TCMA MTEC a member of NSTDA

Abstract book

November 28th-29th, 2019

Pullman Pattaya Hotel G, Pattaya, THAILAND

www.mtec.or.th/TCPC2019

TCPC 2019

The 3rd International Thailand Corrosion and Prevention Control Conference

From Research to Applications in Corrosion Technology

Platinum Sponsor

JST

Gold Sponsors

EGAT Power for Thai Happiness, GCME

With support from

ptt

Exhibitors

Fischer, Panmechanic, TMP, INTEG Integrity in Business, NACE INTERNATIONAL, CHEMATECH CO.,LTD., THAI PARKERIZING, SSI, NDT INSTRUMENTS THAILAND

DISCLAIMER

This book contains the abstracts of the papers presented at the **3rd Thailand Corrosion Prevention and Control Conference (TCPC2019).** They reflect the authors' opinions and are published as received after revision by the authors.

The committee assumes no responsibility for the accuracy, completeness or usefulness of the disclosed information.

Unauthorized use might infringe on privately owned patents or publication rights. Please contact the individual author(s) for permission to reprint or make use of information from their papers.

ORGANIZERS

Organizers

Thai Corrosion of Metals and Materials Association

National Metal and Materials Technology Center

National Science and Technology Development Agency

Ministry of Higher Education, Science, Research and Innovation

Co-organizers

Chulalongkorn University

GC Maintenance and Engineering Company Limited

Helmut Fischer (Thailand) Co., Ltd.

Integ Co., Ltd.

Kasetsart University

King Mongkut's University of Technology North Bangkok

King Mongkut's University of Technology Thonburi

Metallurgy and Materials Science Research Institute, Chulalongkorn University

PTT Exploration and Production Public Company Limited

PTT Global Chemical Public Company Limited

Suranaree University of Technology

Thai Marine Protection Co., Ltd.

Thai Parkerizing Co., Ltd.

Thailand Institute of Scientific and Technological Research

SPONSORS

Platinum Sponsor

JST Group

Gold Sponsors

Electricity Generating Authority of Thailand

GC Maintenance and Engineering Company Limited

Silver Sponsor

PTT Public Company Limited

Exhibitors

Chavanich Co., Ltd.

Helmut Fischer (Thailand) Co., Ltd.

Integ Co., Ltd.

NACE International

National Metal and Materials Technology Center

NDT Instruments (Thailand) Co., Ltd.

Pan Mechanic Engineering Co., Ltd.

Sahaviriya Steel Industries PLC

Thai Corrosion of Metals and Materials Association

Thai Marine Protection Co., Ltd.

Thai Parkerizing Co., Ltd.

CONTENTS

PREFACE

Dear Colleagues,

On behalf of the Organizing Committee, I would like to welcome you all to the 3rd Thailand Corrosion Prevention and Control Conference (TCPC2019) held from November 28 to 29, 2019 in Pattaya, Thailand.

Thailand Corrosion Prevention and Control Conference (TCPC) is a conference that raises awareness and shares scientific advancement in the corrosion field. The goal of this conference is to create a knowledge-experience sharing platform linking among industrial sectors, academic institutes and research agencies in a corrosion technology field. It will focus on corrosion case studies and experience in the real field applications. It will help link collaborations between academic institutes and societies in order to sustain reliable infrastructures and components according to the conference theme: From Research to Applications: Technology Transfer.

Regarding the conference activities, we are proud to have 4 plenary and 29 lectures given by distinguished researchers in the field of materials technology. The presentations covering recent progress and R&D activities ranging from fundamental research to applied research in the fields of corrosion.

Lastly, I would like to thank all of the sponsors who have contributed to the TCPC2019, without whom it would be difficult to organize a successful international conference. Their contributions are greatly appreciated.

