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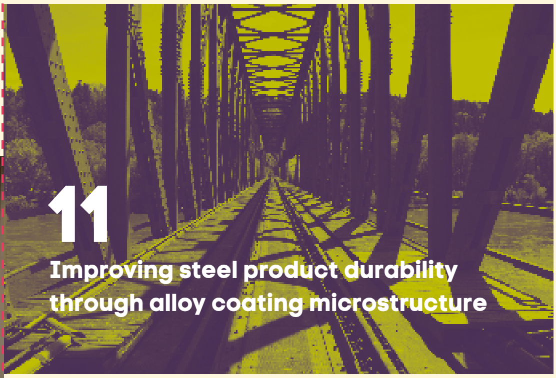
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Improving steel product durability through alloy coating microstructure

EDITORIAL

Mitigating corrosion for a better future

Our society is developing faster and faster, and at the same time has probably never been as fragile and vulnerable as today. The threats of climate change and global warming increase for each day, clearly showing that new innovative ways of acting and living, and new innovative technical solutions will be necessary in the near future.

”New times, new materials, new corrosion challenges” is the slogan for EUROCORR Conference 2019. For me, this clearly shows how important our common work is to contribute to the development of tomorrow’s society.

We all know that corrosion leads to very large and often unexpected costs, but in addition to the economical aspect, corrosion damage can also imply tremendous environmental hazards and dangers for well-being and life. Mitigating corrosion damage improves the quality and lifetime of our infrastructure, both public and industrial. Controlling corrosion is necessary to eventually reach a circular and sustainable society through transition towards renewable energy production for example, or a wider use of lighter materials in the transport industry.

I like to remember this “bigger picture” in our everyday efforts through different types of assignments, from large scientific development projects at the edge of today’s knowledge to shorter term more applied consultancy work or training courses, in which we constantly strive to increase value for customers and work towards a sustainable society.

Solving the present and future societal and industrial challenges implies, the need for an increased mix of skills and competences in addition to excellence in our current areas of expertise.

Since last year, our corrosion business has been grouped under the umbrella of a single institute, RISE. We are around 100 corrosion specialists located at four sites in Sweden and France.

Moreover, within RISE we have nearly 3000 colleagues who work with extremely varied topics such as ICT, microbiology, AM, agriculture, biorefining etc.

In this issue of Corrosion News, you will discover the 14 of us who are presenting parts of our work at EUROCORR 2019. You will also read about our new organisation, our competences and testing capabilities, as well as current initiatives to be launched during the autumn.

I hope you will find this issue of Corrosion News interesting and inspiring. Should you find any article of particular interest, please do not hesitate to contact us for more information. If you pass by Stockholm, Brest, Borås or St-Etienne, feel free to contact us, we will be more than happy to show you our facilities and discuss corrosion with you.

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WHAT WE DO AND WHERE

A global partner in the field of corrosion

At RISE, over 100 researchers and experts work with corrosion and how to prevent it.

RISE, with a corrosion team of more than 100 engineers and technicians in Sweden and France, has among the strongest teams and largest laboratories in the field for applied corrosion research and corrosion protection of materials in the world. We have extensive collaborations with both the industry and the scientific community.

From our four European centres, we can quickly provide solutions to various corrosion problems (including failure analyses, testing, laboratory and field investigations).

Our competency in investigations, diagnostics and studies is available for all metallic materials (steel, aluminium, zinc, copper, titanium and various alloys), paints, polymers and composites.

More than 150 industrial companies in the world are members of our Institute through our different member programs. With hundreds of R&D projects and thousands consultancy projects every year, The corrosion department at RISE is involved in most industrial sectors concerned by corrosion: the transportation industry (marine, land, air), building and infrastructure, military and naval construction, oil & gas industry, nuclear and chemical industries, food industry, electronics, etcetera.

Research Institutes of Sweden

RISE is the Swedish Research Institute and innovation partner. In international collaboration with industry, academia and the public sector, we ensure the competitiveness of the business community and contribute to a sustainable society. Our nearly 3000 employees support and promote all manner of innovative processes. RISE is an independent, state-owned research institute that offers unique expertise and about 100 testbeds and demonstration facilities, instrumental in future-proofing technologies, products and services.

History and location

At RISE, the corrosion department was formed of different entities which are now grouped in a common department.

We are around 60 people in Sweden, 45 in Kista outside Stockholm and 15 in Borås on the Swedish west coast. We are composed of the corrosion group of former Swerea KIMAB (which arose from the Swedish Corrosion Institute and the Institute for Metal Research) and of the corrosion group within RISE (former SP).

In France we consist of IC, the French Corrosion Institute, composed of one site in Brest with 25 employees and one site in St-Etienne with 15 employees.

In addition to our four sites, we have exposure sites located at various places around the world, the largest in Bohus Malmön and Kristineberg in Sweden and Brest in France.

We test and verify in different climates and weather conditions, in air, sea water, soils and aggressive environments, all over the world.

RISE presentations at Eurocorr 2019

SEPTEMBER 10, 12:25–12:45

Dominique Thierry

Session: Corrosion in Oil and Gas Production (WP13) **Presentation:** Re-passivation of Duplex Stainless Steel UNS S82551 in Treated Seawater Injection Service **Room:** Sevilla 3+4

SEPTEMBER 10, 15:50–16:10

Camilla Edvinsson

Session: JS Polymers in organic coating (WP14+19) **Presentation:** FTIR imaging investigation of automotive coating degradation after accelerated exposure **Room:** Andalucía 4

SEPTEMBER 11, 10:15–10:35

Claes Taxén

Session: Nuclear Corrosion (WP4) **Presentation:** Stress corrosion testing of copper in near neutral sulfide solutions **Room:** España 1+2

SEPTEMBER 11, 10:35–10:55

Andrew Gordon

Session: Nuclear Corrosion (WP4) **Presentation:** Corrosion morphology of copper in anoxic sulphide environments – implications for long term storage of spent nuclear fuel **Room:** España 1+2

SEPTEMBER 11, 10:35–10:55

Dominique Thierry

Session: Atmospheric Corrosion (TF) **Presentation:** Long-term Atmospheric Corrosion of Hot-Dip Galvanized Steel and Zn-Al Coated Steel **Room:** Triana 1+2+3

SEPTEMBER 11, 10:55–11:15

Johan Ahlström

Session: Corrosion of Steel in Concrete (WP11) **Presentation:** A test method to determine the corrosion resistance of different types of concrete **Room:** Andalucía 5

SEPTEMBER 11, 12:05–12:25

Flavien Vucko

Session: Automotive Corrosion (WP17) **Presentation:** Hydrogen detection in high strength dual phase steel using scanning Kelvin probe technique coupled with XPS analyses of the surface oxide film **Room:** Giralda

SEPTEMBER 11, 12:05–12:25

Johan B. Lindén

Session: Atmospheric Corrosion (TF) **Presentation:** Inclusion of cut edges and bending in technical life time assessment of inorganic coatings on carbon steel sheet **Room:** Triana 1+2+3

SEPTEMBER 11, 12:25–12:45

Nicolas Bulidon

Session: Nuclear Corrosion (WP4)
Presentation: Assessment of the resistance to stress corrosion cracking (SCC) of C-steel casing and overpack in a cementitious bentonite grout material **Room:** España 1+2

SEPTEMBER 11, 14:40–15:00

Bo Rendahl

Session: Automotive Corrosion (WP17) **Presentation:** Time-resolved model experiments using atmospheric corrosion sensors in programmable corrosion chambers
Room: Giralda

SEPTEMBER 11, 16:10–16:30

Olivier Rod

Session: Corrosion and Protection of Drinking Water Systems (WP20)
Presentation: Influence of production route and heat treatments on the corrosion of brass products for water applications
Room: Andalucía 4

SEPTEMBER 11, 16:10–16:30

Christophe Mendibide

Session: Nuclear Corrosion (WP4)
Presentation: Corrosion behaviour of aluminum alloy 5754 in cement-based matrix simulating nuclear waste disposal conditions
Room: España 1+2

SEPTEMBER 11, 16:50–17:10

Christophe Mendibide

Session: Corrosion in Oil and Gas Production (WP13)
Presentation: Effect of oxygen contamination on the SSC/HIC resistance of low alloyed steels
Room: Sevilla 3+4

SEPTEMBER 12, 10:15–10:35

Nathalie Le Bozec

Session: Automotive Corrosion (WP17)
Presentation: Fatigue Corrosion of Multimaterial Concepts
Room: Giralda

SEPTEMBER 12, 10:35–10:55

Carolina Schneiker

Session: Automotive Corrosion (WP17) **Presentation:** The impact of corrosion on adhesive bonded aluminium for use within the automotive Industry **Room:** Giralda

SEPTEMBER 12, 14:20–14:40

Dan Persson

Session: Mechanisms, Methods & Modelling (WP6+8)
Presentation: Spectroscopic imaging of the buried substrate / polymer interface upon exposure to corrosive environments **Room:** España 4+5

Want to read the speakers' articles?

