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Letters to the editor are always welcome. We invite your suggestions, comments and views on the Newsletter as well as articles for publications. To publish your article, submit it to rishikesh@naceindia.org

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Editorial

Dear Colleagues, dear Readers

It is my pleasure to introduce the new issue of the Corrosion Combat newsletter.

A new section is introduced in the newsletter dedicated to the recent literature on corrosion research for the first time. Under this, two student articles on machine learning in corrosion and corrosion in high entropy alloys (HEA) are included. More such brief literature updates will appear in future issues. In addition, the winning student article from the CIP 2020 is included. It is interesting to see how young minds perceive corrosion problems they witnessed in their everyday life.

The technical articles in this issue are on the most critical sectors of the industry - oil & gas pipelines and refinery and petrochemical process units. The corrosion monitoring in the oil & gas pipelines with coating and cathodic protection is critical for the integrity assessment. In refinery and petrochemical process units, the floating head heat exchanger corrosion is also a critical issue. Technical articles are presented with relevant case studies.

Yet again, NIGIS has displayed excellent resilience and has virtually carried out several professional activities - training courses, conferences, and corrosion awareness competitions. The foundation day was observed on July 17, 2021, which was graced by the Director (Technical), Engineers India Limited. A detailed report on the activities is worth reading.

I hope you'll enjoy reading this issue with its new content.

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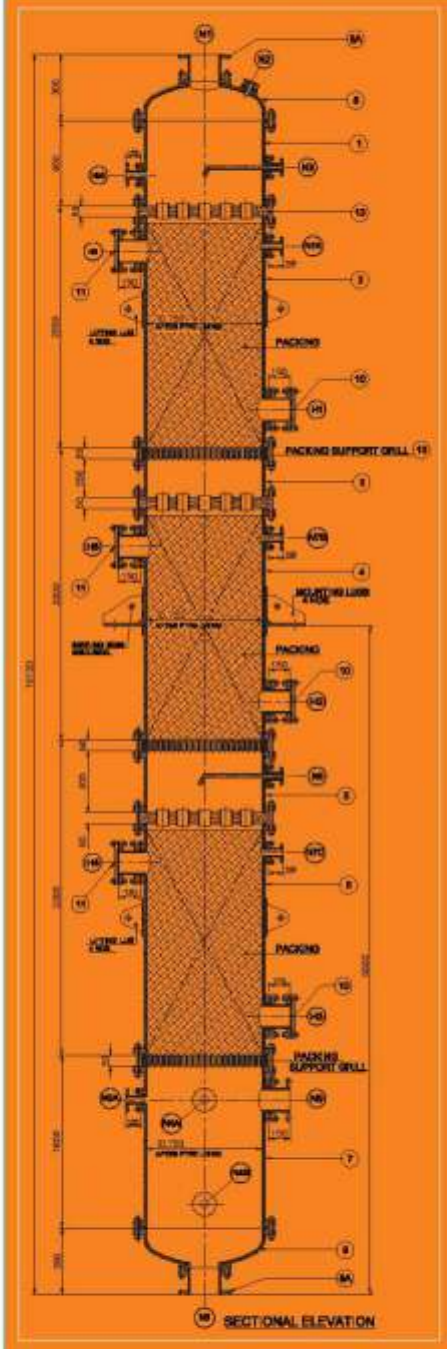

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Integrated advanced CP and coating surveys utilized to assess a newly laid 3LPE coated cross country pipeline

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[1]Professional Engineer (P. Eng),[2]Chartered Engineer (C. Eng.),[3]NACE CP L-2

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Abstract

Various independent studies are conducted each year to conclude sector-wise losses incurred by various industries such as infrastructure, utility, production & manufacturing and defence & nuclear. These losses amount up to 6 Lakh Crores annually in India alone. The Oil and Gas Industry around the world loses up to 10,000 Crores each year due to corrrosion[2]. Pipelines – one of the safest transportation techniques for Oil and Gas are regulated by OISD and PNGRB in India for their safe routine operations, least harm to the environment and the most optimized operating costs.

Pipelines travel underground through some of the harshest soil environments, which when uncared for, propagate the phenomenon of corrosion, leading to loss of containment/loss of integrity. As per regulatory norms, it is mandatory for a pipeline owner to have the most efficient coatings and Cathodic Protection (CP) to arrest corrosion. Periodic assessment of such systems requires efficient surveys and monitoring. Various other external aggravators such as AC interference, Railway Crossings, Temporal phenomena etc. also have to be taken into consideration while these above-ground surveys and monitoring data is being collected. The collection of genuine, traceable, repeatable data will enable the end-user to convert them into information to make correct integrity-based decisions and step forward towards a performance-based integrity management program.

Following a proactive approach, one of the pipeline owners/operators in India utilized the external Line Inspection (XLI) program as a prescriptive procedure for ascertaining the health of the in-place CP system and assess the integrity of the coating. For a pipeline of over 400 km long, stretching across three (3) states of Northern India – the pipeline traverses through critically varying soil and ambient environmental conditions. As per NACE Standard Practice SP0502, it is known that different above-ground survey tools are to be utilized by the pipeline owner for varying soil environments. The XLI system collects up to ten (10) different types of data which includes DCVG, ACVG, ACCA (CAT), CIP – AC & DC, GIS mapping, DOC, GLD and Soil Resistivity. All this data is encrypted for audit purposes by the end-user.

Using these authentic and encrypted raw logs, the owner was able to ascertain intricate concerns with the in-place pipeline CP system, which would otherwise require multiple different expertise to isolate and resolve. This was possible due to all the indirect inspection techniques being integrated and conducted simultaneously. The XLI survey data aligned and correlated very well with the historically conducted in-line inspection (intelligent pigging) information. This article shall discuss the unique findings obtained during the survey.

Keywords: eXternal Line Inspection, Integrated Indirect Inspection, Cathodic Protection AC Interference, Temporal, DCVG, ACVG, ACCA, CIP.

Nomenclature

CP	Cathodic Protection
XLI	eXternal Line Inspection
AC	Alternating Current
DC	Direct Current
CIP	Close Interval Potential
ACVG	Alternating Current Voltage Gradient
DCVG	Direct Current Voltage Gradient
ACCA	Alternating Current Attenuation
CAT	Current Attenuation Test
GIS	Geographic Information System
DOC	Depth of Cover
GLD	Gas Leak Detection
ROW	Right of Way
IT	Influence Test
TR	Transformer Rectifier
TLP	Test Lead Post
CPPSM	Cathodic Protection Power Supply Module
IPS	Intermediate Pigging Station

Introduction

The owner has developed a stringent pipeline integrity management program aiming to increase reliability, whilst optimizing the productivity and efficiency of their network. There are various tools in the owner's integrity toolbox to achieve this goal. CP Health Assessment and Coating Integrity Survey area few of them to assess the risks associated with the time-dependent threat of external corrosion. The owner opted to utilize eXternal Line Inspection (XLI) survey technology to achieve both CP Health Assessment and Coating Integrity in a single traverse over the pipeline.

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Impressed Current Cathodic Protection (ICCP) system. The pipeline comprises four (4) electrically continuous sections including four (4) Transformer / Rectifier (T/R) stations and eleven (11) Cathodic Protection Power Supply Modules (CPPSM). For the purpose of regular monitoring, the pipeline is equipped with a total of five-hundred eighteen (518) test stations. This paper provides a detailed insight into the survey findings and the associated analysis to ascertain successful verifications.

2. Pipeline Network

Following are the details regarding the pipeline network.

- **Length:** >400 Km
- **Diameter:** 18 inches
- Four (4) sections separated by insulation joints
- **Product:** Refined petroleum products
- **Year of Commission:** 2015

3. Pre-Survey

The subject pipeline traverses through three(3) north Indian states – truly varying soil and ambient environmental conditions.

3.1 CP Audit

An audit of the in-place system was undertaken to obtain the operational parameters and determine the effectiveness of the ICCP System in place. Surveyor accessibility was documented to determine site conditions for the feasibility of conducting XLI.

Pre-Survey helps determine the feasibility of Indirect Inspection and helps the involved parties to take requisite actions prior to initiating the survey. It helps in identifying potential locations where extra care must be taken care of during the actual survey, and most importantly ensure the survey is done in "true" "as-is" condition. This is very critical because the survey findings should mimic the condition the pipeline is subjected to on a day-to-day basis. Surveys conducted under such conditions and their subsequent findings allow for the provision of practical mitigations and recommendations, which are now customized to the pipeline based on the ambient conditions.

TR units, Junction Boxes, TLPs, Insulation Joints and Casings were assessed prior to undertaking XLI survey.

3.2 Influence Test

Influence Testing is conducted to verify the influence (range of protection) of each TR / CPPSM installed on the subject pipeline and to determine if there is any external influence from any other sources (ex: foreign pipeline either "parallel or crossing" in the same RoW as the subject pipeline, DC/AC traction, power stations, solar power plant, etc.)

4. XLI Survey

During the XLI survey, above-ground surveys, namely DCVG, ACVG, ACCA (CAT), CIP – AC & DC, GIS mapping, DOC data were recorded simultaneously. The recorded field data is stored in encrypted files with continuous raw logs. The encrypted raw logs may be reviewed and assessed on desktop software which allows the end user to perform extensive data analysis as well as diagnostics. This is achieved by correlating multiple data sets for each point. Below figure1 illustrates a sample snapshot from this software. This location was marked as an anomaly indication. Figure 2 showcases the results found during dig verification for the same location.

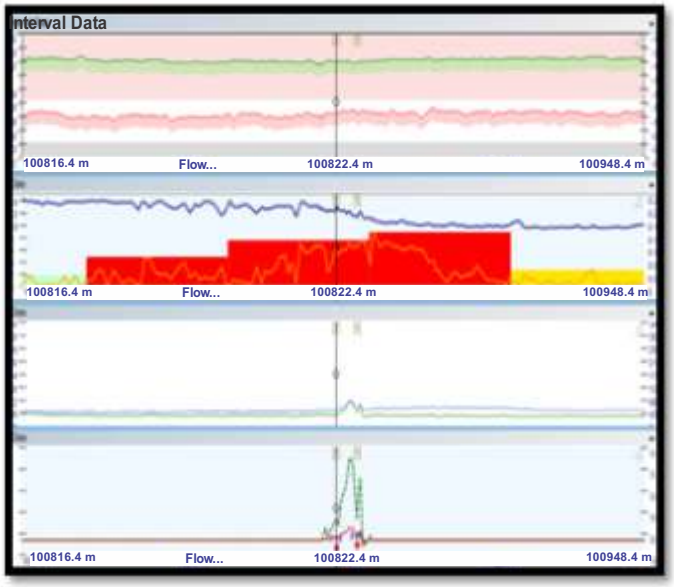

Figure 1: Software extract depicting overlay of multiple surveys

Below table 1 provides the numeric data for the above graphical output.

Table 1: IDi Readings for Anomaly Location

Integrated IDi Surveys	Field recordings
CP CIPS On (V)	- 1.52
CP CIPS Inst. Off (V)	-1.10
ACVG (V)	0.04
Atten.(mB/m)	5.34
DCVG (% IR)	7.18

As depicted in the above figure 1 and table 1, even though there was an anomaly indication picked up by the DCVG, ACVG and ACCA techniques, the CIPS instant Off value confirms that the indication is protected. The same was observed on-field to be a non-corroding coating holiday as depicted in figure 2.

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Figure 2: Coating defect verified through dig verification.

