QUALITY MANTRA

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SPECIAL EDITION ON CORROSION MANAGEMENT AND CATHODIC PROTECTION

A Message

From the DESK of Mr. V. T. Purohit

Since the dawn of human history our rivers nourished life; provided agriculture, transport and helped exchange of ideas and culture. Towns on river banks like Varanasi, Allahbad, Delhi, Bharuch and Surat, all historical towns prosperous during the period of great epics, their history is drowning into mythology. No Wonder, therefore that rivers are treated as goddesses. A bath or a dip in the holy Ganges is a lifetime ambition of many of us.

And now, since the arrival of oil and gas some 150 years ago, we have developed many cities which depend primarily on oil and gas pipelines; Houston our head quarter is a classic example. In India small villages of a few hutments have become big towns with all modern amenities. Uran, Hazira, Nagothane, Orriaya, Jagdishpur are some of the instances. How and why?

The reason is oil or gas pipelines. We construct an oil or a gas pipeline and around them would develop in short time ancillary facilities like petrochemical industries, transport, hotels. Thus these pipeline breed livelihood for many families.

Conversely, we can easily imagine what can happen if these pipes failed, ecological damage in sea, rivers and farmlands; fires or loss of property and may be, of human life would result. And if by chance a pipe feeding border areas or a military or a naval base fails, it is difficult to imagine what can happen to the safety of our borders. A manmade catastrophe. Truly, oil and gas pipes have to be looked upon with same veneration as our rivers.

Corrosion leaks prevented by Cathodic protection has made it possible to obtain the advantages from the pipes. And we, the corrosion engineers have been proclaiming from the house top that corrosion of the industry. It erodes the marrows of the nation's economic bones. Thus the subject of Corrosion in general, that on and pipelines in particular has to be approached with reverence, sincerity and rationality as like Mother Teresa would treat a patient of cancer, with loving care and a duty to be discharged. The missionary zeal and sense of duty demands diligence. Duty thus discharged generates a degree of determination, determination turns into dedication and in time, dedication flowers into devotion to the cause of corrosion, science and technology. The ultimate output of such efforts will be a model of excellence, a prize winner. Adhering to quality mantra is only way to give oblation to the nations pipes. Yes, for Corrosion Engineers, Quality Mantra can bequeath everlasting sublime song and divine music.

V. T. Purohit, Executive Director, ICS-ECD

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MICROBIOLOGICAL CORROSION

By Krishna Datta, Auditor -ICS

Description

Microbiological corrosion is the deterioration of materials caused directly or indirectly by bacteria, algae, moulds or fungi; singly or in combination. Under anaerobic conditions, as may occur in compacted clay soils, corrosion may be stimulated by the activity of micro-organisms such as the sulfate-reducing bacteria (e.g. desulfovibrio desulfuricans). Bacterial corrosion is possible under aerobic conditions as well. In this situation corrosion is often the result of the production of a corrosive metabolite (e.g., an acid), or may be caused by bacteria like ferrobacillus ferrooxidans that may directly oxidize iron into iron oxides or hydroxides, or which may lead to the formation of deposits with the creation of oxygen concentration cells. Other corrosive actions exerted by micro-organisms also have to do mainly with the formation of concentration cells, possibly in combination with fouling problems. Microorganisms Commonly Implicated in Biological Corrosion.

Causes

Living organisms influence anodic and cathodic reactions, and create corrosive conditions. Using the term corrosion in the broadest sense, the microbes (bacteria, moulds or fungi) may cause corrosion by:

- Chemical attack of metals, concrete and other materials by the by-products of microbial life, namely acids (e.g. sulphuric, carbonic or other organic acids), hydrogen sulfide or ammonia.
- Microbial attack of organic materials (e.g. organic paint coatings, plastic fittings and linings), conversion of some natural inorganic materials (e.g. sulphur) or degradation of inhibitors.
- Depassivation of metal surfaces and induction of corrosion cells.
- Depolarization of cathodic reaction (hydrogen reaction).
- Attack of metal by a process in which microbes and the metal cooperate to sustain the corrosion reaction.
- Attack due to a combination of bacteria.