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New methods to determine automotive coating degradation

With new spectroscopic methods such as Fourier Transform Infrared Spectroscopy, FTIR, this study investigates weathering-induced changes in the properties of coated steel.

The automotive industry places great demands on its aesthetic and protective coatings systems and has therefore invested a good deal of effort in developing accelerated tests to help predict the performance of paints in harsh conditions.

The coated materials are expected to withstand different environmental impacts subjected to degradation by UV-radiation as well as by hydrolytic effects. The weathering-induced degradation of the coating, due to humidity and UV-radiation, is a key factor regulating service life of the coating and is studied in accelerated laboratory testing as a complement to outdoor exposures.

Although numerous investigations have been performed in this area, there is still a need for studies utilizing novel methods to determine the influence of degradation on chemical and barrier properties of coated steel. Additionally, more knowledge regarding methods to analyse and quantify degradation in paint systems used in the automotive industry is of high importance to meet future demands. We have focused on utilizing new approaches using methods, such as FTIR-FPA spectroscopic imaging to quantify weathering-induced chemical changes in the coating as well as their in-depth distribution.

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The automotive industry places great demands on its aesthetic and protective coatings systems. In this study, RISE has worked together with the Swedish truck and bus manufacturer Scania. **Photo:** Joachim Kohler Bremen

Atmospheric corrosion sensors in programmable corrosion chambers

A basic understanding of the corrosion impact in accelerated corrosion testing is necessary for the design of relevant test regimes. It's also a first step in being able to model and predict the behaviour of metallic materials under various corrosive conditions.

Modern accelerated corrosion chambers are now very easy to program and can, besides being able to follow standardised cycles, such as VDA 233-102 or Volvo STD 423-0014 (ACT I), also be used to design various experiments with temperature and relative humidity variations in an efficient way.

In order to utilize this possibility to its fullest, however, it is necessary to have access to time-resolved data. Temperature and relative humidity sensors have been available for some time. Atmospheric corrosion sensors for continuous corrosion monitoring have demonstrated to be suitable both in accelerated corrosion tests and in mobile exposures.

A basic understanding of the corrosion impact of different parts of the cycles used in accelerated corrosion testing on one hand, and in (simulated) outdoor service condition on the other hand, is necessary for the design of relevant test regimes. Such an understanding is also a first step in the long-term aim of being able to model and predict the behaviour of metallic materials under various corrosive conditions.

In this study, atmospheric corrosion sensors of zinc foils have been exposed to a number of temperature/relative humidity levels by using a programmed alternating step procedure repeated several times in sequence.

Known amounts of different chloride salts were applied on the zinc foil grids. The integrated amount of corrosion of a sensor was monitored as the resulting increase in electrical resistance of the foil. The corrosion rate for each climatic condition was evaluated by estimating the derivatives at each 2 h plateau in the alternating temperature/humidity step sequence. In this way the corrosion kinetics of four different conditions could be derived for the identical surface conditions simultaneous to a continuously declining access of salt on the surface, quickly revealing the atmospheric corrosion characteristics of zinc. The implications of the technique and resulting findings are discussed.

Contact

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New test method for corrosion resistance of cement

A new study shows that cement binders with high amounts of slag have the highest corrosion resistance, and the binders with fly ash have the lowest.

Slag beats fly ash when it comes to corrosion resistance of binders.

Nowadays it is relatively common to mix in fly ash or slag to Portland cement to decrease the environmental impact. These binders can have different corrosion resistances and thereby be more or less sensitive to chloride induced corrosion. The objective of this study was to develop a test method that is easy and applicable to determine the corrosion resistance of different types of concrete. The test method is performed by potentiostatic polarization of steel cast in mortar where the potential is raised 100 mV once per week if the current does not drastically increase. The results from the potentiostatic method were compared with a field test where the corrosion rate was measured and compared with the time to initiation in the laboratory study. In total seven types of cement were included in the study ranging from ordinary Portland cement to fly ash and slag cements. The cements were chemically analyzed using XRD (x-ray diffraction) and TGA (thermo gravimetric analysis) to determine the different binder types, capability to bind chlorides.

The results showed that binders with a high amount of slag had the highest corrosion resistance and the binders with high amounts of fly ash had the lowest corrosion resistance. It was also concluded that the combination of the potentiostatic method, field test and chemical analysis is a good tool to compare the corrosion resistance of various binders.

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Improving steel product durability through alloy coating microstructure

Zinc-based coatings are widely used for corrosion protection of steel. The zinc coatings provide cathodic corrosion protection of the steel substrate. It is often desirable to increase the corrosion resistance of the zinc coating for aggressive environments and great efforts have been invested into the optimization of the zinc coating composition by alloying.

Zinc-based coatings are widely used for corrosion protection of steel in different environments and applications. The primary task of the zinc coatings is to provide cathodic corrosion protection of the steel substrate. Zinc is very useful in this respect as it keeps a balance between sacrificial protection of the steel and the formation of corrosion products which reduces the corrosion of the zinc itself. However, it is often desirable to increase the corrosion resistance of the zinc coating for aggressive environments and great efforts have been made into the optimization of the zinc coating composition by alloying. It has been shown that the corrosion resistance of zinc-based coatings is improved by alloying with aluminium, which has been successfully implemented in commercial materials such as Zn-5Al and Zn-55Al. More recent development has focused on Zn-Al-Mg and Zn-Mg coatings fabricated by a traditional hot dipping process or by physical vapour deposition (PVD) technology and several Zn-Al-Mg materials have been introduced to the market.

To provide steel makers with the tools to enable the development of new zinc-based and zinc-free coating materials with superior long-term corrosion stability, a European project "Improving steel product durability through alloy coating microstructure" (MicroCorr) financed by the European Commission was initiated 2015. It aimed to establish the relationship between the microstructure of alloyed metallic coatings and their corrosion resistance.

In the MicroCorr project, Al and Mg-alloyed zinc coatings with different variations in the microstructure were studied together with the line-produced materials of the same compositions. Detailed microstructural investigations were carried out on the materials. Advanced electrochemical investigations, microscope studies and spectroscopic measurements were performed to study the electrochemical behaviour and corrosion mechanisms of the different coatings in various environments. The project ended in 2019 resulted in several publications.

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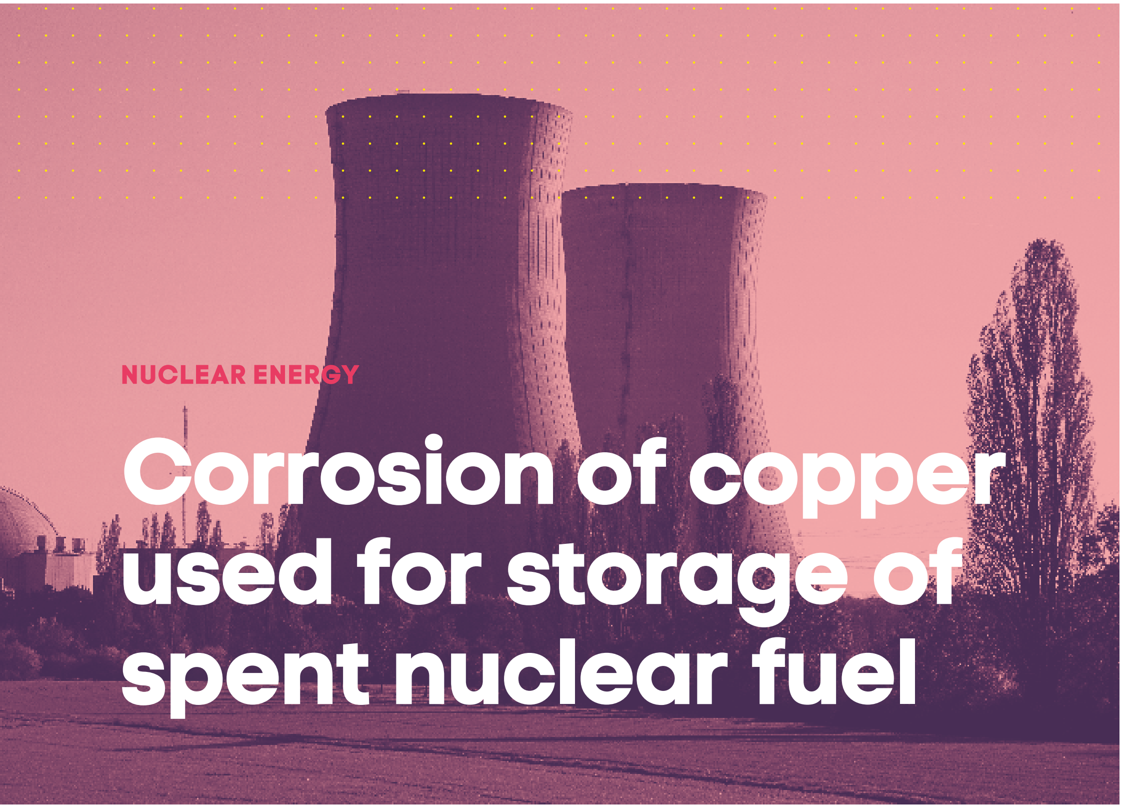