Utilizing the captured data and through preliminary level-I followed by advanced level-II data analysis, the highly descriptive raw logs, also allows the user to verify the presence/absence of any sort of AC and DC interference through their unique signatures.

Figure 3 illustrates a reference CIPS waveform in the absence of AC interference as recorded by the XLI equipment and viewed in the software . For the subject pipeline, evidence was observed for the effect of AC interference with HT/LT crossings and railway crossings. The same has been depicted in below Figure 4. Figure 5 illustrates the same for DC Interference through a foreign source.

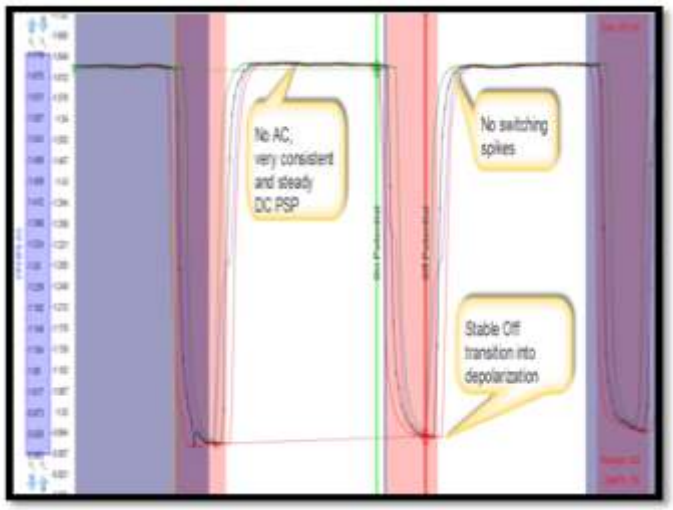

Figure 3: CIPS Waveform Without Interference

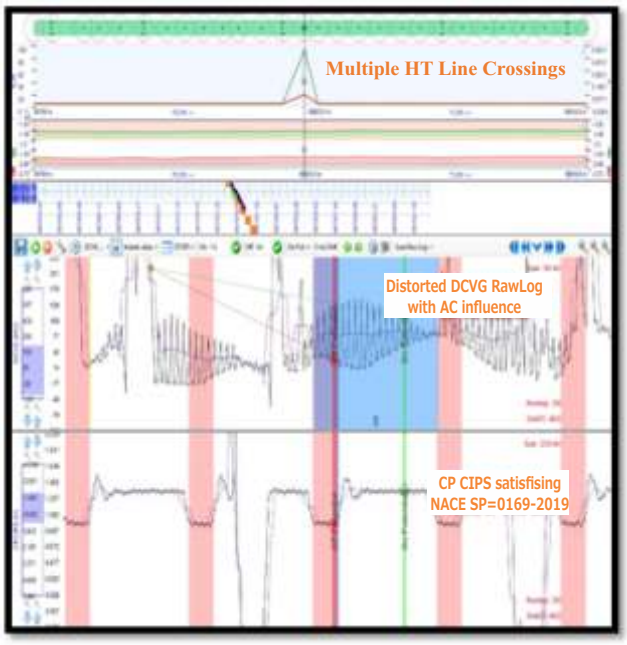

Figure 4: Effect of AC interference depicted through the use raw logs

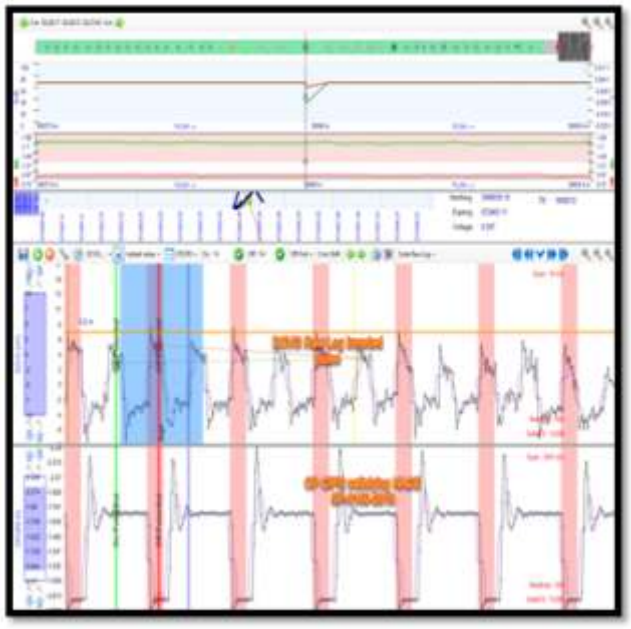

Figure 5: Effect of DC Interference Depicted Through The Use Raw Logs

5. Results and Case Studies

Using XLI technology, a comprehensive survey was completed for the entire pipeline length.

There were some exclusive findings of Integrated Indirect Inspection surveys, which have been categorized as case studies below.

5.1 Case Study 1: Alignment of XLI with In-Line Inspection (ILI) data results

External Line Inspection reported two (2) distinct coating indications from the 2019 survey, as illustrated in Figure-6 (snap shot from the software).

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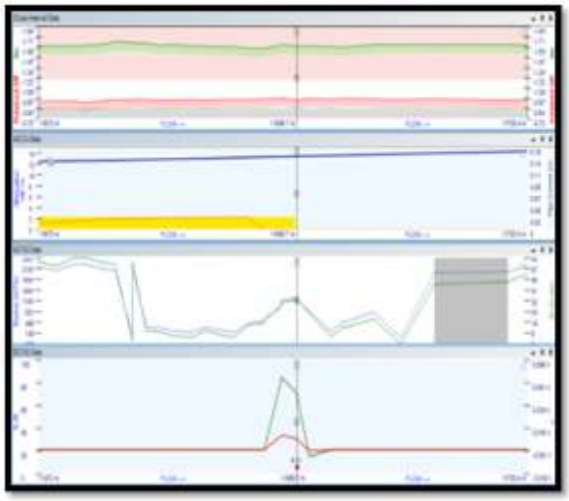

Figure 6: Software Extract of the Two (2) Indications

At this location, ILI reported one (1) metal loss categorized incorrectly as a "Pipe Mill Anomaly"with 5.06 % wall loss in 2018.

Upon dig verification in 2020 at this location, two (2) coating indications were verified as coating anomalies which were observed to be 0.75 m apart as seen in below Fig-7.

The two (2) coating holidays observed D1and D2 coincided with the ILI reported anomaly.

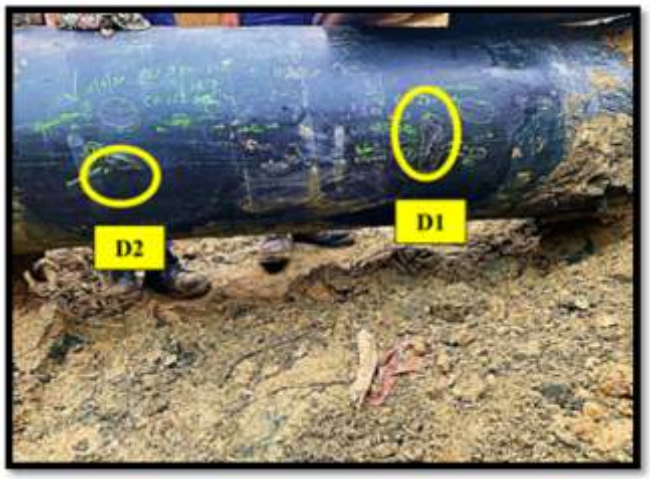

Figure 7: Coating Defects D1 And D2 Excavated During Dig Verification

Figure 8: Coating Defect "D1" Where ILI Had Reported 5.06% Wall Loss

Coating Holiday D1 had dimensions of 40 x 110 x 0.85 mm during XLI JDV. The coating anomaly D2 was not reported by ILI, cross verified by extending the excavation and measuring from the reference girth weld. This coating holiday yielded a metal loss anomaly of 50 x 15 x 1.8 mm underneath the coating as shown in Figure-9.

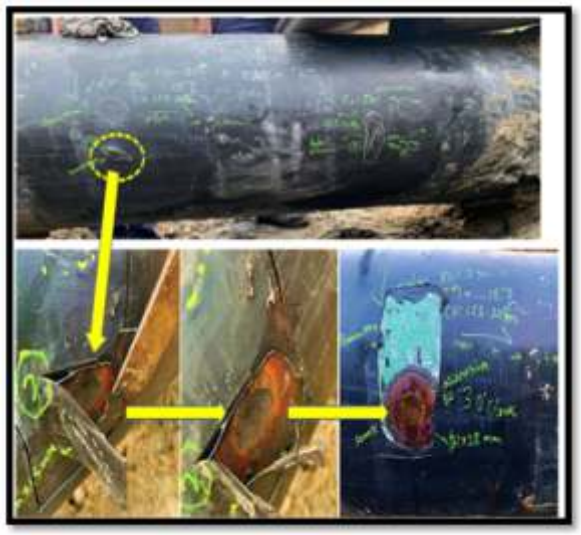

Figure 9: Coating Defect "D2" with 22.80 % Wall Loss

It was interesting to note that a metal loss anomaly of 22.8% was not reported by the ILI campaign of 2018, which is within its tool tolerance sizing specifications. Two (2) queries remain:

I. Was the anomaly present in 2018 during the ILI survey and the tool specification was not sufficient to capture it?

ii. Did the anomaly form after the 2018 ILI survey, which would mean a corrosion rate of 0.9mmpy on a fairly new pipeline?

5.2 Case Study 2: XLI found Pinhole anomaly which could lead to severe localized corrosion if left unchecked

Severe AC Interference in the pipeline ROW occurring from several HVAC power lines in the vicinity of pipeline ROW leads to AC induced corrosion. Such defects are characterized by a ring shaped anomaly with pinhole coating defects. Below Figure 10 and Figure 11 illustrate one such anomaly identified in the subject pipeline section. If the ILI and XLI programs are spaced out strategically, growth rates from such anomalies can be arrested at the earliest and the re-assessment intervals adjusted as well as optimized.

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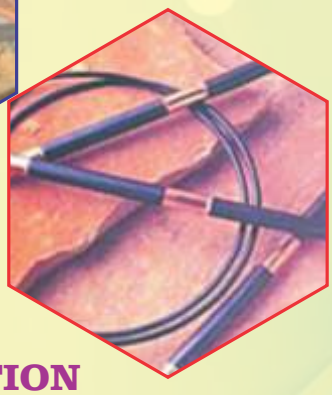

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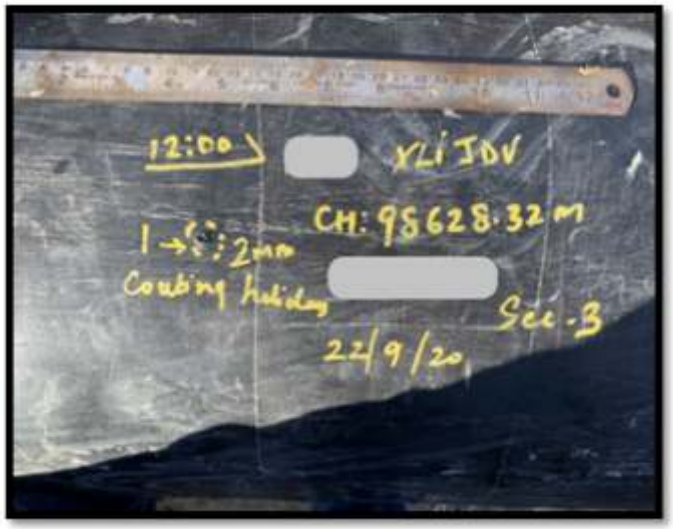

Figure 10: Pinhole Coating Defect

Figure 11: Pinhole Coating Defect After Coating Removal

5.3 Case Study 3: High "On" potential leading to disbondment in a newly coated 3LPE Pipeline

One (1) of the factors that may trigger the phenomenon of Coating disbondment is "instant Off" PSP falling above(more electronegative) overprotection levels (<-1.2 V). Every pipeline owner strives to maintain the pipeline instant Off potential between -0.85 V and -1.2 Vas per NACE SP0169 criteria. Several instances lead to a complete oversight of the overall "Instant Off potential" being fed to the pipeline to obtain and maintain a minimum "Instant Off" polarization of -0.85V.