Aerobic Conditions

Corrosion due to the activity of micro-organisms in aerobic conditions is often the result of the production of a corrosive metabolite. Usually this is an acid, either mineral or organic. A wide range of organisms may be concerned in corrosion of this type, but the sulfur-oxidizing bacteria are by far the commonest and most important. The oxidation of sulfur, thiosulfate, sulfite and several polythionates to sulfate, with the simultaneous production of strong acid, is carried out by a group of bacteria of the genus Thiobacillus. Three species, thiobacillus thio-oxidans, thiobacillus thioparus, and thiobacillus concretivorus, find a place in corrosion phenomena. All three organisms are widely distributed in nature, being found in muds, soils and water.
Other bacteria, like ferrobacillus ferrooxidans, may directly oxidize iron into iron oxides or hydroxides, or oxidize ferrous iron in solution to the ferric state and effect the precipitation of ferric hydroxides (e.g., gallionella ferruginea). Precipitated ferric hydroxides can build up on the surface of a metal component to form hard excrescences known as "tubercles", which are firmly adherent to the metal surface and may set up an oxygen concentration cell (...), leading to accelerated corrosion at the bottom of the tubercle.
The problem is often aggravated by the fact that the anaerobic region at the base of the tubercle provides a suitable habitat for sulfate-reducing micro-organisms; they proliferate in this region and add their own contribution to the total corrosion.

Aerobic Conditions - Sulfate Reducing Bacteria

The reduction of sulfates to sulfides is effected by sulfate reducing bacteria of the genera Desulfovibrio & Desulfotomaculum. The genus "desulfovibrio" comprises 5 species, 4 of which influence corrosion. One of them (desulfovibrio salixigens) has an absolute requirement for about 2.5% sodium chloride, but other (e.g., D. vulgaris, D. desulfuricans) may grow in either fresh or salt water conditions. The fourth species involved in corrosion is D. africanus. The genus "desulfotomaculum" comprises the spore-forming sulfate reducers; it contains 3 species, 2 of which are known to be involved in corrosion (Dtm. orientis, and Dtm. nigrificans - also known as Clostridium Nigrificans).

All these bacteria are obligate anaerobes, i.e. they will not grow in the presence of even traces of oxygen. The desulfovibrio grow well at temperatures between 25 and 45 C, and at pH values between about 5.5 and 9 (optimum pH = approx. 7.2). The pH range of the desulfotomaculum is similar. Dtm. nigrificans, however, is thermophilic, with an optimum growth temperature of 55 C. Growth occurs even at 65-70 C, and the organism can adapt itself to grow at temperatures as low as 30-37 C.

Various theories and reaction schemes have been put forward to explain the details of the corrosive activity of the different species, but no uniform theory seems to apply.

The corrosion process is much more complex than in conventional cases, and the mechanisms involve bacterial utilization of hydrogen formed cathodically from water and the effects of the sulfide metabolic products of the bacteria.

From a practical point of view, the vigorous growth of sulfate-reducers demands reducing conditions which are more rigorous than can be obtained simply by the exclusion of oxygen, and a redox potential of around -100 mV (normal hydrogen scale) is necessary if the bacteria are to thrive. In the absence of interfering influences, however, even a marginal growth will produce sufficient hydrogen sulfide to reduce the redox potential to a more favorable value, so that growth once begun tends to accelerate.

Recognition

Microbial (or bacterial) corrosion at first often appears to be pitting.

Microscopic (i.e., SEM) and micro-analytical (i.e., EDX) investigations often reveal the presence of a series of deposits (e.g. filament-like) that contain a wide range of chemical elements (Si, Ca, etc...).

Anaerobic bacterial corrosion (due to sulfate-reducing bacteria) is immediately recognizable on a freshly exposed metal surface by a black corrosion product with the strong rotten-egg smell of hydrogen sulfide.

The surface is shiny but can be gouged with a knife.

On cast iron, graphitization occurs, the iron being converted to its sulfide, leaving a matrix of low mechanical strength.

Aerobic Conditions (Sulfur-Oxidizing Bacteria). Situations in which the bacteria have been unequivocally incriminated are comparatively rare, but it seems probable that this is often due to inadequate diagnosis of the cause.

