qualification testing of thermal sprayers. It defines requirements, ranges of qualification, test conditions, acceptance requirements and certification for qualification testing of thermal spray performance. ISO 14918:2018 is applicable when the thermal spray’s qualification is required by this document, the purchaser, by inspection authorities or by other organizations. The thermal spraying processes referred to in this document include those spraying processes which are designated as manual or mechanized. The test for mechanized application includes the use of automatically controlled thermal spraying, e.g. robotics, scan units.

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The selection of pump materials for handling waste waters

Waste waters can have a wide range of compositions, and also may vary from reducing to strongly oxidizing. Sometimes corrosion of components is controlled by impurities in the water rather than by the chloride concentration or pH, which means that material selection for pipelines carrying waste water can be difficult. However, for a pipeline of any length, economics will dictate the use of carbon steel, possibly with a suitable protective coating.

In most pipelines handling waste water, one or more pumps would be required to keep the water moving at an adequate rate, and while it would be desirable to use carbon steel pumps to minimise costs, this is only possible with near neutral waters and containing chemicals that are not aggressive. In more aggressive fluids, coatings are not normally an option, partly because of the complex shape inside centrifugal pumps, and partly because of the high flow velocities and turbulence inherently present in a pump of this type. This means that corrosion resistant alloys (CRA) are often required, and it is important to know the detailed composition of the water, to be able to select the most suitable CRA, without excessive cost.

The factors that must be taken into account when selecting cost-effective materials for pumps have been discussed in detail by Phillips and Francis [1], who used examples from the oil and gas industry to illustrate the important points, but the same principles can be used to select materials for waste waters. The most important factor is to get as detailed a view as possible of the likely composition of the waste water, and also the likely variations of this, during the life of the system. This is often very difficult in practice, and it is therefore wise to estimate a worst case scenario, because if a pump fails unexpectedly there is lost working time as well as the cost of replacement.

The article briefly reviews the important corrosion characteristics of some common alloy groups (whose nominal compositions are given in Table 1), with respect to their performance in a variety of waste waters. Some case histories are also given examining why particular alloys were chosen for specific projects.

### Typical waste water pump materials

#### Cast Carbon Steel

The problem with cast carbon steel is that the corrosion rate rises rapidly with increased flow velocity, as shown in Figure 1 for seawater [2]. It can be seen that at velocities greater than a couple of metres per second, the metal loss rate becomes unacceptable. Although this is for seawater, the rate of metal loss at higher flow velocities does not reduce much with chloride content, and at 100 mg/L chloride, the rate is only roughly halved compared to when no chloride is present from the author’s experience. This is compounded because, depending on the pump design, flow velocities at the impeller are often in the range 5 to 10 m/s, and the abrupt changes in direction mean that there is a lot of turbulence.

Where dissolved oxygen content is low and the pH is near neutral, the corrosion rate is lower (than that shown in Figure 1), and Figure 2 shows the corrosion rate at 1 m/s for a range of oxygen contents. This means that at oxygen concentrations...
of 20 to 50 ppb the corrosion rate can be acceptable, but it should be remembered that this is at 1 m/s, and the rate will be significantly higher at 5 to 10 m/s. (The cathodic reaction in these pumps is mostly the reduction of dissolved oxygen to balance the anodic reaction of dissolution of metal. Hence, reducing the oxygen content reduces the corrosion rate).

The corrosion rate of carbon steel also increases significantly at low pH (<3), and may be high at higher pH, if there are aggressive species present.

**Copper Alloys**

Copper alloys have excellent resistance to corrosion in near neutral pH solutions over a wide range of chloride contents, and alloys such as the gunmetals (Cu-Sn-Zn-Pb alloys) and nickel aluminium bronze have given good service [3] in the water industry. However, they can suffer pitting in the presence of sulphides, or other sulphur compounds, which is accelerated at higher velocities [3] (see Figure 3). Sulphides are often produced by sulphate reducing bacteria (SRB) and these can become active under deposits, or fouling, or they may already be present in the source water. Where sulphides are a possibility, copper alloys are not a good choice, and they are also not recommended in solutions operating at high or low pH (<5 or >9).