Two(2) such cases for the subject pipeline are illustrated in Figures 12 and 13 where severe disbondment has already on set for the subject pipeline, commissioned in 2015!

Figure 12: Coating disbondment at D3

Below Table 2 details the survey data as obtained by XLI.

Table 2: Field Recording at Coating Anomaly D3

Integrated IDi Survey	Field Recording
CP CIPS On (V)	-1.83
CP CIPS Inst. Off (V)	-0.89
ACVG (V)	0.02
Atten. (mB/m)	0.00
DCVG %IR	3.93

Figure 13: Coating Disbondment at D4

Integrated IDi Survey	Field Recording
CP CIPS On (V)	-1.67
CP CIPS Inst. Off (V)	-0.92
ACVG (V)	0.07
Atten. (mB/m)	0.51
DCVG %IR	9.45

Table 3: Field Recording for Integrated Surveys at D4

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For a fairly new pipeline coated with 3LPE,severe difference obtained between the On and Off potentials could be one (1) of the reasons for which has led to coating disbondment as showcased through above figures 12 and 13. The occurrence of disbondment was also verified with excavations. These have been labeled as indications D3 and D4.

Coating Disbondment of pipeline protective coating is such an ailment that cannot be detected by any traditional indirect inspection techniques. However, if the user has higher resolution data by using an integrated Indirect Inspection approach, the owner is closer to the location – if compared to conventional as well as stand-alone indirect inspection techniques. Conditions of proven coating disbondment lead to "CP Shielding", wherein protective current will not reach the pipeline because of the shielding effect. CP shielding also leads to capturing of false-positive data from traditional CP surveys making the pipeline prone to external corrosion.

CONCLUSION

The XLI system has been developed for the most proactive approach and is constantly improving via hardware as well as software updates. A comprehensive pipeline management program must employ technologies that provide the most accurate and reliable data, which helps the operator to figure out potential risks and strategize accordingly.

The combined approach where multiple indirect inspection technologies are employed simultaneously adequately addresses the age-olddilemma of "which survey tool to use to effectively capture data for changing environmental and physical conditions for a pipeline", while also providing an efficient data analysis platform through encrypted, auditable and verifiable raw logs.

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Authors

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Himanshu Joshi - Himanshu Joshi working as a Project Manager for Cathodic Protection and Direct Assessment projects, is also a NACE certified CP Level 2 technician. He has also co-authored technical papers for ASME IOGPC conference and the revered Chemical Engineering World (CEW) journal along with various internal publication. His experience encompasses conducting CP surveys to managing and successfully completing international (India & ME) integrity-based programs based on NACE standards. His experience with various firms and his exposure to a varied number of pipelines ranging numerous types of terrains and soil environments has developed a high level of expertise involving cathodic protection assessment and corrosion mitigation techniques.

Praveer N. Singh – Praveer has been working as a Project Manager for Cathodic Protection as well as Direct Assessment Projects for India and Middle-East. He has co-authored technical papers for NACE CorCon as well as various internal white papers. Praveer's experience lies extensively with Middle East clients specializing in integrated surveys and successful management of the same.

A Report – NIGIS 29th Foundation Day 2021

NACE International Gateway India Section (NIGIS) has been celebrating its "Foundation Day" every year at Mumbai. Foundation Day is an important milestone for each organization, where we show our gratitude for the wisdom, courage and commitment demonstrated by those who contributed to the establishment and operations of the Section. Like last year, NIGIS celebrated its 29thFoundation day on July 17, 2021 (Saturday) from 17.30 to 18.30 hrs via its own Virtual Platform.

NIGIS celebrated Foundation Day by inviting all NACE Members, EC Members, Mr. Bob Chalker, CEO and Mr. Tim Bieri, Chairman, Board of Directors as guest of Honors and Ms. Vartika Shukla, Director-Technical, Engineers India Limited as Chief Guest at the function.

The function started traditionally by invoking the blessings of the Deity by e-lighting the Lamp on a virtual platform. Mr. Heramb Trifaley, Vice Chairman NIGIS welcomed all Invitees and in particular Mr. Tim Bieri, President NACE International and Ms. Vartika Shukla, Director- Technical, EIL.

Dr. U Kamachi Mudali, Past Chairman NIGIS, thanked NACE International members for giving him an opportunity to work for the organization as a Volunteer and he also briefed his association with the Section.

Mr. Sumeet Kataria, Secretary in his opening remark remembered Late Shri V T Purohit, Founder Chairman, NIGIS [1992 – 1994] for his invaluable contribution to the Section and corrosion industries.

He then read out the Annual report on Performance and achievements made by the section in the 2020-2021. In his report he stressed on the performance of the section in conducting 29 training programmes which were packed despite of pandemic season catering to the industry. Briefly, he also updated the members about the upcoming CORCON conference, NIGIS Awards, Training program and the commitment of NIGIS to enhance the quality and range of its services through activities in the field of Corrosion Awareness.

Mr. K B Singh, Chairman, NIGIS briefed the members about the future activities of NIGIS. He informed about the forthcoming NIGIS online training programs and NACE International certification training courses planned for 2021 – 2022. He also announced the CORCON 2021 virtual conference which is scheduled during 18 – 20 November 2021 and requested all to participate and share their knowledge & expertise in the conference.

Mr. Bob Chalker, Chief Executive Officer, AMPP in his recorded video message addressed appreciated the hard work done by the Section and it's Volunteers for preventing corrosion. He briefed about the merger of NACE and SSPC to create AMPP. He also informed AMPP developing new Standards which will be useful to industries and society as a whole.

Mr. Tim Bieri, Chairman, Board of Directors, AMPP also expressed his happiness to be a Guest of Honor on this day and appreciated the activities of NIGIS. He briefed activities of AMPP and few of the key accomplishments like installing new Board of Directors, extending dual membership benefits with no additional cost to members and focused Global participation representation and role of the AMPP staff for the success of the organization. He also thanked Ms. Vartika Shukla for her support for the section.

The Chief Guest of the Function Ms. Vartika Shukla, Director- Technical, EIL in her address stated his gratitude for having been invited and appreciated the role of NIGIS in educating the Indian Industry and to fight / combat the Corrosion issues by conducting various training programs. She also briefed about the EIL commitment and activities towards their fight for Corrosion.

Mr. N. Manohar Rao, Trustee introduced the House to the NIGIS Section Governing Board Members for 2021-22 consisting of himself as Trustee, Mr. K B Singh, Chairman NIGIS, Heramb Trifley, Vice Chairman, Mr. Sumeet Kataria, Secretary and Mr. Denzil D Costa, Treasurer. He also informed the new Executive Committee 2021 – 2022 will be formed under the leadership of the new Chairman.

He went on to introduce the NIGIS Office Team comprising of Mr. Manoj Mishra, Manager Admin, Mr. Rishikesh Mishra, Manager Technical, Ms. Amarjeet Bains, Manager, Ms. Kusuma Poojary Accounts, Ms Anita D Souza, Executive Assistance and Ms. Ankita Rane, Admin Assistant who are a strength of NIGIS for executing various activities.

The Foundation day was attended by 102 participants. The Function ended with Vote of thanks by Mr. Denzil D'Costa Treasurer, thanking all Invitees, Members, SGB, Office Team and in particular Guest of Honor Mr. Bob Chalker, Mr. Tim Bieri of NACE International and the Chief Guest Ms. Vartika Shukla, Director- Technical, EIL. He further thanked Dr. Kamachi Mudali, Past Chairman for his outstanding Services to NIGIS for a period from 2005 to 2021.

He also thanked the members and others who were present in the evening. He finally requested support from all dignitaries to help further step up the operations to take NIGIS to greater heights in terms of closely understanding and working with the Industry.

Ms. Vartika Shukla delivering her talk

Mr. Bob Chalker delivering his talk

Tim Bieri delivering his talk.

Mr. K B Singh handing over the memento to Ms. Vartika Shukla at her office.

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Corrosion Resistant High Entropy Alloys (HEAs)

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Corrosion of metals and alloys is a significant hurdle to their application in engineering and medical fields [NACE impact study]. To mitigate corrosion, extensive research is being carried out in corrosion-resistant alloy development. In this strategy, the corrosion resistance in alloys is mainly due to the formation of a protective oxide layer on the alloy surface. The nature of the oxide layer depends on the composition of the alloy and the environmental conditions to which the alloy is exposed. The conventional alloy design involves the addition of corrosion-resistant alloying elements, such as Cr, Cu, Ni, etc., which result in the formation of protective oxide or patina for corrosion resistance. However, the conventional alloy design technique can not avoid intermetallics and carbides forming local micro-galvanic cells to initiate the accelerated corrosion process.

Yeh et al. [2] in 2004 introduced the concept of high entropy alloys (HEAs). These are alloys comprised of five or more elements of equiatomic proportions [3]. The elements in the HEAs are arranged randomly, resulting in high entropy of mixing, which leads to the formation of a single-phase solid solution [4]. The homogenous micro structure of HEAs due to the absence of intermetallics and carbides makes it a potential corrosion-resistant material. Due to their excellent mechanical and wear-resistant properties, HEAs have the potential for engineering applications [5,6,7]. The corrosion behavior of HEAs has been studied and reported since the last decade [8,9]. The studies have shown that the corrosion resistance of HEA is superior to that of conventional stainless steel [8], indicating HEAs as a candidate material to replace stainless steel in corrosion-resistant applications. A comparison of the corrosion behavior of HEAs and stainless steel in chloride-containing solutions at room temperature is shown in Table 1.

In the last five years, a significant volume of research has taken place in developing HEA coatings. The HEA coatings have been fabricated by various techniques such as laser cladding, chemical vapor deposition, magnetron sputtering etc. The HEA coatings have shown excellent corrosion resistance compared to the cast alloys, owing to HEA's homogenous microstructure and the presence of protective oxides on the surface.

Alloy	Solution	$E_{Corr}(V_{SHE})$	$I_{Corr}(\mu A/cm)^2$	Reference
FeCoNiCr	3.5% NaCl	-0.46	0.035	[10]
$FeCoNiCrCu_{0.5}$	3.5% NaCl	-0.49	0.72	[10]
FeCoNiCrCu	3.5% NaCl	-0.53	1.23	[10]
$(TiAl)_{0.7}V_{0.15}Fe_{0.1}Ni_{0.05}$	3.5% NaCl	-0.38	0.037	[11]
AlTiVCrSi	3.5% NaCl	-0.49	0.168	[11]
CoCrFeNiAl0.9	3.5% NaCl	-0.24	0.1	[10]
304L	3.5% NaCl	-0.25	0.601	[10]

The results from HEAs and HEA-based coatings research are very encouraging. The HEAs can replace steel in structural applications due to their excellent mechanical and wear characteristics. In addition, the development of HEA-based coatings can do wonders for corrosion engineers. However, in-depthstudiesare required to understand the nature and compositions of the passive layer developed on the surface of the HEAs.