When corrosion occurs in an environment containing a substantial amount of sulfuric acid, and there is no immediate obvious explanation of its origin, thiobacilli should be suspected. The presence of the organism may be confirmed using some dedicated tests.

Protection Possibilities: Checklist

- Analyze accurately probabilities of microbiological
- Contamination and secure removal of microbial nutrient.
- Provide accessibility for frequent cleaning.
- Change pH, for some species.
- Use biocides (...)
- Select suitable protective coating.
- Select more-resistant materials.
- Use cathodic protection (...)

QUALITY MANTRA

RE-CERTIFICATION OF PIPELINE USING "RISK BASED INSPECTION (RBI SYSTEM)"

By Sundar Kataria, Managing Director & Haridasan Thekkethil, Sr. Auditor

Re-certification and in-services inspection of on-land and sub-sea pipeline are necessary for the safety of the installations by ensuring its integrity, operatability, reliability, availability and safety. Submarine pipeline in the marine, oil and gas encounter with harsh sea environmental conditions that require proper and adequate corrosion prevention and monitoring system Risk Based Inspection (RBI) is that one of the very effective tools available to the industry to safeguard the life, property and the environment specially when the onland and offshore installation are old. The papers give details of re-certification and in-services inspection requirements, RBI System and its suitability to know safety and integrity of the installations.

Pipelines designed to modern engineering codes generally operate in a safe manner, but may be subject to damage during their operational lifetime, potentially impairing their structural reliability. Data of many types are generated during operation of a pipeline system, and these data are used to make decisions associated with operation, inspection and maintenance.

Efficient acquisition, storage, access and analysis of pipeline integrity data has an important role in management of pipeline assets, particularly in the application of modern pipeline engineering activities such as structural reliability analysis (SRA) and risk-based in-line inspection (ILI) scheduling. The data requirements for use of these probabilistic tools can be considerable, and efficient access to valid pipeline integrity data is crucial to these activities.

An examination of the pipeline integrity data requirements for SRA and risk-based inspection scheduling, including how such data are processed, provides a useful insight into the potential uses of these techniques for the wider pipeline population.

The benefits of Risk Based Inspection (RBI) include:

- Reduction of the probability of injuries & fatalities
- Reduction of costs of failures, including repair costs, environmental costs, third-party costs, revenue loss, penalties, domestic reconnections, etc.

The inspection costs include:

- Inspection costs (preparation, cleaning, mobilization, analysis & reporting)
- Repair costs

Conclusions

Modern pipeline engineering techniques, including structural reliability analysis and risk-based inspection scheduling, depend on access to valid pipeline integrity data.

These techniques help to maximize the operational efficiency of pipelines, by maximizing capacity and minimizing inspection and maintenance costs.

Collating and processing the data for input to these techniques is often difficult and time consuming; the development and use of integrated pipeline integrity data management systems will promote and facilitate their more widespread use.

(This paper was presented at CORCON 2002, The NACE East-Asia pacific regional convention on corrosion, held at Goa during 28th to 30th November 2002. For the full paper and further details please contact Mr.Haridasan, ICS Mumbai.)

QUALITY MANTRA

SELECTIVE LEACHING
By Krishna Datta, Auditor - ICS

Description

Selective leaching, also called Dealloying, is the removal of one element from a solid alloy by corrosion processes.
The most common example is dezincification: the selective removal of zinc in brass alloys. Aluminum alloying constituents are removed in dealuminification.
Another example is "graphitic corrosion" of (gray) cast iron, in which the metallic constituents are selectively leached or converted to corrosion products leaving the graphite intact.

Causes

Basically, one element of a metal or alloy is singled out for corrosion attack. When, for example, brasses (Cu-Zn alloys) containing less than 85% Cu are exposed to wet conditions for prolonged periods of time, the zinc may go into solution and the (redeposited) copper has little mechanical strength.
Common cast iron (gray) can also act in this way inasmuch as, in some corrosives, the iron corrodes out leaving just a porous graphite matrix residue that virtually crumbles.
It is always the less noble alloying component which is (selectively) removed, leaving the more noble in place.
Selective leaching can be considered a galvanic (bimetallic) corrosion system on a microscopic scale. Especially the alloys with components far from each other in the electrochemical series - e.g. Cu and Zn - are susceptible.
Note that also carbon (graphite) is electrically active and forms a galvanic couple with Fe in cast iron.