**Stainless Steels**

Stainless steels by definition contain more than 11% Cr, and often have additions of other elements such as nickel, molybdenum, copper, and nitrogen. The main classes of stainless steels used for pumps, i.e. as castings, are martensitic, austenitic and duplex. The selection of the grade depends strongly on the water composition, the redox potential, the pH, and the dissolved oxygen content.

Martensitic stainless steels are not very resistant to pitting and crevice corrosion in aerated waters containing chloride, but they have excellent resistance to corrosion in the presence of sulphides, such as H₂S, as is found in many waste streams in the oil and gas industry. Under conditions where no oxygen is present, then the corrosion risk is from sulphide stress corrosion cracking (SSCC), and the limits of the use of stainless steels is given by ISO 15156 [4].
Austenitic stainless steels are widely used for pumps, and the common grades are CF8 and CF8M which are the cast versions of 304 and 316 respectively. There are also cast versions of the 6% Mo austenitic alloys, but these are rarely used for waste waters because they are more expensive than superduplex stainless steel (as you increase the Cr, Mo and N contents of SS they become more corrosion resistant, and the 6%Mo and superduplex alloys were invented to work in very aggressive waters (high chloride, low pH etc), while CF8 and CF8M do not). In aerated chloride-containing solutions, the risk for these materials is from crevice corrosion, and Figure 4 shows the limits of use of the lower alloyed austenitic and duplex stainless steels [5].

The common duplex stainless steels are grade 4A (the cast version of 2507) and grades 5A and 6A, the cast versions of 2507 and Z100 superduplex respectively. Figure 4 shows the upper temperature limits of use for 2205, and while they are greater than for 316, it is still not suitable for high chloride aerated waters. The cast superduplex alloys have been used in a wide range of aerated chloride-containing waters including seawater and higher chloride brines [5]. Figure 5 shows the critical crevice temperature, CCT (the temperature above which crevice corrosion occurs) for both 2205 and Z100 superduplex, as a function of chloride concentration and the open circuit potential [6]. A potential of +600 mV SCE is very oxidizing, while one of +200 mV SCE is mildly oxidizing. It is clear that the CCT is not affected very much by chloride concentration over the range 3,000 to 100,000 mg/L chloride.

In deaerated waters the limits of use of stainless steels increase, and 2205 can be used with 50 ppb of oxygen up to ~60 C with 100,000 mg/L chloride [7]. For superduplex, the CCT for cast Z100 was 80 C with 410 ppb oxygen and 100,000 mg/L chloride. In fully deaerated waters with H2S, the limits of use to avoid Z100 was 80 C with 410 ppb oxygen and 100,000 mg/L chloride [7]. For superduplex, the CCT for cast and 2205 can be used with 50 ppb of oxygen up to ~60 C with 100,000 mg/L chloride [7].

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The nickel-base alloys, such as the nickel-copper and nickel-chrome-molybdenum alloys, are considerably more expensive than stainless steels and waste waters are not usually aggressive enough to justify their expense. However, the wrought alloys, such as K-500 and 625, are sometimes used for small components in areas at high risk of corrosion damage.

Pump Components
The three main components in a pump are the case, the impeller(s) and the shaft. The first two are usually castings, while the shaft is wrought. Of these three, the shaft is the most important, because if even a small amount of localised corrosion (pitting or crevice corrosion) occurs on the shaft, it will act as a stress raiser. This will be followed soon after by a very expensive fatigue failure of the shaft. Hence, it is common practice to make the shaft from an alloy with superior corrosion resistance to the case and impeller. Where these are in a very corrosion resistant alloy, such as superduplex stainless steel, then the shaft may be in the wrought version of the same alloy. The shaft will have seals, the impeller, and other items fastened on it that can create crevices, so it is important that the shaft resist crevice corrosion.

The author has seen two major pump failures where the shaft was in Ni-Cu alloy K-500, and crevice corrosion occurred followed by a fatigue failure during operation. The repairs in both cases were very expensive.

Because the case and impeller are castings, it is important to select an alloy that has reasonable castability, to avoid excessive costs.