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Literature in Brief

Predicting the atmospheric corrosion behavior of low alloy steels using machine learning approach

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The complexity in environmental conditions and comprehensive viability in compositions of low alloy steels requires advanced data analysis techniques to understand the atmospheric corrosion of steel. The regression analysis method used to study corrosion behavior [1,2]cannot deal with multilevel data. Therefore, it requires robust data mining techniques such as the machine learning method to predict corrosion behavior. The machine learning approach has been used the corrosion rate prediction and to study the interaction between influencing factors based on the available corrosion data in marine atmospheric conditions[3]. The publicly available corrosion data sheet (CoDS) from the National Institute of Materials Science (NIMS) have been used in such studies. Sometimes multiple statistical and machine learning algorithms are used to predict the corrosion rate based on the available data for different environments. The random forest (RF) based- corrosion rate prediction model was also found to be highly accurate and optimized for multiple steels samples in different environments.

The open-source framework for machine learning used in corrosion rate prediction is Python software, scikit-learn toolkit etc. The basic approach for the prediction of corrosion rate using machine learning follows a scheme shown in Figure 1.

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Figure 1: Schematic of the process flow for the prediction of corrosion rate using machine learning approach.

Pitting Corrosion on Stainless Steel Dish Plates

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Problem: Kitchen utensils, mainly dinner ware, are made of Stainless steel (SS) material due to high resistance for oxidation and corrosion. However, the occurrence of localized rusting called pitting on stainless steel dish plates can be observed. Reasons for the same have been investigated and explained in this presentation by showing a real-life examples that I experienced at my institute, with all the pieces of evidence that I collected.

Background: Ours' (RGUKT-RKV) is a fully residential institute and has eight mess halls. Each mess hall serves food for nearly 750 students, and the mess itself maintains dinnerware for the students. The used plates are cleaned on parts of the day, i.e., morning plates are cleaned in the afternoon, afternoon plates are cleaned in the evening, evening plates are cleaned on the following day. To facilitate easy cleaning, the unwashed dishes are preferred for soaking in water for a long duration (about 9-10hrs). The soaked plates are then cleaned by using steel scrubbers. The repetition of the same process of cleaning of used plates results in the formation of black dots at localized regions and leads to final damage.

Investigation: My investigation began with the observation of a locally damaged region under the microscope. The surface of the plate showed many scratches. Further, observation of black dots(that are formed over the surface) at higher magnification showed cavities with cracks. It clearly confirms the occurrence of pitting corrosion, an intensive localized type of corrosion that results in the pits and cavities on the metal surface. The characteristic of Stainless-steel material is the formation of a protective passivation layer over the surface, which inhibits the material degradation. The surface cleaning of plates using a steel scrubber leads to mechanical damage(scratches) of the protective layer and hence acts as an anodic site (a site that is ready to react with the environment). The scratched plates are stacked one over the other and soaked in water during the next cleaning. The presence of food particles over the plate surface makes water full acidic. The pH value of the solution was found to be 5.5(acidic in nature).

Further, no aeration of water during soaking results in stagnant electrolyte over anodic sites (scratched portion). This is a favorable condition for pitting. The protective layer over the surface is regenerative in nature, which means it forms immediately after the breakage, but the presence of chloride ions (from salt, pickles) in the water won't allow it to proceed. As a result, continuous metal dissolution occurs from this localized region resulting in the formation of pits and cavities over the plate.

Effects and Remedies: Underestimation of this attack may result in the complete degradation of the material. Repeated use of these pitted plates for serving food may cause health issues. Moreover, pitting is autocatalytic in nature, and once it gets initiated, it cannot be controlled. So, prevention is the only way to get rid of this kind of problem. The problems of pitting in the present situation can be controlled by avoiding the long exposure of stainless-steel dish plates to stagnant water environments i.e., by maintaining time to time cleaning. The use of automatic dishwashers can help frequent cleaning. Further, the use of sponge scrubbers instead of steel scrubbers has to be appreciated.

A Report
PINCON Conference

On February 5th and 6th, NACE International India Section – North Zone organized PINCON 2021, India's 1st Annual Virtual Pipeline Integrity Conference and Expo which was supported by FIPI - "Federation of Indian Petroleum Industry"

"PINCON" or Pipeline Integrity Conference is NACE India's 1st conference and exhibition, and is dedicated to bring significant awareness to the important subject of Corrosion in Pipeline Integrity Management.

This year's PINCON theme and title was–

"POST COVID "आत्मनिर्भरता" IN PIPELINE INTEGRITY FOR A SUSTAINABLE FUTURE

With the Covid-19 pandemic, the world faced even more challenges in maintenance of ageing pipelines due to unexpected lockdowns, loss of employment, shutdowns, economic losses and increasing health hazards which indirectly increased the cost of corrosion.

Hence, NACE India- North zone conceived the idea of uniting the Corrosion Community through a conference which attracted participants from academic and research institutions, public and private sector organizations including defense establishments and professionals to unite in the fight against Corrosion to develop an "आत्मनिर्भरभारत" or "Self-Reliant India".

Dr. Saumitra Shankar Gupta, Executive Director (Maintenance & Inspection), Indian Oil Corporation Limited (IOCL) was the Conference Chairman and Shri Anil Meghani, General Manager (Maintenance & Inspection), IOCL was the Technical Chairman. A special invite address was posted on the website – www.nacenzpic.org

Special video addresses were received from NACE India President North Zone – Lt Col Atul K. Joshi, GM (Const), IOCL and NACE North Zone Secretary- Smt. Nivedita Bhattacharya, DGM, Engineers India Limited.

Shri Pramod Narang from Director Pipelines, Petronet LNG (PLL) was the "Guest of Honor" and Shri Satpal Garg from PNGRB (Petroleum & Natural Gas Regulatory Board) was the "Chief Guest".

PINCON 's Technical Symposia comprised of 6 topics and had a total of 19 Eminent speakers from various sectors :

Symposia 1- Cathodic Protection of Buried Assets
Symposia 2- Coatings
Symposia 3- Inline Inspection
Symposia 4- Marine Corrosion
Symposia 5- Corrosion Monitoring and Mitigation in CGD (City Cas Distribution)
Symposia 6- Economics Of Corrosion – Secure Metal , Ensure Capital

Each of the technical speakers contributed the very best of knowledge and experience which was appreciated by all.

PINCON also had a Special Panel discussion on **"Corrosion Education in India"** which was convened by the Conference Chairman. The eminent panelists where

- Mr. N Bose Babu from GITL,
- Mr. Alfred Kuhn from Linscan ,
- Mr. Pramod Narang from Petronet LNG
- Mr. Narendra Kumar from Torrent Gas.

To take the Corrosion Education and Corrosion Awareness initiatives of NACE International a step further, the NIGIS - North Zone conceptualized an idea to create short Corrosion stories and videos which would be divided into three different categories and would appeal to a wide variety of audience:-

- School Students,
- Collegiate and Engineering Professionals

Three Corrosion Vodcasts were inaugurated and launched at PINCON 2021.The idea is to create interesting yet useful and informative short videos with real-life examples of corrosion which will educate students about choosing Corrosion as a fulfilling profession.

A team of young corrosion engineers have been selected from the NIGIS North Zone Executive Committee to create these short animated videos with guidance from the senior Corrosion experts in the team. Corrosion Vodcasts can be accessed at Nace India North Zone you tube channel.

The PINCON's 3D Expo was a visual delight. The platform was unique as it was on a 3D platform which was never used earlier. Xporium was the provider of the unique platform which was a complete India developed graphics support. This also supported our or Self-Reliant India"."Vision as per the theme of PINCON 2021.

LINSCAN was the main sponsor of the conference who also provided the Student sponsorship support.

Petronet LNG also provided a special sponsorship

There were a total of 8 Gold plus sponsors, 14 Gold Sponsors, 10 Exhibitors

PINCON had achieved record number of visitors in the Expo:

PINCON LOBBY AREA:		2746 numbers
SPONSOR'S ZONE	:	1888 numbers
EXHIBITOR'S ZONE	:	641 numbers

There were a total of 571 plus delegates with 114 students.

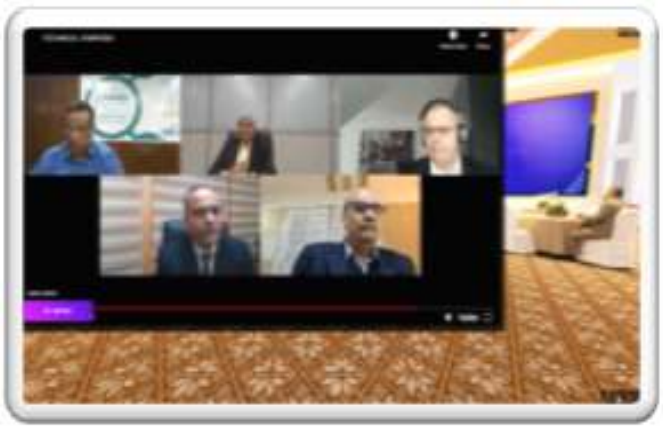
The complete event was handled by the NACE North Zone team. Right from Emceeing, to the backend support , the team co-operated and provided their best efforts.

Overall PINCON was a fantastic event and was appreciated by all. A PINCON Networking Dinner was organized on 27th February , 2021 to felicitate the Sponsors, Exhibitors, Technical speakers and all the supporters and mentors.

The Networking Dinner was organized at : Vivanta by Taj – Dwarka, New Delhi. Mr. Denzil D'costa , NACE International Gateway India Section , Mumbai, Treasurer graciously joined for the event.

The conference chairman provided insights, facts and figures of the Virtual conference. The technical conference chairman formally welcomed all the guests.

The President NZ provided a complete Annual plan for the upcoming activities of the NACE North Zone and insisted on joining the energetic team. He also tentatively announced the dates for the next PINCON 2022 which will be organized at New Delhi. The felicitation event was organized in due accordance with the safety measures of face masks, Sanitisers and social distancing. The Conference magazine E-Souvenir was also published on 1st March 2021.



PINCON 3D Special panel discussion

PINCON 2021 Networking dinner

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Wet H2S Cracking of Floating Head Bolts in Sour Service in Shell & tube Heat Exchangers and its Prevention

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Abstract:

Shell & Tube heat exchangers with floating head assembly are widely used in Refinery and Petrochemical Industries Process units. Failure of Floating head cover bolts due to Sour fluid at Shell side had occurred in a few of the refining process units, including Diesel hydro treater, Crude distillation unit, Propane De-Asphalting unit. The usage of high hardness bolts grade (ASTM A193 Gr B7) was identified to be the cause of failures due to the presence of H2S in the fluid. This paper emphasized the importance of using ASTM A193 Gr B7M bolts in floating head cover to avoid wet H2S cracking in Sour environment. This paper also highlighted the key differences between ASTM A193 Gr B7 & Gr B7M materials and provided recommended practices to avoid failure of floating head bolts in S&T heat exchangers used for processing sour service fluids.