Protection Possibilities: Checklist

- Select materials not susceptible to grain boundary depletion
- Specify suitable heat treatment (avoid specifying heat treatment or welding in the susceptible range).
- Alter environment (e.g. reduce oxygen content in case of dezincification).
- Use cathodic protection.

A Satisfied Customer is your Best Advertisement.
By Uday Dharm, ICS Auditor

A sale is not a one-time transaction it is the beginning of repeat business provided you keep the customer satisfied, And there is no other way of doing it than to be prompt in reaching out to him in his adversity and giving him good after sales service.

No amount of advertising leaflets, banners, hoardings, wall paintings, newspaper and magazine insertions, radio jingles, television advertisement films have the credibility which a satisfied customer has.

If you are sincere in helping him and create in him the confidence that you are always behind him, you will see the word of mouth spread like wild fire. Not only will he give you repeat business, he will get you the business of his friends and acquaintances too.

QUALITY MANTRA

MARINE (SEA WATER) CORROSION
By R. J. Choudhary, OTIS

Corrosion is the destructive attack of a material by reaction with its environment. The serious consequences of the corrosion process have become a problem of worldwide significance. In addition to our everyday encounters with this form of degradation, corrosion causes plant shutdowns, waste of valuable resources, loss or contamination of product, reduction in efficiency, costly maintenance, and expensive over design. It can also jeopardize safety and inhibit technological progress.

Corrosion In Marine Environments

Seawater systems are used by many industries such as shipping, offshore oil and gas production, power plants and coastal industrial plants. The main use of seawater is for cooling purpose but it is also used for fire fighting, oil field water injection and for desalination plants. The corrosion problems in these systems have been well studied over many years, but despite published information on material behavior in seawater, failures still occur.

Most of the element that can be found on earth is present in seawater, at least in trace amounts. However, eleven of the constituents alone account for 99.95% of the total solutes, chloride ions being by far the largest constituent. The concentration of dissolved materials in the sea varies greatly with location and time because rivers dilute seawater rain, or, melting ice, or is concentrated by evaporation.
The important properties of seawater are as below:

- High salt concentration.
- High electrical conductivity
- Relatively high and constant pH
- Buffering capacity
- Solubility for gases, of which oxygen and carbon dioxide in particular are of importance in the context of corrosion
- The presence of myriad of organic compounds
- The existence of biological life either as microfouling (e.g. bacteria, slime) or macrofouling (e.g. seaweed, mussels, barnacles and many kinds of animals or fish).

Customer Feedback :

P.K. Mittal, General Manager Head RCC
Oil & Natural Gas Corporation Ltd.

Regional Computer Centre (RCC), ONGC Vadodara, has been processing seismic data to contribute to the oil exploration activities of ONGC since 1988. till the year 2000, RCC had a Russian computer (EC-1061) with the help of which 2D and VSP data was being processed. Even with the decade old computer, RCC Vadodara always had an obsession for quality.

In the year 2000, the computer system for seismic processing was upgraded with the installation of IBM SP3 Hardware and Geovecteur Plus Seismic Software from CGG France. With the rejuvenated 3D processing capability, the need for Quality Management System (QMS) was actually felt. It was realized that in order to achieve recognition within and outside ONGC, ISO 9001 : 2000 Certification is highly desired.

To achieve the goal of ISO Certification, we contacted ICS who were extremely helpful in bringing out the areas for improvement through their auditors. Shri. Hitendra Dave played a vital role in proactively co-ordinating the auditing and certification activities. With this help RCC, which had started work for ISO 9001 : 1994 certification, was able to secure ISO 9001 : 2000 Certification in a very short time of ten weeks. On our request ICS, Baroda has managed to conduct certification audit at a very short notice and delivered the ISO 9001 : 2000 Certificate within three days from the date of successful accomplishment.