NUCLEAR ENERGY

Corrosion of copper used for storage of spent nuclear fuel

We have studied the corrosion morphology of copper exposed in anoxic sulphide environments, providing an insight into the safety of storage of spent nuclear fuel.

The KBS-3 concept for long-term storage of nuclear waste includes the use of copper capsules. Copper coupons were exposed to H_2S (g) and sulphate reducing bacteria (SRB) in order to examine the magnitude of corrosion and the corrosion morphology of copper in these sulphide environments. In each environment, four different exposure conditions were tested; low and high partial pressures of H_2S gas for 10 and 30 days in each, and; minimal and rich growth media with SRB for 10 and 30 days each.

The results of the analyses show that the extent of corrosion increases with the partial pressure of H_2S (g), and the richness of the SRB growth medium, as well as the duration of exposure. Inspection of the shape and morphologies as well as statistical analysis of the deepest pits and defects found on the exposed coupons suggested that these are not related to the corrosion exposures. Most of them are instead the result of different types of mechanical damage and wear that occurred before or during preparation of the coupons, such as cutting and polishing.

During the course of the present work, a method of evaluating the mass loss due to corrosion (pickling) was developed as the original method of removing corrosion products with a combination of alkaline (20 Wt% NH_4OH) and acidic (37 Wt% HCl) solutions was deemed to have affected pits on the surface of the coupons and thus compromised the accuracy of the pit measurements.

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Hydrogen limits the aluminium content in nuclear waste capsules

While simulating nuclear waste disposal conditions, we have studied the corrosion behaviour of aluminium alloy 5754 in a cement-based matrix.

Low level radioactive aluminium is a waste produced during French nuclear powerplant decommissioning. The concept of treatment of such waste by the French agency for nuclear waste management (ANDRA) is based on an encapsulation of the contaminated parts in a cement-based matrix followed by a deep geological disposal.

Depending on the storage conditions prior to the placement in a despository and final deep geological conditions, different conditions could be encountered leading to possible various hydric environments, from drying to water resaturation of the cement matrix by exposure to high relative humidity and then liquid water.

Considering that cement matrices are alkaline environments, corrosion of aluminium is possible with associated hydrogen evolution. In order to ensure the safety of the disposal facilities, the amount of aluminium that is disposed in each waste package must be specified and is limited based on the amount of hydrogen that can be produced in the corrosion process.

A project was thus been initiated in 2016 in order to gather data on the hydrogen production in conditions representative of disposal conditions. Different stages of the encapsulation process were studied:

- During the cure of the cement
- In conditions simulating resaturation of the cement with water after cure
- In conditions simulating resaturation of the cement with humidity after cure

In each case, evolution of the hydrogen production was monitored to address the corrosion rate variation versus time. An example of monitoring is given below.

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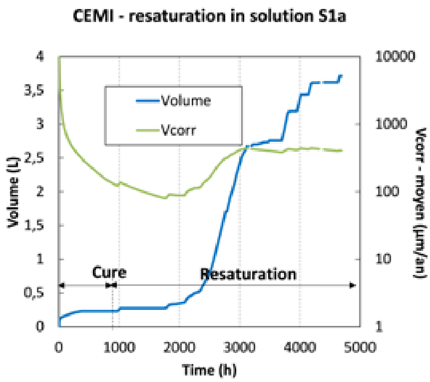

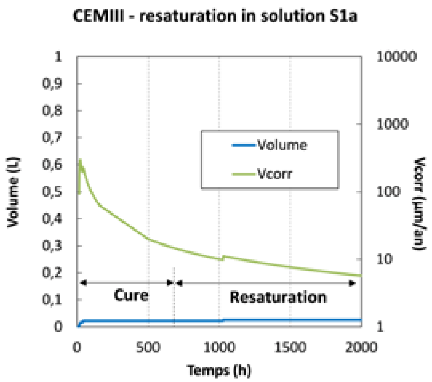

Fatigue corrosion of multimaterial concepts

Fatigue corrosion performance of joined samples may be evaluated using fatigue tests in ambient air on pre-aged specimens or by conducting fatigue tests in water, salt solution or humid air. However, the evaluation of combined fatigue and corrosion performance of joined materials is not well documented in the literature, in particular when considering accelerated corrosion tests.

Specific devices were developed to simultaneously apply fatigue cycles on joined samples exposed to cyclic tests in a corrosion chamber. The fatigue performance of various joined assemblies involving high strength steel (HSS), hot dip galvanized steel (HDG), aluminium alloys or carbon fiber re-enforced polymers (CFRP) were tested in an accelerated corrosion test as per VDA 233-102 and compared to fatigue in air. The assemblies were joined using spot-welding, adhesive bonding, clinching or combination of clinching with adhesive bonding.

For some steel assemblies, simultaneous fatigue and corrosion cycles was compared to alternated fatigue and corrosion cycles.

Noticeable reduction of the fatigue life under simultaneous fatigue and corrosion conditions in comparison with fatigue tests in air (or strength loss after static corrosion tests) was observed, particularly on adhesively bonded specimens, which presented a significant degradation of the cohesive properties of the adhesive. Alternated fatigue and corrosion was much less aggressive (spot welded and adhesive bonded specimens) than simultaneous fatigue and corrosion.
For spot-welded assemblies, the fatigue life was decreased at higher load amplitudes and increased at lower amplitudes under simultaneous fatigue and corrosion conditions.

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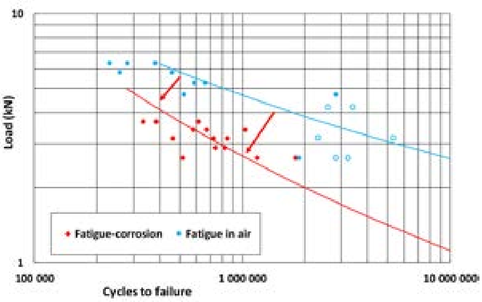


S-N curves for lap-shear adhesive bonded HDG to CFRP in air and in cyclic corrosion test.

Fatigue devices in a corrosion chamber.

From industrial failures towards the development of a qualification test

In 2014 seven petroleum companies sponsored a study of the Hydrogen Induced Stress Cracking of precipitation hardened nickel-based alloys used for the manufacture of high strength components for Oil & Gas applications. It came to show that the API 6A CRA standard as such cannot be used to safely assess the HISC resistance of PH Ni-based alloys

Precipitation Hardened (PH) Ni-based alloys have proved to be sensitive to Hydrogen Induced Stress Cracking (HISC), and HISC related failures in the Oil and Gas industry have been experienced in the case of UNS N07718, UNS N07725 and UNS N07716. For the UNS 07718 the relationship between grain boundary precipitation and Hydrogen Embrittlement (HE) was highlighted early.

This factor was taken in account in the API standard API 6A 718, presenting microphotographs of acceptable or unacceptable microstructures (up to x500 magnification). The extension of the standard to other PH Ni-based alloys was recently proposed in the API 6ACRA, showing acceptable and unacceptable microstructures as one of the criteria used to select appropriate materials for Oil & Gas applications. The images refer to the extent of grain boundary precipitation, whereas a transgranular failure was reported in the case of a UNS 07725 component, showing the poor correlation between HISC resistance and grain boundary precipitation in this case. In addition, other recent studies presented intergranular failures for UNS 07725 seals used in subsea equipment, showing that optical microscopy was not an appropriate method to explain the material behavior, due to the nanoscale of the intergranular precipitates.