Introduction:

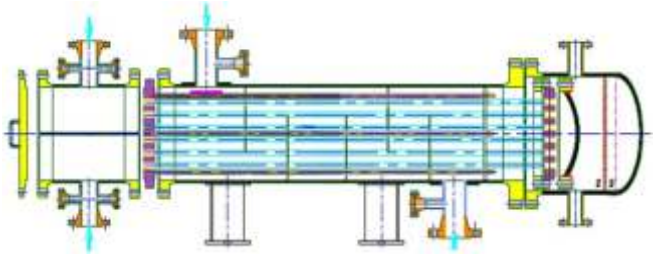

Figure 1: Typical Floating Head Heat Exchanger

In addition to various other configurations of Shell and Tube Heat Exchangers (Fixed & U-Tube), Floating Head type (Figure-1) is the most widely used type heat exchanger for heating & cooling in the refinery process units. Floating head exchangers are configured very sophistically to accommodate the Thermal expansion / Contraction caused by the difference in temperature of Shell side &Tube side fluids. One side of the Tube sheet is fixed between Girth Flanges and the other side is fixed between Floating head assembly as shown in (Figure-2). This assembly allows free movement of fluids caused due to Thermal Expansion, hence the name Floating head Heat Exchangers.

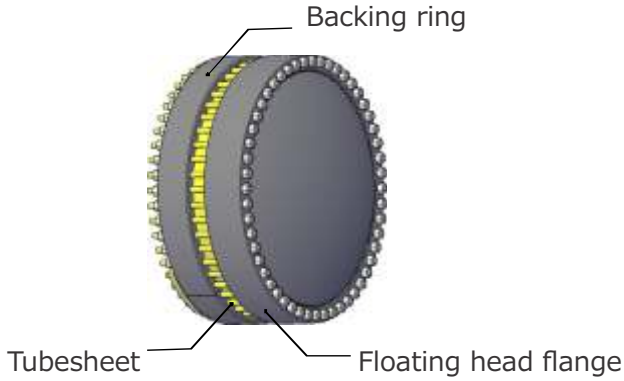

Figure 2: Floating head assembly

Typical Floating head Shell and Tube Heat Exchanger can be designed as per ASME Codes & TEMA Standards. The material of construction of shell and tube side components, including stud and bolt, can be selected based on various process parameters such as pressure, temperature, material properties, corrosion allowance, stream composition etc.

Often ASTM A193 Gr B7 bolts and ASTM A194 Gr 2H nuts are used in carbon steel shell and tube side components. In order to avoid bolt failures in wet H2S environment, ASTM A193 Gr B7M bolts and ASTM A194 Gr 2HM nuts are used in floating head flange, especially for sour services. The penetration of atomic hydrogen into the susceptible material could cause wet H2S damage. Further, the stream parameters such as pH H2S concentration & its partial pressure, temperature, toxic contaminant like cyanide in the stream could cause potential damage to the fasteners. Also, metallurgical properties such as strength, hardness, and susceptible micro structure, steel cleanliness (inclusion and laminations) accompanied with residual and /or applied stress are the critical factors, which can contribute to the failure in wet H2S environment [1]. In AES shell/tube heat exchanger, floating head bolts are in contact with the shell side stream(Figure-3). As mentioned above, the unfavorable environmental condition would crack the high strength bolts leading to cross contamination of shell and tube streams which also results in equipment outrage. Atmospheric distillation column overhead condenser in crude distillation unit, stripper overhead condensers in hydro treater and hydro cracker, main column

overhead condenser in fluid catalytic conversion unit are some of the exchangers designed with ASTM A193 Gr B7M bolts on floating head due to sour environment in its shell side. ASTM A193 Gr B7 bolts are used for floating head where H2S is not anticipated in the shell side stream.

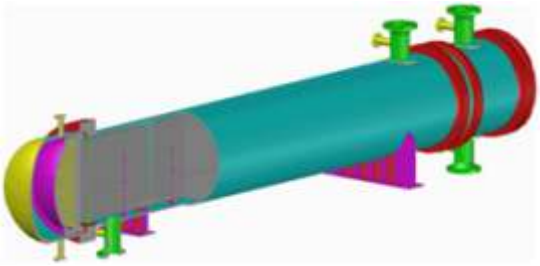

Figure 3: AES Heat exchanger

Case Studies:

The following are the case studies in refineries on the failure of ASTM A193 Gr B7 floating head bolts in the past three years

Case 1 : Stabilizer Overhead Condenser Bolt failure in Diesel Hydro Treating(DHDT) Unit

DHDT unit stabilizer column overhead condensers are stacked AES type exchangers. The leak was suspected in floating head cover flange and hence, shell cover was dropped. Water filling was carried out in tube side pressurized. The leak was noticed (as shown in the figure-4) from the floating head flange due to the shearing of B7 bolts (4nos). Mix up of two grades was evidenced. ASTM A193 Gr B7 bolts were found in place of ASTM A193 Gr B7M bolts and hence, all Gr B7 bolts were replaced with Gr B7M bolts. Also, the gasket was replaced and tube and shell side hydro test was carried out and taken into service.

Case 2 : Stabilizer Overhead Condenser Bolt Failure in Crude Distillation Unit

During plant operation, traces of hydro carbon (shell side fluid-LPG) were observed in cooling water (tube side fluid). On opening the shell cover, one ASTM A193 Gr B7 bolt was found cracked which paved the way for LPG to cross contaminate with cooling water. The hardness of the failed bolt was measured to be 300 BHN (maximum). ASTM A193 Gr B7 bolts were replaced with ASTM A193 Gr B7M and gasket was also replaced and hydro tested and equipment was taken online.

Case 3 : Propane Condenser Bolt Failure in Propane deasphalting (PDA) Unit

Propane DeAsphalting (PDA) unit has propane condensers to condense propane vapor in De Asphalted oil recovery section. Considering absence of H2S content in propane, AESS & T condensers were designed with ASTM A193 Gr B7 floating head bolts as mentioned in Bill of Materials (BOM) of exchanger general arrangement drawing. Yet, floating head bolts were sheared in-service. It was analyzed and found that H2S slip page into shell side stream had caused the brittle failure of high hardness bolts (As shown in figure-5a & b) All Gr B7 bolts were replaced with Gr B7M with new gasket, and equipment was hydro-tested and taken into service.

Figure 5 : Floating head bolts with brittle mode of failure

ASTM A193 Gr B7 VS ASTM A193 Gr B7M [2] :

Chemical composition, Mechanical Properties and Heat treatment are compared in the following tables:

Grade	ASTM A193 Gr B7	ASTM A193 Gr B7M
wt %		
C	0.37 min - 0.49 max	0.28 min - 0.49 max
Mn	0.65-1.1	0.65-1.1
P	0.035	0.035
S	0.04	0.04
Si	0.15-0.35	0.15-0.35
Cr	0.75-1.2	0.75-1.2
Mo	0.15-0.25	0.15-0.25

Table 1: Comparison of ASTM A193 Gr B7 and B7M chemistry

Properties	Size: M64 and below		Size: Above M64 to M100	
	Gr B7	Gr B7M	Gr B7	Gr B7M
Tensile strength, min, Mpa	860	690	795	690
Yield strength, min, Mpa	720	550	655	550
Elongation in 4D, min, %	16	18	16	18
Reduction in Area, min, %	50	50	50	50
Hardness (HB)	321 max	235 max	321 max	235 max

Table 2: Comparison of Mechanical properties between ASTM A193 Gr B7 and B7M with respect to bolt size

Grade	ASTM A193 Gr B7	ASTM A193 Gr B7M
Minimum Tempering temperature (°C)	593	620

Table 3: Comparison of Heat treatment between ASTM A193 Gr B7 and B7M

The differences are highlighted & discussed as follows:

- Carbon content in Gr B7M can be as low as 0.28 wt% to achieve desired low hardness where as in Gr B7,minimum carbon content shall be 0.37 wt%.
- Maximum hardness permitted for Gr B7 is 321 HB, where as it is restricted to maximum of 235 HB for Gr B7M
- Irrespective of bolt size, Gr B7M can have minimum tensile strength 690 Mpa. However, Gr B7 minimum tensile strength shall be 860 Mpa for size M64 and below and 795 Mpa for size above M64 to M100.Most of the floating head bolt size in AES type exchanger is less than M64. Hence, B7M minimum UTS is 690 where as Gr B7 minimum UTS is 860 Mpa.
- In quenching and tempering heat treatment operation, tempering temperature for Gr B7M is 27'C higher than the minimum tempering temperature of Gr B7. The desired low hardness value in Gr B7M is achieved by higher tempering temperature.
- Also, for B7M, tempering heat treatment shall be final activity. All kind of Machining and forming activities shall be completed strictly prior to heat treatment operation as laid down by ASME procedure

Recommended Practices:

- The following are there commended practices in Refinery Process units to avoid Wet H2S Cracking of Floating Head Flange Bolts of S & T Heat Exchanger in Sour service.
- To avoid mix up of Gr B7 and Gr B7M materials during routine maintenance of heat exchangers, separate lot for Gr B7M bolts shall be maintained in warehouse for floating head flanges and workmen shall be informed about the importance of using Gr B7M in floating head cover flange.
- Usage of ASTM A193 Gr B7M bolts as per drawing shall been ensured by 100% visual inspection during tube hydro-testing of AES type heat exchanger.
- Considering the possibility of H2S slip onward page into Shell side stream, it is wise to consider the usage of ASTM A193 Gr B7M bolts for all floating head in hydrocarbon service AES type exchangers even though ASTM A193 Gr B7 bolts are mentioned.
- During procurement of ASTM A193 Gr B7M bolts, Quality Assurance Plan shall insist upon Stage wise inspection of Hardness testing, Tensile testing, product marking etc and witness by Third party inspector in addition to in house quality control team. It shall also been ensured that no machining and forming operation including cutting, thread rolling are carried out after heat treatment operation for Gr B7M.
- 100% Hardness testing for Gr B7M is supplementary requirement as per ASTM A193 standard specification. Considering the criticality, 100% hardness testing by Indentation method shall be made mandatory in the stage of procurement.The same shall be distinguished by bolt manufacturer in product marking by having a line under the grade symbol as B7M as mentioned in ASTM A193 standard.

REFERENCES:

1. API RP 571 – Damage Mechanisms Affecting Fixed Equipment in the Refining Industry.
2. ASTM A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.

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A Report - Metallurgy and Materials Technology for Corrosion Mitigation

NACE International Gateway India Section (NIGIS) had organized an online Educational & Training Programme on Metallurgy and Materials Technology for Corrosion Mitigation during 19 - 20 February 2021. Mr. N Manohar Rao, Trustee, NIGIS inaugurated the course and briefed the activities of the NIGIS and the benefits of attending the newly developed program.

Prof V S Raja, Programme Coordinator stated that the programme specifically tailored is unique in nature as it addresses the diverse engineering properties of materials along with the corrosion. The experts will bring out elegantly these aspects to engineers who do not have a formal exposure to both corrosion and metallurgy.

Industries suffer hugely on account of loss in productivity, safety, environment and the nation's non-renewable resources, caused by ubiquitous corrosion failures. Material selection for engineering applications is a complex task, as the industrial processes demand that these metals primarily meet various other properties such as mechanical and thermal.

The program mainly discusses Corrosion: forms and preventions, Properties and application of non-metallic materials: polymers, ceramics, graphite and glasses, Properties and application of ferrous metals: cast iron, steels and stainless steels, Properties and application of non-ferrous metals: alloys based on copper, titanium, nickel, tantalum and aluminium, Heat treatment and surface engineering of alloys: as applicable to industrial components and corrosion control, Corrosion issues and remedies in welding and fabrication on corrosion issues, Materials testing and evaluation: mechanical properties. microstructure and chemical composition and Materials selection criteria in relation to industrial environments and life cycle cost and case studies.