Yours sincerely,

Gobboon Lothongkum

Prof. Dr.-Ing. Gobboon Lothongkum
TCPC2019 Chairman
President
Thai Corrosion of Metals and
Materials Association

Dr. Julathep Kajornchaiyakul
TCPC2019 Chairman
Executive Director
National Metal and Materials
Technology Center

COMMITTEES

Advisory Committee

Assoc. Prof. Siriluck Nivitchanyong	Thai Corrosion of Metals and Materials Association

Chairmans

Prof. Dr.-Ing. Gobboon Lothongkum	Chulalongkorn University and Thai Corrosion of Metals and Materials Association
Dr. Julathep Kajornchaikul	National Metal and Materials Technology Center

Technical Committees

Assoc. Prof. Dr. Patama Visuttipitukul	Chulalongkorn University
Mr. Tanapat Kaewmaneekul	GC Maintenance and Engineering Company Limited
Mr. Dokkun Bundet	Helmut Fischer (Thailand) Co., Ltd.
Mr. Attapong Terdpravat	Integ Co., Ltd.
Assoc. Prof. Dr. Aphichart Rodchanarowan	Kasetsart University
Asst. Prof. Dr. Thee Chowwanonthapunya	Kasetsart University
Assoc. Prof. Siriporn Daopiset	King Mongkut's University of Technology North Bangkok
Prof. Dr. Somrerk Chandra-ambhorn	King Mongkut's University of Technology North Bangkok
Dr. Pongsak Tuengsook	King Mongkut's University of Technology Thonburi
Ms. Kanokwan Saengkiettiyut	Metallurgy and Materials Science Research Institute, Chulalongkorn University
Assoc. Prof. Dr. Yuttanant Boonyongmaneerat	Metallurgy and Materials Science Research Institute, Chulalongkorn University
Dr. Amnuaysak Chianpairot	National Metal and Materials Technology Center
Dr. - Ing. Ekkarut Viyanit	National Metal and Materials Technology Center
Dr. Namurata Palsson	National Metal and Materials Technology Center
Dr. Pitichon Klomjit	National Metal and Materials Technology Center

Dr. Wanida Pongsaksawad	National Metal and Materials Technology Center
Mr. Passaworn Silakorn	PTT Exploration and Production Public Company Limited
Mr. Montri Charoenlarbwitchayo	PTT Global Chemical Public Company Limited
Dr. Siriwan Heyman	PTT Global Chemical Public Company Limited
Assoc. Prof. Dr.-Ing. Pornwasa Wongpanya	Suranaree University of Technology
Dr. Pinai Mungsantisuk	Thai Marine Protection Co., Ltd.
Mr. Suphot Sukphisarn	Thai Parkerizing Co., Ltd.
Mrs. Wanaporn Khanitnantharak	Thai Parkerizing Co., Ltd.
Dr. Pratip Vongbandit	Thailand Institute of Scientific and Technological Research

TCPC 2019 Technical Program

The 3rd International Thailand Corrosion and Prevention Control Conference

From Research to Applications in Corrosion Technology

November 28, 2019 Pullman Pattaya Hotel G, Pattaya, THAILAND

08:00 - 09:00 Registration

09:00 - 09:20

Opening Ceremony (Bua Chompoo Room, 2nd Floor)

Session Chair:

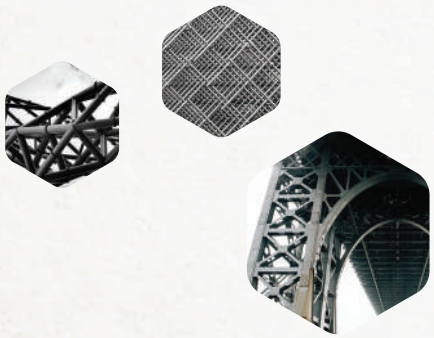
Prof. Dr.-Ing. Gobboon Lothongkum
Thai Corrosion of Metals and Materials Association & Chulalongkorn University

09:20 - 09:55

PL-01 : Innovative Anticorrosion Coatings Made in Thailand
Assoc. Prof. Dr. Daniel Crespy
Vidyasirimedhi Institute of Science and Technology

09:55 - 10:30

PL-02 : The Risk, the Cost and the Protection of Steel Reinforced Concrete Structure in Marine and Severe Environments – A Review
Dr. Pinai Mungsantisuk
Thai Marine Protection Co.,Ltd.



10:30 - 10:50

Coffee Break & Exhibition

Session: Infrastructure Construction

Session Chair:

Dr. Ekkarut Viyanit
National Metal and Materials Technology Center

10:50 - 11:10

IC-01 : Corrosion Damage Evaluation of Port Structure in Thailand's Eastern Economic Corridor (EEC)
Asst. Prof. Dr. Nantawat Khomwan
Kasetsart University Kamphaeng Sean Campus

11:10 - 11:30

IC-02 : Development of the Reactive Silane-Based Surface Impregnating Material for Preventing Deterioration of Reinforced Concrete Structures in Consideration of Thailand Climate
Dr. Norimasa Mimura
Sho-bond Corporation, Japan

11:30 - 11:50

IC-03 : Corrosion Protection for Industrial Buildings and Structures in Thailand
Dr.Yut Panitanwong
The Concrete Products and Aggregate Co.,Ltd.