Continues →

A three year project was launched in 2014 and sponsored by seven petroleum companies (Anadarko, BP, ENI, Equinor (Statoil), Petrobras, Shell and Total), dedicated to the study of the Hydrogen Induced Stress Cracking (HISC) of Precipitation Hardened Nickel-based alloys (PH Ni), used for the manufacture of high strength components for Oil & Gas applications. In addition to existing materials, such as UNS 07718, other grades with high strength (Y.S. 150 ksi min.) have been considered in the program since almost no data were available on the HISC behavior of these materials.

The major objectives of this project were then to possibly answer the following questions:

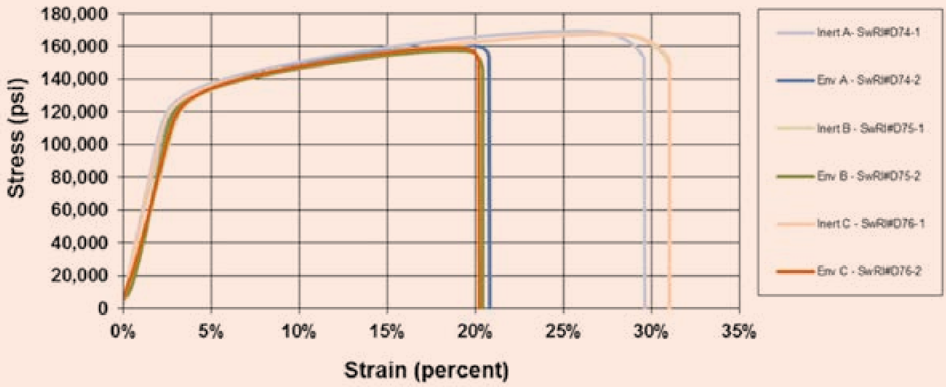
- Is the microstructure evaluation sufficient to assess the HISC resistance?
- Is there a simple HE test that could be used as a qualification test method?

Optical microscopy is not appropriate for grain boundary precipitation evaluation

In this program 28 heats of 9 PH Ni-based alloy grades were studied, provided either by material suppliers or material manufacturers. Most of these heats were found acceptable, in agreement with the API 6A CRA standard criteria, however some of the microstructures were particularly difficult to rank: under or over etching can lead to different interpretations of the observed microstructures. Moreover, it was demonstrated in the advanced characterization that the grain boundaries could be affected by submicronic precipitation, hardly detectable by optical microscopy.

The program included the following main tasks:

Material selection and supply, Material characterization, HISC testing, Advanced microstructure characterization. Concerning the HISC tests, three laboratories were involved in the experimental work: French Corrosion Institute, RINA (CSM, Roma, Italy) and South West Research Institute (SWRI, San Antonio, USA). The final part of the program was dedicated to the discussion of relationship between HISC and microstructure and to the proposal of a possible standard procedure applicable to PH Ni-based alloys.



The stress-strain curves obtained for a given PH Ni-based alloy tested in this program

Development of a test method related to HISC behavior

In past studies, a Slow Strain Rate Tensile (SSRT) based test method was successfully used on UNS 07718 alloys, allowing the discrimination of acceptable and unacceptable microstructures. This method was then implemented. Environmental tests were conducted in a de-aerated 0.5M sulfuric acid solution, heated at 40°C. The applied cathodic current density was 5 mA/cm², and the applied strain rate was 10^{-6}/sec. Mechanical tests (baseline material properties) were performed in an inert environment (oil) in the same conditions. As a minimum, for each heat, 3 tests under cathodic polarization (CP) and 3 inert tests were performed, in different locations of the bars.

The plastic elongation obtained under CP was found to be a useful criterion to compare the HISC resistance of the different materials, it fell below 5% in the case of the three tested failed parts included in the program, whereas very HISC resistant materials displayed plastic elongations higher than 15%. The cracking mode was in most cases intragranular or mixed inter/intragranular. The microstructural approach, in line with the assessment of grain boundary precipitation, could only partially explain the results due to the complexity and combination of the HE mechanisms involved in the HISC behavior of these alloys.

More reliable assessment of HISC sensitivity as a major result of this program

One of the main results of this program is the fact that the API 6A CRA standard as such cannot be used to safely assess the HISC resistance of PH Ni-based alloys. Other results have been produced recently in the literature which confirm this point.

The test method developed in this work provides an interesting tool, since it could be shown that for failed materials, the elongations measured by SSRT under CP fell below 5%. This may help in the selection of appropriate acceptance criteria, using a test related to the actual hydrogen/microstructure/strains interactions. The possibility to consider this test method in the NACE TM0198 standard will be discussed in the coming months.

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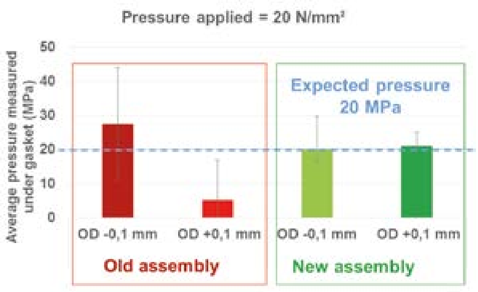
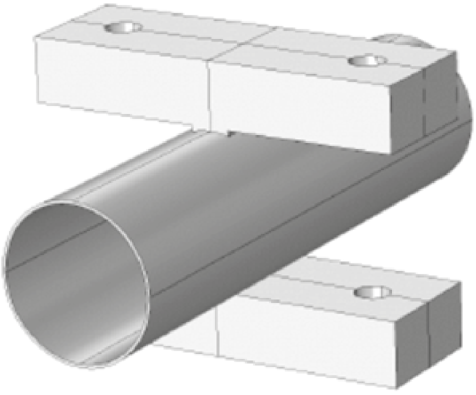
New methods for testing crevice corrosion shows promising results

A new assembly for testing crevice corrosion has shown a significant improvement in the reproducibility of the results. This assembly is now used in several projects involving the qualification of the crevice corrosion susceptibility of stainless steel grades.



Average pressure under gasket using old and new assembly



Design of the new crevice assembly for tube

Crevice corrosion resistance is one of the main parameters limiting the use of stainless steels in seawater handling systems. Crevice corrosion resistance of passive alloys can be evaluated using different standardized techniques such as ASTM G48, or the more recent ISO 18070:2015. In most testing the crevice assemblies are mainly restricted to plate geometry specimens, for more crevice geometry control. Some crevice assemblies for tube geometry have been proposed and used during the last ten years, including in the ISO18070:2015, but they generally showed a large dispersion of the results due to the difficulty to control crevice geometries on curved surfaces. From this background, an optimized crevice assembly was developed and tested at Institut de la Corrosion to allow better reproducibility of crevice corrosion tests on stainless steel tubes.

Investigation and optimization using finite element modelling has allowed the proposition of a new design, which provides better control of gasket pressure, and consequently a better reproducibility than previous existing assemblies. The gasket is made of PVDF and the surface was deigned to get results directly comparable to the surface used in the standard ISO18070:2015 assembly for plate. Significant improvement of the pressure distribution under the confined area was obtained.

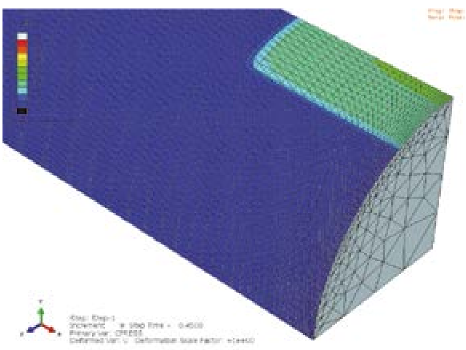
Congratulations to...

Flavien Vucko has received the 2018 honorary diploma from the French Corrosion Society (CEFRACOR). This award is intended to recognize exceptional researchers who have authored works in the field of theoretical or practical study of corrosion or anticorrosion. Mr Vucko received the diploma in recognition of his important work in hydrogen embrittlement and corrosion fatigue.

The project ADLEAF has been awarded with the best report of 2019 by the strategic innovation program Metallic Materials. Charlotta Obitz led the project that aimed to create conditions for lead-free brass alloys. The project had a significant impact and led to several scientific articles and conference presentations and the creation of a new competence centre within the field of brass alloys.

Björn Tidbeck has received the 2018 Einar Mattsson Award, in recognition of his important contributions to the field of corrosion protection for infrastructure. Mr Tidbeck is an innovative researcher whose significant expertise confirms RISE's position as an internationally leading company within the field of corrosion.