The faculty included academic experts from IIT Bombay vis-a-vis Prof V S Raja, Prof. N. Prabhu and Prof. S. Parida. Mr. Rishikesh Mishra, NIGIS was the coordinator for the program.

Fifty one professional Engineers from various industries such as, Boeing India Pvt. Ltd., Boekhoff Technocrates, Chennai Petroleum Corporation Limited, Cormit Elect Projects Private Limited, Engineers India Limited, GE Power India Limited, Harita-NTI Ltd., Hindustan Petroleum Corp Ltd, Indian Oil Corporation Ltd, Mangalore Refinery and Petrochemicals Ltd., MCPI Private Limited, Nayara Energy Limited, NITK, Surathkal, Numaligarh Refinery Limited, Owens Corning India Pvt Ltd, Rashtriya Chemicals and Fertilizers Ltd., Rothe Erde India Pvt. Ltd, Struct Care Projects, Suzlon Energy Limited and Wearresist Technologies Pvt. Ltd. Participants were from countries like Bangladesh, UAE, Saudi Arabia apart from India who attend the program. The training program had stupendous success and received high appreciation from participants.

Mr. Sumeet Kataria, Secretary, NIGIS attended the valedictory session and conducted the open forum of the session. He proposed vote of thanks to the speakers, NIGIS staff and as well as the participants.

Participants of Metallurgy and Materials Technology for Corrosion Mitigation

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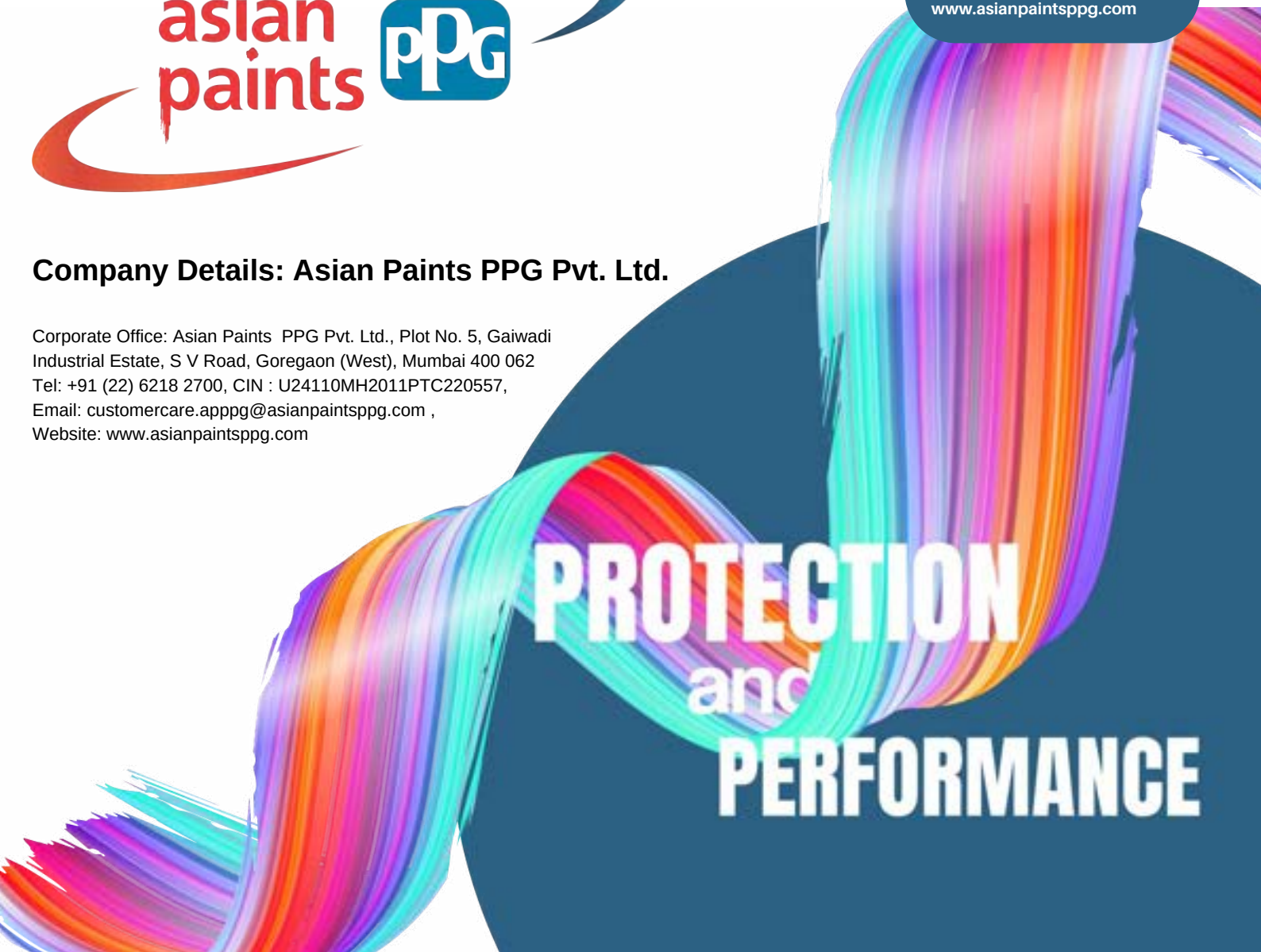

A Report- Refinery Corrosion – Challenges and Remedies

NACE International Gateway India Section (NIGIS) had organized online Educational Training Programme on "Refinery Corrosion – Challenges and Remedies" during 5 and 6 March 2021. Mr. N Manohar Rao, Trustee, NIGIS inaugurated the programme and briefed on the AMPP and the activities of the NIGIS and welcomed the Speakers and all the participants across the globe. The programme was inaugurated virtually.

Corrosion in Refining industry is a big challenge which requires an integrated corrosion management enabling protection of refinery assets and opportunity to process different kind of crude oil for better economics. The corrosion problems in refineries are mainly due to various corrosive components present in crude oil, distillation and cracking processes involved in production of various hydrocarbon streams, environmental issues and chemicals used in refinery processes. Starting from the choice of appropriate metallurgy and then process related corrosion mitigation strategies help refiners to combat corrosion processes.

The program covered corrosion issues and their mitigation methodologies for various refinery units along with some case studies, which provided a deep insight about the subject. The topics which were covered by the professional experts were:

1. Choice of Materials for Refinery Configuration by Prof V S Raja, IIT Bombay
2. Steam Boilers–Corrosion and Mitigation by Anand Avadhani,Wex Technologies Pvt. Ltd
3. Corrosion & Mitigation in Cooling Water Networks by S M Mahadik, Vasu Chemicals
4. High TAN Corrosion-Challenges of processing opportunity Crude Oil by Dr. Jaya Rawat, BPCL.
5. Corrosion issues in Crude Distillation Unit – Case Studies by Ankur Verma, BPCL.
6. Corrosion issues in Hydro Processing Units – Case Studies by Dr. Chaitanya Kumar, BPCL.
7. Corrosion in Amine Units – Case Studies and Remedies by Amish Jani, Reliance Industries Limited

Thirty six Professional Engineers from various industries such as Boekhoff Technocrates, Bharat Petroleum Corporation Limited, Chennai Petroleum Corporation Limited, Hindustan Petroleum Corp Ltd, Dorf Ketal India Pvt. Ltd, Indian Oil Corporation Ltd., MCPI Private Limited, Crest Ultrasonics India Pvt. Ltd., Heavy Water Board, Tamilnadu Petro Products Limited, Kuwait National Petroleum Company, etc. participated. Mr. Rishikesh Mishra, Manager, Technical Services, NIGIS was the coordinator for the programmes.

Mr. N Manohar Rao, Trustee, NIGIS chaired the closing session and conducted the open forum of the sessions. It was summarised that it is an excellent platform provided by NIGIS for every interactive sessions on the different types of Oil Refineries and Petrochemical Complex problems faced in the industry. The closing of the training programme ended with thanks to all participants, speakers and the organisers and a group photograph taken.

Participants during virtual training Program Refinery Corrosion – Challenges and Remedies

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A Report - Coating Failure Assessment (Extending Life of Coating System)

NACE International Gateway India Section (NIGIS) organized an on-line educational training program on "Coating Failure Assessment (Extending Life of Coating System)" during 19th – 20th March 2021. Fifty Nine (59) professionals from industries attended this course. NIGIS created a pool of corrosion professionals, who would be able to fight against corrosion in their respective specialised segments.

The program started with a welcome to dignitaries & participants by Mr. Manoj Mishra, Manager Admin-NIGIS.

Mr. N Manohar Rao, Trustee-NIGIS inaugurated the program and briefed about NIGIS, annual events and training programs.

Mr. Heramb Trifaley, Vice-Chairman-NIGIS and Program coordinator briefed about the training program and also introduced the faculty members Mr. Maheshkumar Aradhye, Associate VP (R&D), Grauer & Weil (India) Ltd, Mr. Denzil Dcosta, National Sales Manager, Graco India Ltd, Dr. Buddhadeb Duari, Director, Lalita Infraprojects Pvt Ltd, and Mr. K V Badrinarayan, Technical Manager, Akzo Nobel India Ltd.

The participants gained both theoretical and practical aspects through the talks on how to prevent and control corrosion. The following topics were covered in the training program:

1. Introduction of Corrosion and Prevention Techniques
2. Factors for Designing a Coating System
3. Coating Application
4. Coating Defects
5. Coating Failure Analysis – Site Testing & Non-liquid Coatings
6. Coating Failure Analysis – Pipeline Coatings
7. Lab Analysis of Coatings & Failure Case Studies

Each lecture was followed by an interactive session of questions and answers.

We received excellent feedback from multiple participants on the way each of the lectures were organized and delivered. The program provided an excellent platform for interaction on matters concerning corrosion problems and solutions.

Mr. Heramb Trifaley, Vice-Chairman, NIGIS chaired the closing session. He lauded the efforts by SGB & EC members, participants and NIGIS staff, especially Mr. Manoj Mishra & Mr. Rishikesh Mishra. Mr. Heramb also informed that NACE International and SSPC have united to serve the world to control and prevent corrosion and is now known as "Association for Materials Protection and Performance" (AMPP).

A Report - Pipeline Internal & External Corrosion in Oil and Gas Industry

NACE International Gateway India Section (NIGIS) organized an on-line educational training program on "Pipeline Internal & External Corrosion in Oil and Gas Industry" during 29th – 30th April 2021. Fifty Four (54) professionals from industries attended this course. NIGIS created a pool of corrosion professionals, who would be able to fight against corrosion in their respective specialised segments.

The program started with a welcome to dignitaries & participants by Mr. Manoj Mishra, Manager Admin-NIGIS.

Mr. N Manohar Rao, Trustee-NIGIS inaugurated the program and briefed about NACE International, AMPP and activities of Gateway India Section. He announced the dates of NACE certification courses on CP-3, CP-4, DA and Corrosion Control in Refinery Industry conducting by NACE India Section. Mr. Rao also informed the dates of the future educational training programs.

Dr. Anil Bhardwaj, Program coordinator briefed about the online training program and introduced the faculty.