11:50 - 13:10

Lunch

Session Chair:

Dr. Wanida Pongsaksawad
National Metal and Materials Technology Center

13:10 - 13:30

IC-04 : Reinforced Concrete, Corrosion and Galvanic Anode Cathodic Protection – A Review of Best Practice and Strategies for Life Extension of Marine Structures using Galvanic Anode Cathodic Protection
Tom Wenzel
Freyssinet Asia, Singapore

13:30 - 13:50

IC-05 : Atmospheric Field Exposure of Duplex Stainless Steel to Marine – Offshore and Onshore –Environments
Claes Tigerstrand
Outokumpu Stainless Ab, Sweden

13:50 - 14:10

IC-06 : Corrosion Behaviours of $25Cr_3Ni_7Mn_{0.66}N$ Duplex Stainless Steel in Artificial Seawater
Songkran Vongsilathai
Chulalongkorn University

14:10 - 14:30

IC-07 : On the Nature and the Control of Thermal Oxide Formation on Hot-Rolled Low Carbon Steels
Prof. Dr. Somrerk Chandra-ambhorn
King Mongkut's University of Technology North Bangkok

14:30 - 14:50

IC-08 : Corrosion Case Studies in Railway Tracks on Steel Bridge Structures
Phitsanu Pholkainuwatra & Prapas Metheephatikul
State Railway of Thailand

14:50 - 15.40

Coffee Break & Exhibition

Session: Inspection, Maintenance and Corrosion Prevention

Session Chair:

Dr. Amnuaysak Chianpairot, National Metal and Materials Technology Center
Attapong Terdpravat, NACE Bangkok Thailand Section

15:40 - 16:00

IM-01 : Process Vessel Internal Corrosion Management Solution with Organic Coating
James Nippard
Belzona Asia Pacific, Thailand

16:00 - 16:20

IM-02 : Technology Solution for Corrosion under Cementitious Fireproof (CUF)
Miles Edward Buckhurst
Jotun AS, Norway

16:20 - 16:40

IM-03 : Hydrogen Diffusivities of AISI 304 and AISI 304 Coated by Ni and Au
Krittayot Wannapoklang
Chulalongkorn University

16:40 - 17:00

IM-04 : Small Bore Connection Inspection Campaign to Reduce Risk of Pipe Work Failure from Vibration and Incorrect Installation
Peera Yongsuwan
Prompt Solutions Co.,Ltd.

17:00 - 17:20

IM-05 : Cathodic Protection of Oil & Gas, Refinery, Petrochemical and Power Plant Facility with Case Studies
Shaikh H Rashid
Himoya Corrosion Technology Pvt. Ltd., India

17:20 - 17:40

IM-06 : Inspection for Hot Dip Galvanized Steel Products
Thuangpoom Sataranuwat
Thai Galvanizing Association and Union Galvanizer Co.,Ltd.

17:40 - 18:00

IM-07 : Effect of Alkaloids Extracted from *Crotalaria spectabilis* Stem on the Corrosion Inhibition of Mild Steel in 1M H_2SO_4 Solution
CANCELED
Hari Bhakta Oli
Tribhuvan University, Nepal

18:30 - 20.00 **Banquet**

TCPC 2019 Technical Program

The 3rd International Thailand Corrosion and Prevention Control Conference

From Research to Applications in Corrosion Technology

November 29, 2019 Pullman Pattaya Hotel G, Pattaya, THAILAND


Session Chair:

Dr. Ekkarut Viyanit
National Metal and Materails Technology Center

09:00 - 09:35

PL-03 : Cathodic Protection Systems for Concrete Structure in Marine Environment
Dr. Xavier Hallopeau
Freyssinet International & Cie, France

09:35 - 10:10

PL-04 : The Design Optimization for Construction Materials and Corrosion Control for Pressure Containments
Passworn Silakorn
PTT Exploration and Production Public Company Limited

10:10 - 10:30

Coffee Break


Session: Oil, Gas, Refinery and Petrochemical

Session Chair:

Dr. Pitichon Klomjit
National Metal and Materails Technology Center

10:30 - 10:50

OG-01 : Failure of Instrument Gas Tubing and Re-thinking for the Solutions
Kamonwan Ruangpattanatawee
PTT Exploration and Production Public Company Limited

10:50 - 11:10

OG-02 : Chloride Stress Corrosion Cracking (Cl-SCC) and Where to Find It in Petrochemical Plant
Weerawat Terdthaichairat
PTT Global Chemical Public Company Limited

11:10 - 11:30

OG-03 : Offshore Well Casing Splash Zone Remediation and Repair Alternatives
Chanat Sirisoonthorn
Chevron Thailand Exploration and Production, Ltd.

11:30 - 11:50

OG-04 : How to Address Corrosion Under Insulation (CUI) Issues in Petrochemical Plants? – A Systematic Approach
Tanapat Kaewmaneekul
GC Maintenance and Engineering Company Limited

11:50 - 12:10

OG-05 : The Advancement of Non-destructive Testing Technologies in The Oil & Gas Industry
Puripong Klamdith
GC Maintenance and Engineering Company Limited

12:10 - 13.10

Lunch

Session Chair:

Dr. Namurata Palsson
National Metal and Materials Technology Center

13:10 - 13:30

OG-06 : Case Study of Cathodic Protection System for Steel Used in Buried/ Immersed Environments or Concrete Structures in Oil and Gas Refinery
Sarun Choomchaiyo
Aurecon Consulting (Thailand)

13:30 - 13:50

OG-07 : The Study of Using Thermoscan for CUI Detection
Kittapart Wiriyachanta
Bangchak Corporation Public Company Limited

13:50 - 14:10

OG-08 : Development of Water Base High Emissivity Ceramic Coating for Scale & Fouling Prevention and Energy Saving at High Temperature Application
Nikom Chawalitkijmongkol
Thaioil Energy Services Co., Ltd.

14:10 - 14:30

OG-09 : Overview the Materials Selection for Engineering Work Practice
Pattima Rattanatrakool
GC Maintenance and Engineering Company Limited

14:30 - 14:50

Coffee Break

Session: Power Generation

Session Chair:

Assoc. Prof. Dr. Patama Visuttipitukul
Chulalongkorn University

14:50 - 15:10

PG-01 : Stress Analysis and Corrosion Fatigue Test of the Propeller Blade in Cycloidal Drive
Capt. Swieng Thuanboon
Royal Thai Naval Dockyard, Royal Thai Navy

15:10 - 15:30

PG-02 : Corrosion Behaviour of Stainless Steels in Molten Nitrate Salt
Asst. Prof. Dr. Piyorose Promdirek
King Mongkut's University of Technology North Bangkok

15:30 - 15:50

PG-03 : Corrosion Reduction by Feed Water Treatment Program AVT-R to AVT-O at BLCP Coal Fired Power Plant
Kaewmanee Netrkaew
BLCP Power Limited

15:50 - 16:10

PG-04 : Investigation of Cl-SCC of a Stainless Steel Bellow in Boiler Penetration Seals
Jutaporn Chaichalerm
IS Industrie (Thailand) Co., Ltd.