QUALITY MANTRA

Corrosion Testing:

By R. J. Choudhary, OTIS

Test methods for determining corrosion resistance are specific and must be based in conditions prevailing in certain environments and applications. A large number of factors affect corrosion behavior, and therefore there is no universal corrosion test. The most reliable indication of corrosion behavior is service history. However, that information is rarely available exactly as needed and therefore other tests are required ranging from simple field trails to highly accelerated laboratory tests. It is the need to obtain information outside of service history that introduces ambiguity in corrosion testing.

In order to quantify the corrosion resistance of a material, it is common practice to submit the material to severe environments than normally encountered in service, hoping to accelerate the damage. Alternatively, a corroded surface and the corrosion products formed during normal exposure can be studied with very sensitive surface analysis techniques, hoping to amplify the visibility and characteristics of the damage. Since most corrosion processes occur at the metal / environment interface, much progress in the study of corrosion mechanism can be related to the high level advances made in surface analysis techniques. In fact, scientists involved in the study of fundamental processes of corrosion have often been the first to explore the application of new surface analysis techniques to materials engineering problems.

Corrosion types can be broadly of eight forms such as Galvanic, Crevice, Pitting, Inter-granular, Erosion, Stress Corrosion, and Hydrogen damage. At otislab, most of the advance testing facilities including Stress Corrosion (SSCC), Hydrogen damage (HIC) studies are undertaken.

Otis lab is one of the few lab in Asia region regularly carrying CSCC (MgCl2 Test, CaCl2 Test) and many accelerated corrosion tests.

Corrosion tests widely in use during material selection, welding qualification. IGC testing is the most common testing. IGC practices are sub classified into A, B, C, D, E and carried as per ASTM A262 standards. HIC & SSCC tests are conducted as per NACE TM0284-96 and NACE TM0177-96 standard.

QUALITY MANTRA

Quality 4 U

Strength in the Fruits of Spirit

There's a strength in love, and a loving person is strong because he is able to overcome his selfishness.
There's a strength in joy, and a joyful person is strong because he has never been defeated by challenges and temptations.
There's a strength in peace, and a person who owns peace is strong because he has never been in doubt.
There's a strength in patient endurance, and a patient person is strong because he is able to bear everything and he has never felt hurt.
There's a strength in generosity, and a generous person is strong because he has never held his words and hands to do good deeds.
There's a strength in kindness, and a kind person is strong because he is always able to do good things for everyone.
There's a strength in faith, and a faithful person is strong because he is able to defeat his worldliness by his faith to God and other people.
There's a strength in mildness, and a mild person is strong because he is able to restrain himself from revenge.
There's a strength in chastity, and a chaste person is strong because he is able to control his lust.

Quality Thought

Coming together is a beginning, keeping together is progress, working together is success.
"Quality is everyone's responsibility." -- ***W. Edwards Deming***

There is one rule for the industrialist and that is: Make the best quality of goods possible at the lowest cost possible, paying the highest wages possible." -- ***Henry Ford***

Welcome and Good Wishes:

We welcome and wish good luck and success to our new employees:
-Blasis A. Taylor joined ICS Baroda as Secretary
-Krishna Datta joined ICS, Mumbai as Auditor. (A specialist in Food Industry).

Birthdays:

Somnath Pal	1st January	Blasis Taylor	12th January	Ismail Sheikh	20th January
Bina Bhandari	15th January	Vaishali Naik	19th January		

Announcement:

ICS Electro Corr-Damp Pvt. Ltd., a group company of ICS provides corrosion and cathodic protection services for public and private sector industries to safeguard important infrastructure, installations and facilities from corrosion thus ensuring them safety, integrity and operatability / availability of these national wealth.

Publication:

ICS has recently completed their R & D Projects by publishing a book on "Excellence in Education Management". The author of this book is Mr. Sundar Kataria, Managing Director, ICS. This book has received praise in the education sector and on review by environmental educationists it was commented that it is a unique book to guide educational institutions in adopting the modern management system to improve quality education and make it world class.

Please send your articles and news to the Editor/ Co-ordinator **EDITORS: Mr. Sundar Kataria - 22 6245747**
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