The faculty members for this program were Dr. Anil Bhardwaj, Former-Group GM, Head Materials & Corrosion Group, IEOT, ONGC, Dr. S K Srivastava, Former-DGM, Materials & Corrosion Group, IEOT, ONGC, Mr. Pankaj Panchal, Director, Corrosion Protection Specialist Pvt Ltd, Mr. Ashish Khera, Director-Allied Engineers and Mr. Bipin Kumar, GM (Mech.) Materials & Corrosion Group, IEOT, ONGC.

The participants gained both theoretical and practical aspects through the talks on how to prevent and control corrosion. The following topics were covered in the training program:

1. Electrochemical & Microbial Corrosion in Pipelines
2. Causes and Mechanism of Pipeline Internal Corrosion
3. Pipeline Internal Corrosion Monitoring and inspection
4. Pipeline Internal Corrosion Control
5. Pipeline External Corrosion Control by Cathodic Protection
6. Pipeline External Corrosion Control by Coating Health Assessment
7. Direct Assessment of Corrosion for Pipeline Integrity Management
8. Pipeline Failure Case Studies

Each lecture was followed by an interactive session of questions and answers.

We received excellent feedback from multiple participants on the way each of the lectures were organized and delivered. The program provided an excellent platform for interaction on matters concerning corrosion problems and solutions.

Mr. N Manohar Rao, Trustee-NIGIS chaired the closing session. He lauded the efforts by SGB & EC members, Faculty members, participants and NIGIS staff, especially Mr. Manoj Mishra & Mr. Rishikesh Mishra.

Participants during virtual program of Pipeline Internal & External Corrosion in Oil and Gas Industry

A Report- Cathodic Protection – AC/DC Interference and Mitigation

NACE International Gateway India Section (NIGIS) had organized online Educational Training Programme on Cathodic Protection – AC/DC Interference and Mitigation during 21 – 22 May 2021. As we could not able to accommodate large number of participants, we repeated the same program during 24 – 25 May 2021.

Mr. N Manohar Rao, Trustee, NIGIS inaugurated these programmes and briefed the activities of the NIGIS and he inaugurated the programme virtually. Mr. Pankaj Panchal, Program Coordinator welcomed all the participants and explained the importance of Cathodic Protection – AC/DC Interference in Pipeline industries.

The Oil and Gas Demand is increasing by the day and to cater that we have so many underground pipelines in the country / global level it was found essential to train the engineers on the interference. The power demand is also increasing, so power companies are installing new AC/DC powerlines. Mitigation of AC/DC interference is challenging due to common pipeline and powerline corridor.

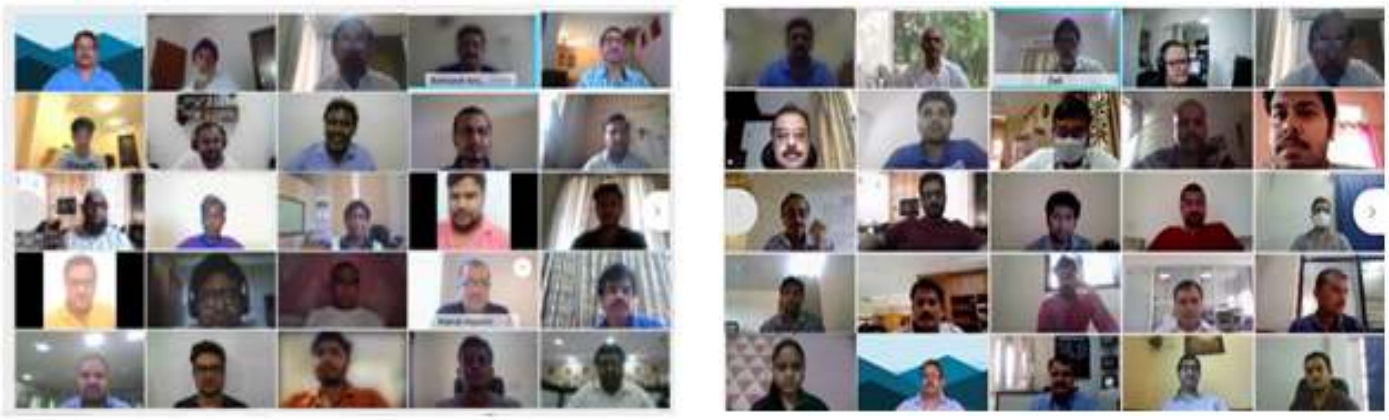
The learning Objectives for the program were to understand DC Stray Current, DC Traction, Existing Pipelines CP systems, Telluric Current and DC powerlines, Mitigation of DC Interference, to understand AC Interference due to AC powerline & traction for human safety for people working on pipeline & AC Corrosion due to induction effects, AC Corrosion Modelling, assumptions, Results and Mitigation of AC Interference, SSD and Grounding Systems.

The faculty included professional experts and the topics which were covered:

1. AC Interference - Mr. Prashanth BG, Jef Techno Solutions Pvt. Ltd.
2. AC Interference - Mr. Craig Botha, Reignite, South Africa
3. DC Interference - Mr. Pankaj Panchal, Corrosion Protection Specialist Pvt Ltd
4. Interference and Coatings - Mr. K B Singh, K B Associates

One Hundred three Professional Engineers attended in the two programmes were from various industries such as Adnoc Onshore, Assam Gas Company Ltd, Bharat Petroleum Corporation Limited, BORL, BPCL-Kochi Refinery, CMP Europe, Corrosion Cures Pvt. Ltd., Corrosion Protection Specialist Pvt. Ltd, Corrosion Technology Services India Pvt Ltd, Corrtech International Pvt. Ltd, DNP Ltd, Gail India Ltd, HPCL, HPCL-Mittal Pipelines Limited, Indian Oil Corporation Ltd, Indradhanush Gas Grid Limited, K.B Singh & Associates, Larsen & Toubro Limited, Mangalore Refinery And Petrochemicals Ltd., MEECC, Oil India Limited, Pipeline Infrastructure Limited etc. participated. Apart from India participants attended from across the globe such as UAE, Qatar, Saudi Arabia, USA, Italy, Canada, Muscat, Abu Dhabi, Kuwait etc. Mr. Rishikesh Mishra, Manager Technical Services, NIGIS was the coordinator for these programmes.

Mr. N Manohar Rao, Trustee, NIGIS chaired the closing sessions and conducted the open forum of the session. It was summarised that it is an excellent platform provided by NIGIS for a very interactive sessions on the different types of corrosion problems faced in pipeline industry. The training programme had stupendous success and received high appreciation from participants. The closing of the training programme ended with thanks to all participants and speakers and the organisations for nominating the participants. The programme closed virtually with Curtain closed animatedly.



Participants during CP – AC/DC Interference and Mitigation programmes

Report :Corrosion Awareness Video Competition (CAV)- 2021

The NACE International Gateway India Section (NIGIS) - South Zone organized National Level Short-Video Competition "Corrosion Awareness-2021" to create awareness on corrosion phenomenon occurring in day today life. The participation of student/group of students pursuing a Graduate or Postgraduate degree from any Indian university was welcomed by releasing the brochure on 26th March 2021. The announcement was circulated by NIGIS Mumbai and NIGIS South Zone and NIGS SZ Student section through email and social media. We received 82 registrations and 17 student teams uploaded their videos from different colleges across India. A committee was constituted. An evaluation criteria was evolved and members reviewed independently. The CAV-2021 evaluation committee meeting was held on 13th June 2021 at 10 hrs through online Google meet mode.

The following members attended the meeting.

1. Dr. R. Venkatesan
   Immediate Past President,
   Nace India South Zone
2. Dr. Rani. P. George
   President & Faculty Advisor,
   Nace India South Section
3. Dr. S. Rangarajan
   Convener, CAV-2021 evaluation Committee
4. Prof. Haji Sheik Mohammed
   Member, CAV-2021 evaluvation committee
5. Dr. Venkatesh Kumar
   Member, CAV-2021 evaluation committee
6. Dr. S.C. Vanithakumari
   Member, CAV- evaluation Committee

Invitees:

1 Ms. Madhura B
President, NACE SZ student section

2 Mr. Naveen Krishnan
Secretary, NACE SZ Student Section

The committee after detailed deliberations finally ranked them The committee recommended to provide certificates for Winners and participants to encourage them and cash prizes as announced. The names of the winners and their affiliations are given below:

Rank 1.

Topic title General Corrosion

Student Name 1. Maniteja Gurenka

Institute Details Sathybama Institute of Science and Technology, Chennai

Rank 2.

Topic title Atmospheric Corrosion of Steel Railways Structures and its Prevention

Student Name
1. Nalla Madhuri
2. D. Chanukya
3. G. S. Sreevatsan
4. Sujith M

Institute Details Department of Mechanical Engineering, Amrita School of Engineering / Amrita Viswa Vidyapeetham Chennai.

Rank 3.

Topic title Hot Corrosion in Marine gas turbine engine

Student Name
1. Shriram Kulkarni
2. Swatata Banerjee

Institute Details S.R.M College of Engineering, KTR, Chennai .

Rank 4.

Topic title Corrosion in Oil Marine gas turbine engine

Student Name
1. S. Srivatsav
2. Yadu Udayan
3. Ashvita Aj
4. Boddu Anurag Krishna

Institute Details Amrita School of Engineering Amrita Viswa Vidyapeetham Chennai.

After finalizing the winners of CAV-2021, event participation and winners certificate and also the mode of claiming cash prize for the awardees from NACE International Gateway India Section office, Mumbai was discussed.

Dr Rani President NIGIS SZ thanked the efforts of several NIGIS SZ members including Dr. R. Venkatesan and Mr. Rishikesh Mishra, NACE International Gateway India Section for giving wide publicity to CAV – 2021 brochure. The assessment of videos is carried out confidentially and scores are allotted on the basis of video making criteria. In this regard we have to appreciate NIGIS SZ Student section to get involved voluntarily Ms Madhura and Mr Naveen are thanked for their efforts in completing this event successfully.

A Report - Corrosion Protection by Protective Coating & Cathodic Protection System

NACE International Gateway India Section (NIGIS) organized an on-line educational training program on "Corrosion Protection by Protective Coating & Cathodic Protection System" during 28th – 29th May 2021. Sixty (60) professionals from India & Overseas attended this program. NIGIS created a pool of corrosion professionals, who would be able to fight against corrosion in their respective specialised segments.

The program started with a welcome to dignitaries & participants by Mr. Manoj Mishra, Manager Admin-NIGIS. Mr. Heramb Trifaley, Vice-Chairman-NIGIS briefed about this technical program and introduced the faculty members.

Mr. N Manohar Rao, Trustee-NIGIS inaugurated the program and welcomed all the participants & faculty members. He briefed about NACE International, AMPP and activities of Gateway India Section. He announced the dates of NACE certification courses and future educational training programs.

The faculty members for this program were Dr. Anil Bhardwaj, Former-Group GM, Head Materials & Corrosion Group, IEOT, ONGC, Mr. K V Badrinarayan, Technical Manager, Akzo Nobel India Ltd, Mr. Heramb Trifaley, MD, AGEP India Pvt. Ltd, Mr. Maheshkumar Aradhye, Associate VP (R&D), Grauer & Weil (India) Ltd, Mr. Sandeep Vyas, Sr. GM, (Head CP Systems & QMS for EPC Pipelines), Reliance Industries Ltd, Mr. Kaushik Duari, Lalita Infraprojects Pvt Ltd, Mr. H Rashid, Director, Himoya Corrosion Technology Pvt Ltd and Mr. Pankaj Panchal, Director, Corrosion Protection Specialist Pvt Ltd.