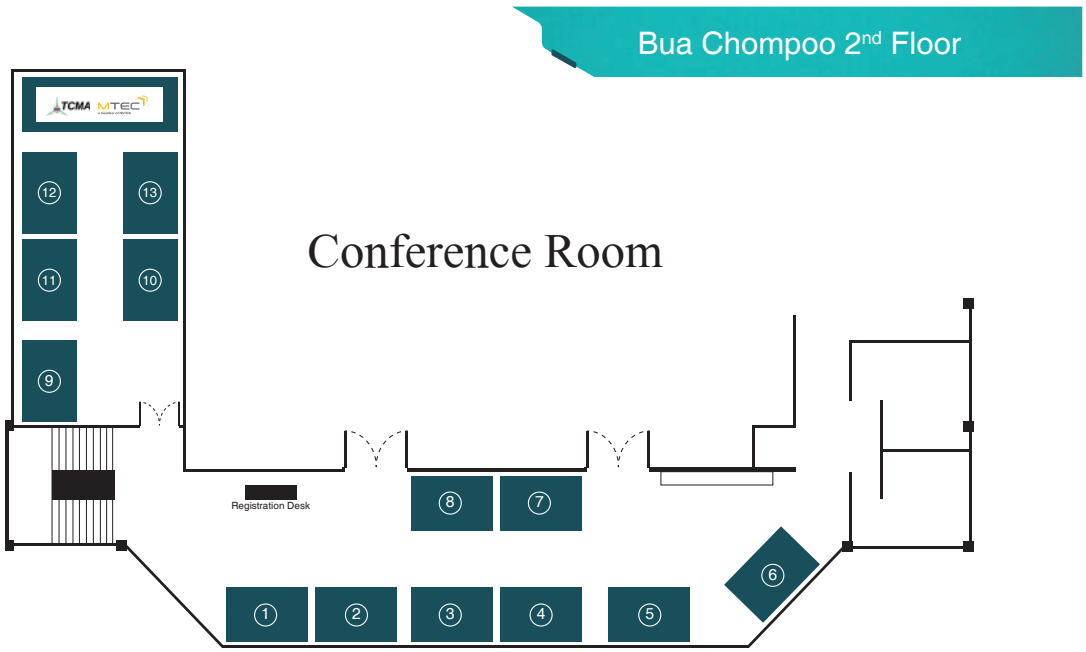
16:10 - 16:30

PG-05 : Development of AISI 430 Stainless Steel Coated by Mn-Co Spinel Doped with a Reactive Element for SOFCs Interconnect Application
Panya Wiman
King Mongkut's University of Technology North Bangkok

16:30

Closing Ceremony

CONFERENCE AND EXHIBITION FLOOR PLAN



Exhibition List:

Booth Number	Company
1	Electricity Generating Authority of Thailand
2	GC Maintenance and Engineering Company Limited
3	PTT Public Company Limited
4	Thai Marine Protection Co., Ltd.
5	Helmut Fischer (Thailand) Co., Ltd.
6	Integ Co., Ltd. and NACE International
7 - 8	JST Group
9	Chavanich Co., Ltd.
10	Pan Mechanic Engineering Co., Ltd.
11	Thai Parkerizing Co., Ltd.
12	Sahaviriya Steel Industries PLC
13	NDT Instruments (Thailand) Co., Ltd.

LIST OF PRESENTATIONS

Plenary Lectures

PL-01 **Innovative Anticorrosion Coatings Made in Thailand**

Assoc. Prof. Dr. Daniel Crespy

Vidyasirimedhi Institute of Science and Technology

PL-02 **The Risk, the Cost and the Protection of Steel Reinforced Concrete Structure in Marine and Severe Environments – A Review**

Dr. Pinai Mungsantisuk

Thai Marine Protection Co., Ltd.

PL-03 **Cathodic Protection Systems for Concrete Structure in Marine Environment**

Dr. Xavier Hallopeau

Freyssinet International & Cie, France

PL-04 **The Design Optimization for Construction Materials and Corrosion Control for Pressure Containments**

Passworn Silakorn

PTT Exploration and Production Public Company Limited

Infrastructure Construction Session

IC-01 **Corrosion Damage Evaluation of Port Structure in Thailand's Eastern Economic Corridor (EEC)**

Asst. Prof. Dr. Nantawat Khomwan

Kasetsart University Kamphaeng Sean Campus

IC-02 **Development of the Reactive Silane-Based Surface Impregnating Material for Preventing Deterioration of Reinforced Concrete Structures in Consideration of Thailand Climate**

Dr. Norimasa Mimura

Sho-bond Corporation, Japan

IC-03 **Corrosion Protection for Industrial Buildings and Structures in Thailand**

Dr. Yut Panitanwong

The Concrete Products and Aggregate Co., Ltd.

IC-04 **Reinforced Concrete, Corrosion and Galvanic Anode Cathodic Protection – A Review of Best Practice and Strategies for Life Extension of Marine Structures using Galvanic Anode Cathodic Protection**

Tom Wenzel

Freyssinet Asia, Singapore

IC-05 **Atmospheric Field Exposure of Duplex Stainless Steel to Marine – Offshore and Onshore – Environments**

Claes Tigerstrand

Outokumpu Stainless Ab, Sweden

IC-06 **Corrosion Behaviours of $25Cr_3Ni_7Mn_{0.66}N$ Duplex Stainless Steel in Artificial Seawater**

Songkran Vongsilathai

Chulalongkorn University

IC-07 **On the Nature and the Control of Thermal Oxide Formation on Hot-Rolled Low Carbon Steels**