The main features required to minimise costs while obtaining satisfactory properties in pump components, are reviewed in reference 1. The duplex stainless steels are easier to cast than the 6% austenitic alloys, and comparing castings in grade 5A and grade 6A superduplex stainless steels showed that grade 6A is easier to cast in thicker sections [10]. The lower alloy stainless steels are relatively easy to cast. The production of good quality castings in the higher alloy stainless steels requires care, and Francis and Hebdon discuss in detail what the technical requirements are, and the need to audit foundries to ensure compliance with the technical specification [10], although they were reviewing seawater pumps the same considerations apply to pumps handling waste waters.

Case History Examples

I

It is well documented that when a stainless steel is immersed in an aerated natural water, the potential increases over a period of a few days to weeks, finishing in the range +250 to +400mV SCE. This has been found for both seawater and fresh waters. The ennoblement is due to the formation of a biofilm that cathodically depolarises the reduction of dissolved oxygen. This makes the initiation of localised corrosion more likely.

These electropositive potentials can mean that an alloy is past its pitting or crevice potential. The potential of such materials then decreases, and this is often used as an indicator that crevice corrosion has initiated (Figure 7). With SRB, the H2S produces local reducing conditions and negative potentials. Iversen [11] demonstrated this by exposing stainless steel coupons to the Swedish waste water plants. In the early stages a biofilm formed that produced electropositive potentials, similar to those seen in seawater. However, over time the potential slowly decreased to very negative values. This was ascribed to the formation of a thicker biofilm such that SRB became active beneath it. With this electronegative potential, no localised corrosion initiated. However, some waste water plants add oxidising chemicals, such as potassium permanganate, as part of the waste treatment process. This can change the local redox potential such that corrosion can occur because sulphide can...
and the possibility of some oxygen ingress. The oxygen ingress multi-stage pump, which demonstrates the requirement for ISO 15156. This resulted in significant cost savings for the large cast 13% Cr martensitic alloy would also be satisfactory, using a pump, which would have been satisfactory, but the author so the fluid could be treated as a sour water with oil. A collection line was being installed at a Middle Eastern plant over time, the pumps were also made in grade 6A superduplex. Because of the strong possibility that the waste fluid mixture would become more aggressive over time, the pumps were also made in grade 6A superduplex. lower the threshold potential for localised corrosion. Iversen describes the results of exposure tests of 304L, 316L and 2205 at six Swedish waste water plants [12,13]. The results showed that 304L suffered MIC at 4 plants, all where the chlorides exceeded 200mg/L, which is above the threshold for crevice corrosion of 304L at room temperature (Figure 4). 316L corroded at one plant, where the chloride exceeded 500mg/L and there were lots of deposits on the metal. This is below the chloride threshold for crevice corrosion of 316L at room temperature in sterile solutions (Figure 4). Alloy 2205 suffered no corrosion in any of the plants, Iversen concluded that chloride alone could not predict the likelihood of MIC [12]. These results show that in waste waters where MIC is possible, it is necessary to consider a higher alloy than would be required under sterile conditions.

The author was asked to consider materials for a main oil line pump, which was pumping oil from an offshore platform to a treatment plant. This would normally require a carbon steel because oil, per se, is not corrosive. However, this was an ageing field and there was a significant water content with a high chloride level. In addition there was some H₂S and CO₂ present, and the possibility of some oxygen ingress. The oxygen ingress was sufficiently low that it would be mopped up by the H₂S, and so the fluid could be treated as a sour water with oil. The pump manufacturer was considering a 22% Cr duplex pump, which would have been satisfactory, but the author pointed out that under the conditions in the design specification, a cast 13% Cr martensitic alloy would also be satisfactory, using ISO 15156. This resulted in significant cost savings for the large multi-stage pump, which demonstrates the requirement for knowledge as to how components in the fluid will interact, in order to optimise materials selection.

A collection line was being installed to collect waste waters from a number of chemical plants, and the fluids were likely to contain a wide variety of chemicals. These included organic and inorganic acids, alkalis, aerated waters of high chloride content, and other chemicals. The concentrations were relatively low and the temperature was ambient, so it was thought that 22%Cr duplex would be satisfactory. However, part of the line passed through a tunnel with restricted access, and the tunnel owners did not want a leak at any time in the future if the fluids became more aggressive. Hence, the piping was upgraded to superduplex stainless steel. Because of the strong possibility that the waste fluid mixture would become more aggressive over time, the pumps were also made in grade 6A superduplex.