This crevice assembly has been used for crevice corrosion assessment of stainless steel alloys in seawater with very promising results. Corrosion testing performed in the frame of this project has shown a significant improvement of the reproducibility of the results. This new assembly is now used in several projects involving the qualification of the crevice corrosion susceptibility of stainless steel grades. It can also be adapted and used for fit-for-purpose testing such as evaluation of different gasket materials, different gasket pressures, etc.



Finite element modeling of the pressure under the gasket

Contact

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Evaluation of corrosion protection performance at cut-edges and bends

Producers and users often request technical lifetime assessments of inorganic coatings on carbon steel sheet materials as part of certification/ type approval or quality control purposes. Coated sheet materials can be produced in continuous processes resulting in large coils which are further processed through various operations (cutting, pressing, bending, welding, hole-punching etc.) which could influence the protective coating, and thus also the technical lifetime of the final product.

Accelerated corrosion tests, field exposures, and visual inspections are prerequisites of technical lifetime assessments. However, typical post processing techniques likely to effect the corrosion protective capability of a coating, are often not included in the evaluation. To fully assess the performance of the corrosion protection on steel sheet intended for further processing, the influence of these operations needs to be considered.

In this study, a method for including assessment of cut edges and bending (90 and 180 °) has been developed and its applicability for lifetime assessments has been studied. Three common types of inorganic coatings (zinc-aluminium-magnesium, aluminium-zinc, and hot-dip galvanised) have been exposed in an accelerated corrosion test (ISO 11997-1 Cycle B) for a total duration of 22 weeks. Reference specimens of carbon steel and zinc were exposed together with the samples for evaluation of the corrosivity according to Nordtest NT MAT 003. Visual inspections were carried out weekly with focus on base metal corrosion at cut edges and bends.

Post processing techniques are often overlooked.

The corrosion attacks at cut edges and bends were studied by first dividing the area of interest in squares (5 x 10 mm) using a transparent template, then assessing the level of base metal corrosion (0 %, less than 50 %, and more than 50 % of the area) visible within each individual square, and counting how many squares in each category. Thereafter the size of the largest corrosion attack was measured over the whole area of interest for each test object. The results of this study have so far indicated that evaluation of the area of the corrosion attack, and the size of the largest corrosion attack can be

useful for assessments of corrosion protection at cut-edges and bends. It has further shown how steel substrate thickness can influence the corrosion protection performance at cut-edges and bends, which indicates the importance for inclusion of that specification during assessment and especially any type of certificate or type approval. However, this study has not considered acceptance criteria for corrosion protection at cut edges and bends. Further work could focus on improving and validating these evaluation methods for visual assessment (including looking into possibilities with computer aid) and standardising sample preparation.

Accelerated test results will be compared to results from field test (exposure start 2018) on the west coast of Sweden. The results from this study can contribute to the development of methods for visual inspections and technical lifetime assessments of inorganic coatings on carbon steel sheet with the inclusion of parameters relevant for its intended use.

Contact

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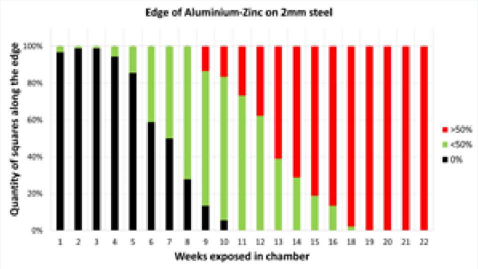
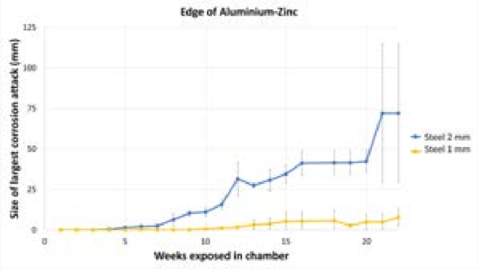
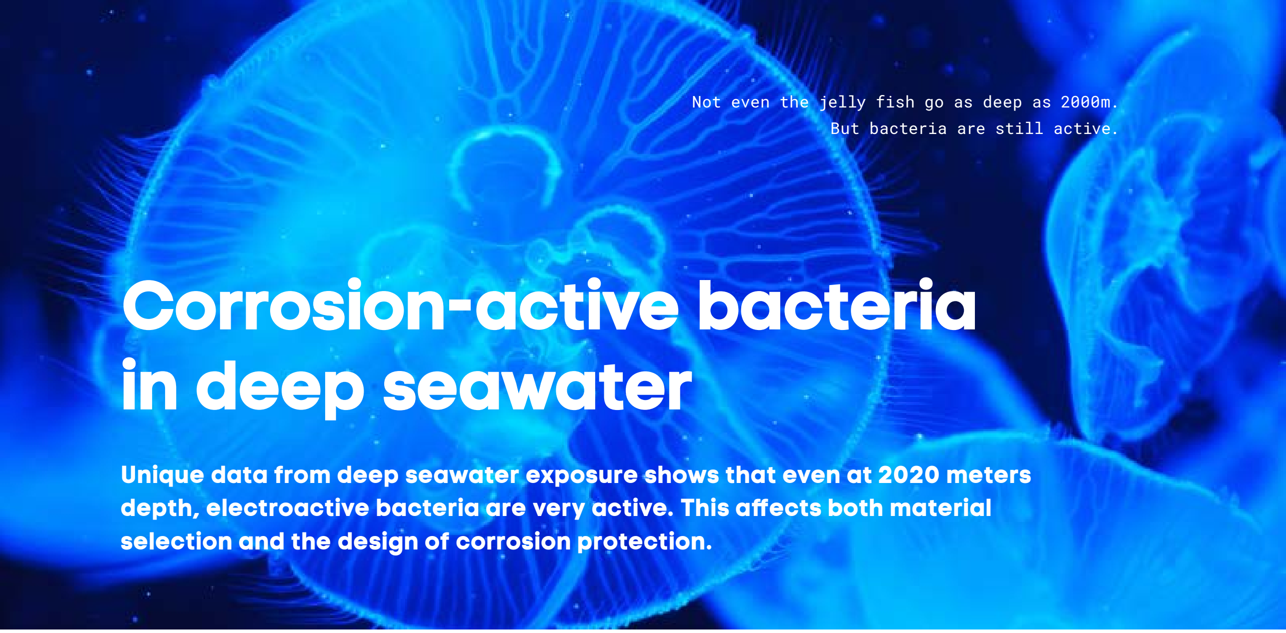


Results from the visual assessment of the corrosion protection at a cut edge of an aluminium-zinc coating (25 µm) on 2- and 1-mm thick steel substrates. The size of the largest base metal corrosion attack within the area of the cut edge, was measured (n=3).



Results from the visual assessment of the corrosion protection at a cut edge of an aluminium-zinc coating (25 µm) on 2- and 1-mm thick steel substrates. The size of the largest base metal corrosion attack within the area of the cut edge, was measured (n=3).



Not even the jelly fish go as deep as 2000m.
But bacteria are still active.

Corrosion-active bacteria in deep seawater

Unique data from deep seawater exposure shows that even at 2020 meters depth, electroactive bacteria are very active. This affects both material selection and the design of corrosion protection.

The exploration and exploitation of deep seawater presents promising prospects for many industries. Hence, the use of reliable materials resistant to corrosion in deep seawater conditions is required, while no or limited field data can be found in the literature. To fill the gap of knowledge, Institut de la Corrosion deployed monitored corrosion coupons and CP (cathodic protection) sensors for 1 year in deep seawater, at 2020 meters depth in Atlantic. The systems have been specifically designed and qualified to bear deep seawater exposure for long durations.

In this study, Carbon steel, 13-Cr Ferritic, Austenitic, Lean Duplex, Duplex, Super Duplex, Super Austenitic, Hyper Duplex Stainless Steels and Nickel-based alloys were exposed. Potential monitoring was performed *in-situ* (at both 1020 m and 2020 m) in order to characterize the formation of electroactive biofilms at the surface of passive alloys in these environments.

The CP sensors developed by Institut de la Corrosion allowed to get *in-situ* long-term polarization data of both carbon steel and stainless steel. Unique data have been obtained from this deep seawater exposure campaign, allowing adapted material selection and accurate CP designs to protect structures in these environments.