The participants gained both theoretical and practical aspects through the talks on how to prevent and control corrosion. The following topics were covered in the training program:

1. Fundamentals of Corrosion & Corrosion Management
2. Corrosion Protection by Surface Preparation & Coating Application
3. Specification & Standards Recommendation & Responsibilities for Corrosion Protection
4. Selection of Coatings for Corrosion Protection
5. Fundamentals of Cathodic Protection System
6. Design Aspects of Cathodic Protection Systems
7. Cathodic Protection Field Measurement Techniques
8. Interference in Cathodic Protection Systems

We received excellent feedback from multiple participants on the way each of the lectures were organized and delivered. The program provided an excellent platform for interaction on matters concerning corrosion problems and solutions. Each lecture was followed by an interactive session of questions and answers.

Mr. N Manohar Rao, Trustee-NIGIS chaired the closing session. He lauded the efforts by Dr. B Duari, coordinator-training program, Faculty members, participants and NIGIS staff, especially Mr. Manoj Mishra & Mr. Rishikesh Mishra.

A Report - Pipeline Case Studies

NACE International Gateway India Section (NIGIS) organized an on-line educational training program on "Pipeline Case Studies" during end June & early July and created an awareness in the minds of engineers by the case studies which was practical in nature. First program was held during 25th – 26th June 2021 and attended by fifty four (54) professional from industries.

The program started with a welcome to dignitaries & participants by Mr. Manoj Mishra, Manager Admin-NIGIS. Mr. N Manohar Rao, Trustee-NIGIS inaugurated the program and welcomed all the participants & faculty members. He briefed about NACE International, AMPP and activities of Gateway India Section. He announced the dates of NACE certification courses, future educational training programs and CORCON 2021: corrosion conference & expo.

The faculty members for this program were Mr. Sandeep Vyas, Sr. General Manager, EPC Pipelines, Reliance Industries Ltd, Mr. Pankaj Panchal, Director, Corrosion Protection Specialist Pvt Ltd., Mr. K B Singh, Consultant, K B Associates, Mr. Ashish Khera, Director, Allied Engineers and Mr. N. V. Suryanarayana Raju, Dy. General Manager - Operations, Hindustan Petroleum Corporation Ltd

The participants gained both theoretical and practical aspects through the talks on how to prevent and control corrosion. The following topics were covered in the training program:

- Overview on Pipeline and Cross country pipeline CP system - A Case Study from Design Concept to Commissioning.
- Case Study -AC / DC interference on Cross Country Pipeline, CIPL / DCVG / CAT Survey on Pipeline.
- Case study of Shorting of Cased Crossings in Buried Pipelines / Causes, Detection, Impact on Carrier Pipeline & Mitigation and Case study of coating failure in Hydrocarbon Pipeline.
- Offshore Non-piggable loading SPM line inspected non-intrusively, Piggable line, severe Internal Corrosion found with ILI, ICDA used after for RCA, New Trunk Line - faults found by XLI CP & Coating.
- Surveys Non-piggable, without CP lines, inspected for all threats .
- City gas Non-piggable pipeline inspected 360 degrees.
- Possible reasons for Permanent Cu/CuSo4 Half Cell failure in ICCP system and preventive steps one should keep in mind, Case study on How to manage Common ROU Pipeline CP interference and HVDC interference to Underground Pipeline – A Theoretical Study.
- Case Study - Station / Plant CP System: A Case Study from Design Concept to Commission.

Pipeline Case Studies: 25 & 26 June 2021

Second program was conducted during 02nd – 03rd July 2021 and attended by forty five (45) professional from industries.

Pipeline Case Studies : 2 & 3 July 2021

Excellent feedback was received from the two training programs from participants on the way each of the lectures were organized and delivered. The program provided an excellent platform for interaction on matters concerning corrosion problems and solutions.

Mr. K B Singh, Chairman, NIGIS provided the vote of thanks during the open forum discussions and conclusion of the program. He to informed participants to take the benefits and advantage of NIGIS training programs and utilized the same in quality of works. He lauded the efforts by SGB, Faculty members, participants and NIGIS staff Mr. Manoj Mishra & Mr. Rishikesh Mishra.

A Report - Fundamentals of Coating Lining

NACE International Gateway India Section (NIGIS) organized educational & training program on "Fundamentals of Coating Lining" during 12 - 13 July 2021 at Emerson, Talegaon, Mawal, Pune. Twenty (20) participants attended this program. NIGIS educational program provide an excellent opportunity for exchange of knowledge and information on matters concerning corrosion problems and solutions through the training programs.

The program started with a welcome to dignitaries & participants by Mr. Hitendra Karalkar, Production, Emerson.

The inaugural function started with a welcome address by Mr. Kisan Bharade, Sr. Manager-QA/QC, Emerson. In his address he appreciated the efforts of team members of NIGIS for providing educational training program to their participants.

Mr. Manoj Mishra, Manager Admin. NIGIS briefed about the training program and introduced the faculty members and NIGIS activities.

Mr. Denzil D'costa, Program Coordinator & Faculty member highlighted various aspect on Fundamentals of Coating & Lining. He also informed that program is specially made for properly understand the technical aspects of surface preparation and application of a protective coatings system on a variety of structures for the industries. The program is beneficial to Quality Control (QA/QC Personnel), Production, Technician, Supervisor, Painter, Blaster, User, Fabricator & Paint Contractors. Mr. Heramb Trifaley, Vice-Chairman-NIGIS and faculty member highlighted that the program is beneficial to all the participants belonging to paints & coating industries.

Mr. Ajay Raina and Mr. Yoganand, Technical Support Team, Fischer Measurement Technologies (India) has demonstrating the testing equipment (Measuring Made Easy) and Mr. Atul Rana, Manager, Graco India has also demonstrating the coating equipment and practical training to the participants during program.

Mr. Sean Simoes, Operation Leader, ISV, Emerson has appreciated all his team and NIGIS organized this training program and concluded the program by delivers the vote of thanks. Mr. Manoj Mishra distributed NIGIS Blasting Nozzle and T-Shirt to the participants.

Group Photo -Fundamentals of Coating Lining in Emerson, Pune

A Report - Training Programme "Case Studies in Oil Refineries"

NACE International Gateway India Section (NIGIS) had organized online Educational Training Programme on "**Case Studies in Oil Refineries"** during 09-10 July 2021. As the program received tremendous response regarding the participation and could not accommodate a large number of participants, we conducted the same programme again during 23-24 July 2021.

Mr. N Manohar Rao, Trustee, NIGIS inaugurated both the programmes and briefed the activities of the NIGIS and welcomed all the participants. The programme was inaugurated virtually.

Failure is not an option. In high risk, high value industries, such as oil and gas corrosion failures have many repercussions: loss of money, loss of production, safety and environment damage. Best industry practices are implemented to avert or minimize corrosion failures. But failures still happen. Wise men say, "We should learn from others' failures". Failure is an opportunity to learn.

This program provided a Case Studies in Oil Refineries describing the failures, analyses of such failures and remedial actions. Failure investigation is an intricate exercise, mainly because of the variety in practices, operations and events. The program didn't only teach participants the reasons for various failures, but had also enable understanding the methodology of failure analyses for appropriate corrective actions. The topics which were covered by the professional experts:

1. An insight into common failures observed in oil Refineries - Mr. B S Negi, CEO, PDMCS
2. Steps on Failure Investigations (Root Cause Analysis) - Mr. Rajesh Wadhawan, Former CGM, BPCL
3. Stress Relaxation Cracking of SS 347 Piping - Mr. B S Negi, CEO, PDMCS
4. Failure case studies in hydro-processing unit - Mr. Lal Gopalani, Former CGM, IOCL
5. Failure of SS Vessel by Chloride SCC - Mr. R P Bhan, Former CGM, HPCL
6. Thermal Fatigue Failure of SS Piping - Mr. B S Negi, CEO – PDMCS
7. Failure case studies in crude distillation unit - Mr. Lal Gopalani, Former CGM, IOCL
8. Failure of Flue Gas Cooler in FCC - Mr. R P Bhan, Former CGM, HPCL
9. Failure of Bitumen Storage Tank/ Failure of REAC Channel box weld joint - Mr. Rajesh Wadhawan, Former CGM, BPCL

Eighty Four Professional Engineers from various industries such as Arudra Engineers Private Limited, Bahrain National Gas Company, Bharat Petroleum Corporation Limited, Boekhoff Technocrates, BPCL-Kochi Refinery, Brahmaputra Cracker and Polymer Ltd, Chennai Petroleum Corporation Limited, Durr India Pvt Ltd, Engineers India Limited, Hempel Oman LLC, Hindustan Petroleum Corporation Ltd, HPCL-Mittal Energy Ltd., Indian Oil Corporation Ltd, Mattest Research Academy, MEECC, National Institute of Technology Karnataka Surathkal, Nayara Energy Limited, NIT Srinagar Kashmir, Numaligarh Refinery Limited, Precision Equipments (Chennai) Private Limited, Quest Global Engineering Service Pvt. Ltd., Reliance Industries Limited, Sandvik Materials Technology India Pvt. Ltd., Struct Care Projects and Suvidya Institute of Technology Pvt Ltd etc. participated. Mr. Rishikesh Mishra, Manager Technical Services, NIGIS was the coordinator for the programmes.

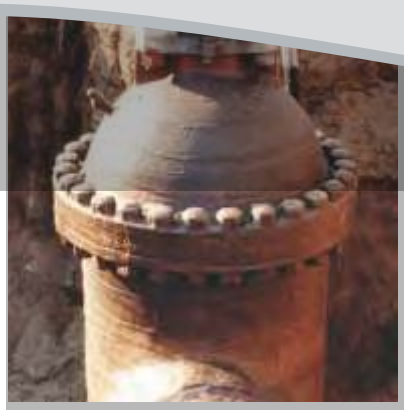
Mr. Sumeet Kataria, Secretary, NIGIS chaired the closing sessions of the two programmes and conducted the open forum of the sessions. It was summarised that it is an excellent platform provided by NIGIS for every interactive sessions on the different types of Oil Refineries and Petrochemical Complex problems faced in industry. The closing of the training programme ended with thanks to all participants, faculties and the organisers.

Participants of Oil Refinery : 09-10 July 2021

Participants of Oil Refinery : 23-24 July 2021

Trenton offers three Wax-Tape® brand anticorrosion wrap systems.

High-quality, easy-to-apply wraps that protect irregularly shaped fittings and require minimal surface preparation.



Belowground applications

Wax-Tape® #1

Anticorrosion Wrap:
A very durable wrap that uses a thick, non-stitch bonded synthetic fabric and has no clay fillers, so it stays conformed to irregular profiles. The wrap requires no abrasion blasting, can be backfilled immediately and is compatible with cathodic protection.

Aboveground and belowground applications

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Self-Firming Anticorrosion Wrap:
A unique, microcystalline-wax-saturated wrap that slowly firms up to provide excellent aboveground and belowground protection. Comes in a variety of colors and usually requires no outerwrap.

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Wax-Tape® HT-3000

High-Temperature Anticorrosion Wrap:
Designed for operating temperatures up to 230°F (110°C), Wax-Tape® HT-3000 wrap can be used on high-temperature oil and gas piping, on compressor station discharge piping, beneath thermal insulation and in high ambient temperature conditions.

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