A collection line was being installed at a Middle Eastern plant to take what was described as waste sour fluids for treatment and disposal. These were basically high chloride waters with varying contents of CO₂ and H₂S, but in addition some of the waters could be aerated. Because the oxygen content was unknown, but likely to be variable, an alloy was required with a good tolerance of sour deaerated waters and also of aerated high chloride waters. The 1km line was installed with NPS 24 superduplex stainless steel pipe, valves and pumps, and it has performed well for over 15 years.

Conclusions

The selection of materials for waste water pumps is a complex operation and requires experience of materials, corrosion and the interaction of chemicals in the specific fluid. In addition it is important to know whether MIC is possible, because this can significantly reduce the limits of operation of some materials. Without a suitably qualified corrosion engineer, the consequences in additional cost and lost production can be enormous. In addition, the corrosion engineer needs to be involved at all stages from design to delivery. Hiring a corrosion engineer at the beginning of a project will cost you a little money, however if you do not hire them, don't feel bad about it, as you will be giving them much more work later on. Resistance to corrosion is designed in at the specification stage, and once the equipment is built, it is difficult to add it later on.

References


Editor’s note: This article is based on a presentation given at CEOCOR 2018

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Most of the petrochemical plants globally are ageing, and some of them are operating past their design life. There are many reasons for failure which affect the reliability of plant equipment, or component, and corrosion is foremost, in not only the petrochemical industry, but also impacts on the equipment and assets of refineries and other plants. Uncontrolled corrosion can cause leaks and component failures, bringing about a reduction in both the performance and reliability, and in extreme cases, corrosion can lead to unexpected failures that can be costly in terms of repair costs, environmental damage, and potential harm to human life. Microbiologically influenced corrosion (MIC), is a specific type of corrosion caused by microorganisms, and can occur during plant construction, operation, or during plant shutdown. Corrosion is the deterioration process of a material due to reaction with its surroundings. It is often deceptive and hidden until striking at the worst moment of a system's operation. There are a number of ways to try and prevent such damage, and the optimum control method relies on an early diagnosis of the corrosion issues, but in some cases, such a task is far from trivial. There are a number of methods available to monitor the corrosion which involve collecting information on the progress of corrosion damage to a material, or on the corrosivity of the environment surrounding the material. Corrosion inspection is usually a survey of the material to assess the condition at any given time, whereas corrosion monitoring consists of a series of surveys in a given time period. Microbiologically influenced corrosion is caused by specific genera of bacteria which feed on nutrients and other elements found in waters and soils. Sea water is a primary source of sulphate reducing bacteria. These days when the market economic situation is on a down-turn, maintenance costs need to be reduced whilst enhancing the plant efficiency with reliable operations. As per design and codes, every plant needs to be shut-down after several years of service for safety inspection, and to carry this out without any problem is the main challenge for reliability and inspection staff, as several issues can occur during plant startup. Plant preservation is most important to keep the equipment reliable and safe, as a number of corrosion issues, for instance MIC, can occur if proper attention is not given. It has been also noted that sometimes when a plant is under construction, and the water being used for hydro-testing equipment does not conform to the standard methods, then this can affect the equipment reliability when it comes into operation, or even before startup during the commissioning stage. In particular, biological activity can modify the local environment and render it more corrosive to metals especially stainless steel, and in petrochem plants there are many ways for this type of corrosion to occur. This article will discuss the microbiological induced corrosion (MIC) seen on a petrochem plant pipework. A study was carried out to find out the root cause of the failure of piping at the plant, which operates under a chloride-rich environment. This plant was a new construction and was completed in 2015. The material of construction of this pipework was 304L austentitic stainless steel. Looking at the plant maintenance history, it could be seen that some piping and tank leaks occurred during 2015 and 2016. To find out the reason for such failure (leaks), a sample was cut from the corroded piping system for detailed study and analysis. **Experimental procedure** A series of experiments was carried out on specimens of 304L pipework taken from the plant, including mechanical testing, metallurgical analysis, water analysis, and a background and design studies, based on a review of similar tests available from the American Society for Testing and Materials (ASTM) and National Association of Corrosion Engineers (NACE). Figure 1 shows an example of the corroded pipe selected for the examination and analysis to identify the reason for the corrosion. There were corrosion pits along one side of the internal surface, which was identified as being the bottom side of the pipe when in service. The same part of the pipe exhibited corrosion pits on the external surface. The longitudinal (seam) weld showed no significant indications of corrosion. Figure 2 shows macrographs of corrosion pits / spots on the external surface. Figure 1: External appearance of pipe sample; corrosion pits on the internal surface (d) are at the inside of the region with corrosion pits on the external surface (b). Figure 2: Macrographs of corrosion pits /spots on external surface of pipe sample B.
The pipe sample was then sectioned longitudinally so that the internal surface could be examined in more detail. Figure 3 shows this internal surface with/without corrosion pits/spots.