The results from potential monitoring, biofilm sensors and CP data, clearly indicated that even below 2000 meters depth, electroactive bacteria are still present and can impact material selection and CP design. This joint industrial project was sponsored by Petrobras, Industeel Arcelor-Mittal, Outokumpu Stainless, Sandvik MT, Naval Group and Saipem, with logistic support of Ifremer and FIXO3.

Contact

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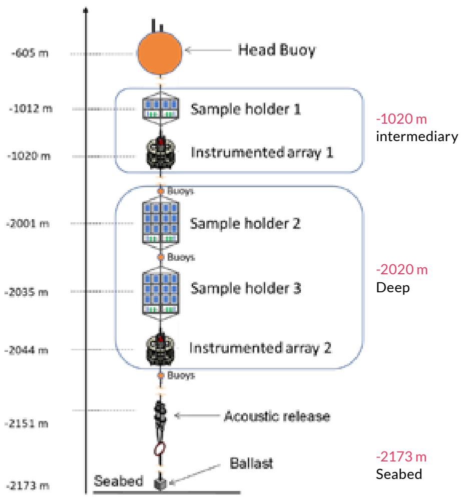

Modelling of corrosion for optimal cathodic protection and material assessment

After years of global experience in cathodic protection, RISE has built a unique database of polarization curves. Models based on the data now aids design for protection of infrastructure in various environments.

RISE has the expertise to simulate corrosion phenomena using finite element software (COMSOL Multiphysics). For cathodic protection of infrastructure in various environments modelling is used to aid the design of the protection.

For example, several offshore projects conducted worldwide have allowed us to build a solid polarization curve database which is used for the modelling of cathodic protection. Recently, cathodic protection modelling studies were conducted regarding windfarm offshore monopile protection. The use of long-term field collected polarization data as in-data for the modeling allowed us to get more realistic results.

Another example is water and sewer pipes suffering from leakage currents originating from urban railways. The model output gives insight to the distribution of current in the ground beneath the tracks and allows investigation of available counter measures that limit the pipe deterioration e.g. cathodic protection.

Models of varying complexity can support the assessment of deteriorating single or multiple metallic materials by corrosive processes. Critical elements behind atmospheric corrosion of metallic materials are also simulated at RISE for detailed analysis of deterioration processes and material development. The models can account for chemical and electrochemical reactions, heterogeneous reactions, gas dissolution and wetting.

Contact

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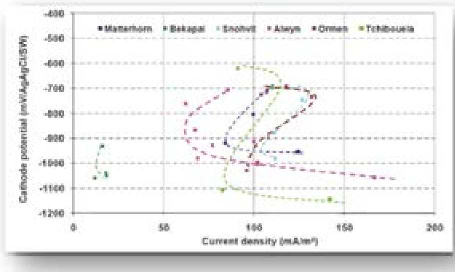
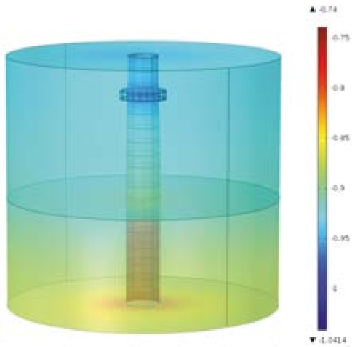
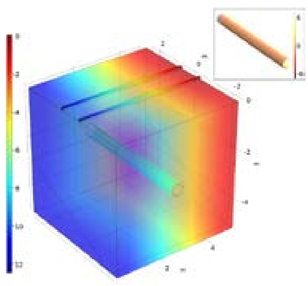
`tommy.zavalis@ri.se`



Polarization curves obtained from offshore project ICP DATA



Cathodic protection modeling of offshore windfarm monopile



Section of tracks and underlying ground layers. Potential distribution (mV vs SHE) over section with (caption) current density distribution (μA/m2) on cast iron pipe.

How we work

We believe that combining the following complementary ways of working is essential to deliver valuable applied research to our customers.

We strive to combine, in all our competence areas, practical expertise and field testing, which is absolutely essential within corrosion, with accelerated testing and laboratory experiments. This is complemented by advanced analysis and characterization, theoretical understanding and modelling as a tool to understand mechanisms, improve experiments and predict lifetime related to corrosion.
Finally, we prioritize our international network, not least with industrial customers ensuring a good industry understanding, and participate actively in conferences and education.

Inspections, consultations and analyzes

Field or laboratory inspections, testing, failure analysis, expert advice etc.

Rapid response problem solving

Quick handling for solving complex problems requiring several different competencies

Courses, seminars, conferences and training

Standard or customized events

National and European Research Programs

Participation together with our customers in projects in Sweden, France or the EU

Industrial research

Research performed within our different member programs (page 34–35)

Joint Industrial programs (JIP)

Industrially financed programs comprising of typically 8–12 companies, which share the cost of the project. A JIP is usually performed on a 3 year basis.

RISE COMPETENCE AREAS

Surface technology and surface protection

RISE offers competence, testing and analysis capacity through the whole value chain from substrates and coating formulation to testing of the final products in relevant environments.

For this, we use our large range of state of the art test instruments for surface analysis and characterization such as surface morphology (AFM), elemental analysis (XPS, ToF SIMS, IMC, SEM/EDS, ICP-MS/OES, GD-OES), electrochemical techniques (EIS, SVET, SKP), molecular binding (FTIR, CRS) and imaging/microscopy (SEM, TEM, 3D scan, thermo-camera, confocal microscope).

METALS & SUBSTRATES

Our research includes surface cleanliness, surface evaluation/testing, material analysis & metallography, electrochemistry, tribology/friction/adhesion and coil coating.

COATING & PAINT FORMULATION

We study surface modification of functional additives, functional surfaces/coatings for better UV-/corrosion-/chemical-/water-/dirt-/fire- resistance, icephobic coatings, surface- and colloid chemistry, tribology/friction/adhesion, surface testing, toxicology and tailored additives for coatings to obtain new coating properties.

SURFACE PRE-TREATMENT

Research on surface modification, adhesion, joining/gluing and evaluation of different surface pre-treatment methods with focus on environmentally friendly techniques.

SURFACE & CORROSION PROTECTION

We study generic types of surface treatment/technology, anti-corrosive coatings, bonding, drying/curing, surface durability, coating application at our fully equipped paint centre. Our surface treatment laboratory is designed to reproduce the whole painting process as used in the coil coating industry from surface cleaning, coating application and thermal paint curing.

CORROSION & CORROSION TESTING

We perform accelerated indoor corrosion testing according to international standards for automotive, offshore and building, marine, protective and electronics. We are accredited according to ISO 17025:2018 and certified to do pre-qualification/type approval testing of protective coatings. We also perform field tests at stationary atmospheric corrosion test sites, natural seawater testing sites, stationary corrosion test sites in soil and mobile test sites for automotive.

Towards sustainable development

RISE works in eight main segments in the Corrosion area, where we contribute to sustainable development for both industry and society. The focus is on increased lifetime of products and structures, decreasing the environmental impact and increasing safety through cost-effective solutions.

Automotive and transportation

We began working with vehicle corrosion issues in the early 1970s. We work with all aspects, from inspection of cars that have been in service in the field, test vehicles that have been subjected to proving-ground tests and vehicle components that have undergone accelerated corrosion testing. We also work in the field of aerospace corrosion through a newly formed member program. Every third year we arrange an international seminar on corrosion in the vehicle industry which attracts industry participants from around the world.

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Energy

Corrosion in combustion and gasification plants is a main focus area, in which we address problems related to corrosion and mechanics in both the low and high-temperature sections of heating systems. We are also active within district heating and cooling systems. We also address corrosion in nuclear plants including longterm waste storage. More recently we also started working with wind turbines, solar plants and energy storage such as batteries.

rikard.norling@ri.se

Infrastructure and buildings

Our main focus is on metallic materials used in building construction and civil engineering. This includes structures, roads, bridges and bridge guard rails, tunnels, piping/pipelines, climate control systems, harbours and more. We also work extensively with concrete reinforcement and plastic materials used for piping with focus on ground pipework, including plastic welding assessment. We do inspections and failure analysis as well as research and development.