Optical microscopy was carried out on the corroded sample and metallographic sections were prepared in the conventional manner. The sections were examined under an optical microscope in un-etched and etched conditions. The etchant was acidified ferric chloride. Three transverse sections were prepared in order to examine the pitting damage that was observed visually at the internal and external surfaces. Figure 4 shows a macrograph taken for one of the prepared sections to illustrate the maximum size of pits found in these sections (similar-sized pits were observed at both internal and external surfaces). Figure 5 presents photomicrographs of typical examples of pits found at internal and external surfaces.
The defects observed at the external surface have irregular or 'jagged' edges, whereas the internal surface pits are more rounded in appearance and tend to increase in size beneath the surface.

The sample was also analyzed under Scanning Electron Microscope (SEM) examination and Energy Dispersive Spectroscopy (EDS) to check the condition of the corroded sample.

The EDS analysis of the bare metal surface showed enhanced oxygen levels, indicating that the whole surface has some level of oxidation. Deposits collected from a corroded area primarily exhibited high oxygen levels, and analyses for both these areas examined exhibited similarly enhanced levels of, amongst other elements, oxygen, sulphur and calcium.

More detailed analyses of the corrosion deposits / products were also carried out. One sample, had iron oxide plus significant amounts of Na, Mg, Si, Cl and Ti, with lesser amounts of S and Ca. Similarly, a second sample contained iron oxide plus significant amounts of Mg, Si, Cl and Ti, but compared with the other sample, there was less Na and Ca and more S.

From a study of the plant water history used for hydro pressure testing, it was noted that there were high levels of chloride and sulphate, which are potentially corrosive species.

**Conclusions**

There were corrosion pits along the bottom side of the internal surface, and the same side of the pipe exhibited corrosion pits on the external surface. Metallography showed that the depth of the pits was limited to a fraction of the pipe wall thickness – there was no evidence of through-wall penetration in the sections examined.

Metallography also showed that the morphology of the pits at the external surface was characteristic of acid (chloride) attack, whereas the shape of the pits on the internal surface showed that Microbiologically Influenced Corrosion (MIC) played a role in the damage.

It was concluded that the root cause of the internal damage was the water used for hydro-testing (sea water had been used at this plant for the testing). The EDS analysis of internal surface deposits showed some indications of sulphur, which indicated that MIC was involved. The purpose of this pipework is to convey exhaust gas. Corrosion pitting on the internal surface would not arise during service, provided the exhaust gas is free of moisture. Furthermore, the pitting has only affected the bottom side of the pipe. For this reason, it was clear that the internal damage had been caused by the water used for hydro-testing.

After hydro-testing has been completed, it is important that piping is fully drained and dried, otherwise pooling of residual, stagnant water along the bottom of the pipe can provide the corrosive environment to promote corrosion (pitting and/or MIC) prior to return to service, as happened in this case.

The external corrosion was due to the high chloride environment the plant operated in as the plant is very near the coast, and the external surface was not protected by a coating. Applying a protective coating should help to overcome the issue.

**Recommendations**

To maintain the integrity and reliability of plant equipment, proper attention needs to be paid to the issues described in this article. The corrosivity of water used for hydro-testing should be controlled by water treatment and dosing with corrosion inhibitors.

In addition, plant components should be inspected at regular intervals in order to check on any corrosion and depth of corrosion pits and to identify SCC cracks at an early stage, and during the shutdown or repair, the proper procedures must be carried out.
Innovative Products

Protecting pipeline casings from corrosion

According to Cortec, its patented CorroLogic® VpCI® Filler offers a practical and effective solution for long-term corrosion protection of challenging environments such as pipeline casings and tubular vessels or structures.

Standard methods for protecting these vulnerable annular void spaces have been to use coatings and cathodic protection (CP), which can be deficient or cumbersome. To replace or supplement these traditional corrosion protection options, Cortec has developed a practical and effective gel filler product. The two part product, when mixed and pumped into a structural void space, turns into a gel which fills and protects the space from corrosion. The filler also provides resistance to bacterial corrosion and prevents infiltration of air and water inside the filled structures, concluded the company.

New high-performance primer for protective coatings

Tikkurila has announced the launch of a new high performance primer, Temacoat HS-F. According to the company, this durable, all-seasons epoxy coating has optimal anti-corrosion properties, fast overcoating times and excellent adhesion to steel, zinc and aluminum surfaces. It can be used on building frameworks, bridges, refineries, power plants, conveyors and other structural steel and equipment in the heavy-duty Protective Coatings market.

The volume solids content of Temacoat HS-F Primer is 80%, so the paint has a lower VOC value compared to conventional epoxy primers. It also provides shorter drying and recoating times even at low temperatures (down to -10°C), which is a considerable advantage, and it can be used all year round, expanding the geographic area of application. This high-performance primer enables a wide range of film thicknesses to be applied in one layer, which makes the painting process of complex structures easier, stated the company.

References

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

**MISTRAS GROUP LTD**
Norman Way Industrial Estate, Over, Cambridge, CB24 5QE
Tel: 01954 239612 Email: info@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 4013 Email: paul.lambert@mottmac.com www.mottmac.com

**OCEANEERING INTERNATIONAL SERVICES LTD**
Oceanereering House, Pitmedden Road, Dyce, Aberdeen, AB21 0DP
Tel: 01224 798870 Email: info@pim-ltd.com www.pim-ltd.com

**PAINT INSPECTION LIMITED**
61 High Street, Fareham, PO16 7BG
Tel: 0845 4836880 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 519900 Email: enquiries@safinah.co.uk

**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 213590 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

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**STEEL PROTECTION CONSULTANCY LTD**
PO Box 6386, Leighton Buzzard, Beds. LU7 8BX
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 46238 Email: info@toplinelimited.net www.toplinelimited.net

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**SPECIFIERS**

**SSE LTD**
Grampian House, 200 Dunkeld Road, Perth, PH1 3GH
Tel: 01738 456000 Fax: 01738 456047

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**SUPPLIERS COATINGS**

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**CARBOLINE**

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**DENSO**

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BRANCH DATES

12th August 2018
Aberdeen Branch Corrosion Awareness Day
09.00 – 16.00
Venue: Emerson, Dyce
Wide Range of Corrosion Topics and Equipment Demonstrations, from the Aberdeen Corrosion Awareness Team.

25th September 2018
Aberdeen Branch/ TWI joint technical meeting
18.00-21.00
Venue: Robert Gordon University
Preferential Weld Corrosion (PWC) of Pipelines and Topsides Piping Systems.

11th October 2018
London Branch
18.00 – 21.00
Venue: Imperial College, Skempton Building, London SW7 2BB
Advanced Cathodic Protection Design by Finite Element Method
Paolo Marcassoli, Cescor

25th October 2018
London Branch Joint Meeting with the Society of Chemical Industry
18.00 -21.00
Venue: SCI HQ, 14 Belgrave Square, London SW1X 8PS
A Fighting Ship and Fighting Corrosion, Speakers: Dr Eleanor Schofield - Mary Rose Trust and Jim Glynn – ICorr and Beanny Ltd

30th October 2018
Aberdeen Branch
18.00 – 21.00
Venue: Robert Gordon University
Integrity issues and Planned Production Losses – How to Break the Cycle!

ADDITIONAL DIARY DATES

12th-20th November 2018
ICorr Insulation, Fireproofing and Hot Dipped Galvanizing Inspector Course
For more information follow the link at https://trainingsolutions.imeche.org/training/coating-inspection/international-icorr-training

12-13th September 2018
OCCA Centenary Conference
The Parkinson Building, University of Leeds, LS2 9JT
For more information, see conference@occa.org.uk

12-14th November 2018
PDA Europe Annual Conference
Bucharest, Romania.
Further information can be obtained from, info@pda-europe.org

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