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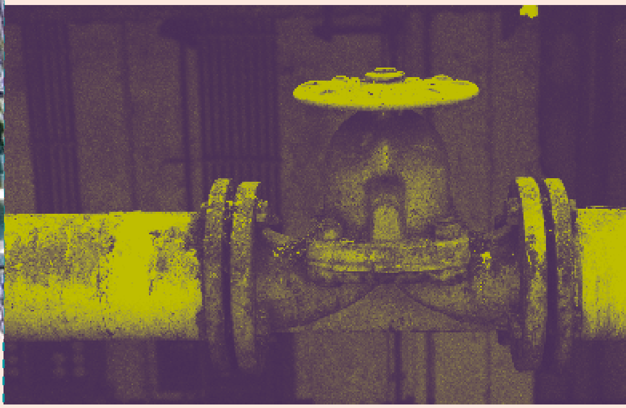

Process and chemical industry

We work with research, development, testing and assessment of polymeric materials and metals for use in harsh environment, for example in water and waste-water applications and pulp and paper. We also have extensive experience within corrosion of polymeric materials in aggressive environments such as the chemical industry, pickling plants or flue gas stacks. One of our largest member programs is in the field of polymer corrosion. We also work with non-destructive testing and sensors.

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Oil and gas

We work with research, development, testing and assessment of metals and polymers for use in oil and gas applications in St Etienne, France. The laboratory is equipped specifically for testing of materials for oil and gas production and is ATEX-certified and specially equipped for testing in hydrogen sulphide (H_2S) and under high pressures and temperatures. Example of work include stress corrosion cracking and corrosion fatigue in H_2S environments and studies of permeation data and degradation mechanisms of elastomers in H_2S.

christophe.mendibide@institut-corrosion.fr

Offshore and marine

We conduct extensive research and development activities in this field, mainly concerning stainless steels, nickel alloys and titanium. This includes electrochemical measurements; stress corrosion cracking; corrosion fatigue; field testing in seawater; calculation of cathodic protection; and assessment of various types of corrosion protection.

nicolas.larche@institut-corrosion.fr

Steel and metal

We work in the field of corrosion properties of coil-coated steel products where we have a member program. We also work with brass alloys with a newly formed member program, as well as aluminium alloys and stainless steel. Moreover, we collaborate with actors in the fields of additive manufacturing and hydrogen embrittlement.

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Electronic and communication

We evaluate systems, equipment and components targeted to environmental durability including corrosion, but also thermal design, vibration and measurements of cleanliness and we are accredited for all relevant standards within the field of environmental durability.

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NEW TEST BED

New test rig for chlorine in plastic piping

To test the effects of water disinfection on the corrosion rate in plastic piping, RISE has just commissioned a test rig with a pipe-loop system in which chlorine or chlorine dioxide is added to water which is continuously circulated. This is needed to maintain the desired concentration and the pH at a constant level, which is necessary to maintain a controlled environment.

Chlorine has been used as a very effective water sanitizer for over a century. Despite this there are still uncertainties in exactly how plastic pipes are degraded in this environment. A better understanding of this would increase the possibility to predict the service life of different plastic pipe formulations and a better design of the additive system.

One of the difficulties with understanding the mechanism is that the reactivity of chlorine varies very much with pH and it has to be controlled in order to understand the degradation mechanism.

In addition to chlorine the rig can also be used for testing in chlorine dioxide which is becoming more and more popular as a disinfectant for water. Due to the efficiency of chlorine dioxide in legionella prevention, it has become popular to install small chlorine dioxide generators in hotels and hospitals where there is an increased risk for legionella. There is, however, a difference in the reactivity between the different disinfectants, which is also reflected in their disinfectant properties. It has been observed that chlorine dioxide is more aggressive than chlorine towards polyolefinic (polyethylene, polypropylene and polybutylene) pipes.

The adaptable new test rig will provide answers to a range of questions related to water chemistry and microbiology in water systems, sensor performance and corrosion in plastics, and promises to be an aid to materials development.

Contact

Johanna Josefsson,
johanna.josefsson@ri.se

Johanna Josefsson is the contact person for the new test rig that gives companies a possibility to test their drinking water pipes – and serves as an aid to materials development.
Photo: Salma Salim

NEW TEST BED

Flue gas ducts and stacks of fiber-reinforced plastics

Fiber reinforced plastic (FRP) is an often-used material to handle the corrosive environments that flue gases in an incinerator constitutes. However, there have been a number of costly delamination damages in FRP used in flue gas that have been unexpected and difficult to explain.

In order to improve the understanding of the underlying failure reason a test bed has been constructed that simulate a by-pass operation in an incineration plant, an operation that is known to increase the risk of changes in the structural properties of FRP-structures. The test bed gives the possibility to study the effect of temperature and water on cylindrical pieces of FRP with a diameter of 40 cm. The test bed enables a rapid and frequent cycling between cool (70 °C) and moist air to hot air (185 °C). Heating and cooling take about three and half minutes respectively, and a whole temperature cycle can be performed in 70 minutes.

The heating is done under high air velocity (8 m/s) to simulate heat convection expected in a flue gas stack. While FRP is the main material studied at this time, other materials such as dual laminates and metals are to be investigated.

Contact

Love Pallon
love.pallon@ri.se

Love Pallon at the new test rig for flue gas. **Photo:** Salma Salim

Our testing facilities

The ambition of the Corrosion team at RISE is to have a combination of field testing, accelerated testing and modelling activities in all our main segments and environments. Combining this complementary way of working with the broad competence of RISE is one key to success within our different segments. The following gives some examples of our extensive testing facilities.

Atmospheric corrosion testing

Field testing is conducted on either a mobile station (vehicle) in a transport environment or a static field station. We have several permanent field stations at our disposal, but also work in partnership with institutes with stations in marine, industrial and urban environments around the world. We have field stations in rural environments (Enköping/Ryda), subarctic envrionment (Gällivare), urban environments (Stockholm), industrial environments (Singapore and China), as well as marine environments (Bohus-Malmön, Brest and Singapore).

Testing in climate chambers is used to compare the corrosion resistance of different materials and material combinations in a variety of atmospheric environments. We offer a wide range of options for climate chamber testing. Our climate chambers are equipped to enable the environmental conditions to be varied during exposure in a controlled manner. The main parameters that are varied are temperature, humidity, salt content, UV light and the presence of corrosive gases. We have climate chambers for temperature and humidity cycling, corrosive gas testing combined climate and salt spray chambers, climate chamber testing with simultaneous mechanical fatigue testing. Our laboratory in Borås in Sweden also offers accredited corrosion testing.

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Weathering testing

We offer accredited weathering testing on surfaces utilizing state of the art equipment with both control of UV spectrum as well as temperature and humidity. We offer the possibility to expose entire assemblies and 3D objects. Our lab utilizes both fluorescent as well as xenon lamps. Both standardised testing as well as custom exposures are possible and measurement of color, gloss and coating deterioration is offered.

konrad.tarka@ri.se

Test in soils

We have field test stations and laboratory tests where we can investigate moisture content, oxygen availability, chemical composition/ mineral content, redox potential, pH, resistivity and microbial activity. Soil composition varies both vertically and horizontally and is heavily influenced by excavation and seasonal variations.

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dominique.thierry@institut-corrosion.fr

Tests in H_2S environments

Standard cracking tests in H_2S containing environments can be performed (for example according to NACE TM0177, NACE TM0284, NACE TM0316, NACE TM0198...) under high pressure of CO_2 and/or H_2S and at elevated temperature. We can also perform cracking tests, slow strain rate tensile test, high pressure and high temperature tests in autoclaves, corrosion fatigue tests, tests in explosive environments, and hydrogen permeation tests and electro-chemical tests under pressure.

christophe.mendibide@institut-corrosion.fr

Testing in natural sea water

Tests in natural seawater can be performed at our French field laboratory in Brest. Materials are tested in a natural seawater that can be regulated from 4°C to 90°C and treated with a chlorination regulation system and an oxygen control system. It also includes a complete and independent in-situ "monitoring corrosion" system for continuous measurements of electrochemical potential, current and cathodic protection. We can perform experiments at smaller or larger scale for different marine applications, for example heat exchangers, umbilicals, connectors, chlorination full units and pumps, etc. We also have a marine station in Kristineberg on the west coast of Sweden.

nicolas.larche@institut-corrosion.fr

High temperature testing

We can perform high temperature corrosion tests in the aggressive gases such as CO, H_2S, SO_2, Cl_2 and HCl. We adress corrosion problems in combustion environments, e.g. biomass or waste-fuelled CHP plants, aircraft engines, gas turbines, as well as in heat-treatment applications and in refineries.

rikard.norling@ri.se

Joint industrial projects

The following projects are examples of JIP (Joint Industrial projects), on-going and to be started 2020. The new projects will be planned during autumn 2019 and we are presently seeking interested industrial partners. Do not hesitate to contact us if you are interetsed in one of these topics.

Corrosion and hygienic properties of materials in contact with drinking water – Comparative (NEW)

Even though materials for water distribution have been under focus recently, there is today a lack of comparative test methods performed in the same way for different types of materials. Correlation between corrosion and hygienic properties for all types of materials is poor and there is no study including biofilm formation and leaching properties, according to real operating conditions uniformly for all types of materials. The aim of this project is to perform comparative testing of different materials (e.g. copper and alloys, stainless steel, coated carbon steel, polymers) regarding material degradation, biofilm formation and leaching, using different types of water, and to perform, analyses and characterization in order to correlate the differences observed between the materials with the mechanisms governing their behavior.

mylene.trublet@ri.se

Retrieval of metal samples exposed in soil for 37 years (NEW)

The aim of this planned JIP is to retrieve metal samples that has been exposed for 37 years. The samples have been exposed at eight different test sites, above and below the ground water table, in natural backfill and in sandy backfill. Each set of samples consists of 8 different types of samples; copper, lead, carbon steel, Aluzinc coated steel, two types of aluminum, zinc, and hot-dip galvanized steel. The results will yield information on how commonly used infrastructure metals are affected by corrosion in different soil environments in a long-term perspective. Furthermore, analyzing the backfills will give valuable information on how backfills age and how this affects the corrosion.

Jonas.engblom@ri.se

Accelerated corrosion test for hydrogen cracking resistance of advanced high strength steels for automotive applications (on-going)

Many studies have shown that the sensitivity to hydrogen embrittlement increases with the mechanical strength of steel. The standard samples used today for cyclic corrosion tests do not allow determination of a stress/strain threshold that leads to cracking. The aim of this project is the development of a new accelerated corrosion test dedicated to hydrogen production under realistic conditions. Relevant parameters for hydrogen assisted cracking of AHSS will be determined. Then, a test will be proposed for the characterization of hydrogen resistance of AHSS. The development of demonstrator specimens will be performed in parallel in order to be representative of real automotive components with a reduced size specimen.

flavien.vucko@institut-corrosion.fr

Corrosion in agriculture environments (on-going)

There are many potential causes of corrosion in animal buildings, related to the animals themselves, acids, and salts, mechanical destruction and bacteria. The project aims are (1) to study the material performance of metallic coatings in both liquid and atmospheric environments in a selected animal farming, (2) to study the effect of galvanic coupling (e.g. stainless steel, rebar in concrete…) on the corrosion resistance of metallic coatings and on the degradation of coil coating, and (3) to evaluate new coil coating materials with respect to these environments.

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Crevice corrosion of stainless steels (and Ni-based alloys) in tropical seawater (on-going)

It was shown in a previous program (BiofouCORR) that the influence of temperature on natural tropical biofilms was very different compared to the one on biofilms formed in temperate seawaters. Thus, there is an interest to evaluate the localized corrosion resistance of materials in heated tropical seawaters (i. e. from 40 to 50°C), which cannot be simulated using temperate seawater heated above 30°C. In this program, the corrosion resistance of 8 different alloys (including stainless steel Ni-based alloys) and 5 different product forms (wrought, cast, tubes, etc.) is evaluated. Exposures are performed in natural and heated seawater in a tropical site (Singapore) and in Brazil. Results will be compared to temperate seawater (France) and the effect of gasket material on crevice corrosion resistance will be investigated.

nicolas.larche@institut-corrosion.fr

Influence of H_2S fugacity on SSC cracking resistance of carbon steels (on-going)

The main objective of this project is to evaluate the potential impact of fugacity on the risks of H_2S cracking. An original approach is proposed, consisting of using hydrogen permeation measurements. Using this experimental technique in autoclave tests at constant pH and PH_2S and at various total pressures should allow varying H_2S fugacity, all other things being equal. Since hydrogen permeation in metals is the main process leading to H_2S cracking: such measurements will give a direct quantification of environment severity. In addition, hydrogen permeation is a sensitive technique, which should be capable of detecting small effects of fugacity, if any.

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WELCOME TO OUR

Member Research Consortia

Our member programmes within corrosion are the foundation of our good relationship with the industrial sector.

By gathering different players with interests in the same research area, we are able to find efficient solutions to joint challenges. Many research projects are initiated through collaborative membership programmes. The member programmes engage in total more than 150 companies, large and small, from different sectors, industries and countries. Joining means increased possibilities, expanded networks and access to the recent updates on knowledge and know-how.

Want to become a member?

Contact the person responsible for the membership programme that you are interested in.

Automotive corrosion

We study and analyze corrosion of various types of materials to improve and develop solutions that lead to greater sustainability and competitiveness in the automotive industry.

bo.rendahl@ri.se

Aerospace

We focus on corrosion and corrosion protection for Aerospace. We work with research and development, testing and evaluation of materials for use in aerospace applications.

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Brass Alloys

The research will focus on optimization of machining and production routes to ensure a sufficient productibility and good final properties, mainly corrosion, for lead free brass alloys, as well as a better understading of the corrosion mechanisms.

olivier.rod@ri.se

Coil coating

We are working to better understand and disseminate knowledge about coil-coated products. Besides providing a unique platform for regular meetings, exchange of knowledge and experience and discussions, the MRC sponsors several research programs.

dominique.thierry@institut-corrosion.fr

Corrosion in oil and gas production

We work with research and development, testing and evaluation of polymers and metals for use in oil and gas applications. Several studies proposed by the members are ongoing with a specific focus on the test methodologies and evaluation of the resistance of materials in H_2S containing environments.

christophe.mendibide@institut-corrosion.fr

Corrosion protection

We work with various methods of corrosion protection, such as organic and inorganic coatings, cathodic protection, temporary corrosion protection as well as studying the effects of changes in operating environments.

bjorn.tidbeck@ri.se

Corrosion in pulp and paper industry

Materials in the production process of this industry are generally exposed to a very corrosive environment. We deal with issues linked to minimize the corrosion problems in the pulp and paper industry, by experience collection, research projects and consulting.

magnus.nordling@ri.se

Corrosion test methods

Testing the corrosion resistance of materials is an important requirement when selecting materials, protection and design of a structure. In addition, corrosion monitoring techniques provide direct and online measurement of metal loss/corrosion rate in real environments.

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Marine corrosion

This programme is aimed at those with an interest in the corrosion resistance of materials used for seawater applications. Together we test the limits of applications for given materials and design solutions for corrosion protection.

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Soil

We work with corrosion and cathodic protection of buried structures. The main objectives are to gather end users, engineering companies and material producers (piping & coatings) to discuss issues/concerns related to corrosion in soil and CP in soil.

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andrew.gordon@ri.se,

Corrosion properties of polymers

This program is aimed at corrosion science for polymeric materials, analogous to that of metals, to create "true" relevant corrosion and permeation resistance data, i.e. data which can be used to obtain reliable designs with respect to corrosion of polymeric materials.

elin.funhammar@ri.se

Surface technology

We work within the areas of corrosion protection of coating systems, degradation of organic coatings and advanced analytical techniques. We also work with test methods, new surfaces and coatings including functional coatings.

johan.tidblad@ri.se

Upcoming events

Seminar of materials in contact with drinking water

OCTOBER 2, 2019

Location: Stockholm
Contact: Mylène Trublet,
mylene.trublet@ri.se

Member Research Consortia Day

NOVEMBER 6, 2019

Location: Stockholm
Contact: Salma Salim,
salma.salim@ri.se

Plastic for pickling committee (PPC)

NOVEMBER 6, 2019

Location: Stockholm
Contact: Dongming Liu,
dongming.liu@ri.se

Corrosion in thermal power plants (held in Swedish)

DECEMBER 2, 2019

Location: Stockholm
Contact: Magnus Nordling,
magnus.nordling@ri.se

8th International Seminar in the Field of Automotive Corrosion

JUNE 3–4, 2020

Location: Stockholm
Contact: Bo Rendahl,
bo.rendahl@ri.se

Training in cathodic protection for seawater applications

Preparation for certifications levels 1, 2 and 3 according ISO15257.

OCTOBER 7–11 + OCTOBER 21, 2019

Level 2 (48h)
[examination 22/23 October]
Location: Brest, France

OCTOBER 14–18, 2019

Level 3 (40h)
[examination 22/23 October]
Location: Brest, France

OCTOBER 7-18, 2019

Level 2+3 (80h)
[examination 22/23 October]
Location: Brest, France

FEBRUARY OR MARCH 2020

Level 1 (24h over 3 days)
(to be defined)
Location: Brest, France

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