Prof. Dr. Somrerk Chandra-ambhorn

King Mongkut's University of Technology North Bangkok

IC-08 **Corrosion Case Studies in Railway Tracks on Steel Bridge Structures**

Phitsanu Pholkainuwatra & Prapas Metheephatikul

State Railway of Thailand

Inspection, Maintenance and Corrosion Prevention Session

IM-01 **Process Vessel Internal Corrosion Management Solution with Organic Coating**

James Nippard

Belzona Asia Pacific, Thailand

IM-02 **Technology Solution for Corrosion under Cementitious Fireproof (CUF)**

Miles Edward Buckhurst

Jotun AS, Norway

IM-03 **Hydrogen Diffusivities of AISI 304 and AISI 304 Coated by Ni and Au**

Krittayot Wannapoklang

Chulalongkorn University

IM-04 **Small Bore Connection Inspection Campaign to Reduce Risk of Pipe Work Failure from Vibration and Incorrect Installation**

Peera Yongsuwan

Prompt Solutions Co., Ltd.

IM-05 **Cathodic Protection of Oil & Gas, Refinery, Petrochemical and Power Plant Facility with Case Studies**

Shaikh H Rashid

Himoya Corrosion Technology Pvt. Ltd., India

IM-06 **Inspection for Hot Dip Galvanized Steel Products**

Thuangpoom Sataranuwat

Thai Galvanizing Association and Union Galvanizer Co., Ltd.

IM-07 **Effect of Alkaloids Extracted from *Crotalaria spectabilis* Stem on the Corrosion Inhibition of Mild Steel in 1M H_2SO_4 Solution**

CANCELED

Hari Bhakta Oli

Tribhuvan University, Nepal

Oil, Gas, Refinery and Petrochemical Session

OG-01 **Failure of Instrument Gas Tubing and Re-thinking for the Solutions**

Kamonwan Ruangpattanatawee

PTT Exploration and Production Public Company Limited

OG-02 **Chloride Stress Corrosion Cracking (Cl-SCC) and Where to Find It in Petrochemical Plant**

Weerawat Terdthaichairat

PTT Global Chemical Public Company Limited

OG-03 **Offshore Well Casing Splash Zone Remediation and Repair Alternatives**

Chanat Sirisoonthorn

Chevron Thailand Exploration and Production, Ltd.

OG-04 **How to Address Corrosion Under Insulation (CUI) Issues in Petrochemical Plants? – A Systematic Approach**

Tanapat Kaewmaneekul

GC Maintenance and Engineering Company Limited

OG-05 **The Advancement of Non-destructive Testing Technologies in the Oil & Gas Industry**

Puripong Klamdith

GC Maintenance and Engineering Company Limited

OG-06 **Case Study of Cathodic Protection System for Steel Used in Buried/ Immersed Environments or Concrete Structures in Oil and Gas Refinery**

Sarun Choomchaiyo

Aurecon Consulting (Thailand)

OG-07 **The Study of Using Thermoscan for CUI Detection**

Kittapart Wiriyachanta

Bangchak Corporation Public Company Limited

OG-08 **Development of Water Base High Emissivity Ceramic Coating for Scale & Fouling Prevention and Energy Saving at High Temperature Application**

Nikom Chawalitkijmongkol

Thaioil Energy Services Co., Ltd.

OG-09 **Overview the Materials Selection for Engineering Work Practice**

Pattima Rattanatrakool

GC Maintenance and Engineering Company Limited

Power Generation Session

PG-01 **Stress Analysis and Corrosion Fatigue Test of the Propeller Blade in Cycloidal Drive**

Capt. Swieng Thuanboon

Royal Thai Naval Dockyard, Royal Thai Navy

PG-02 **Corrosion Behaviour of Stainless Steels in Molten Nitrate Salt**

Asst. Prof. Dr. Piyorose Promdirek

King Mongkut's University of Technology North Bangkok

PG-03 **Corrosion Reduction by Feed Water Treatment Program AVT-R to AVT-O at BLCP Coal Fired Power Plant**

Kaewmanee Netrkaew

BLCP Power Limited

PG-04 **Investigation of Cl-SCC of a Stainless Steel Bellow in Boiler Penetration Seals**

Jutaporn Chaichalerm

IS Industrie (Thailand) Co., Ltd.

PG-05 **Development of AISI 430 Stainless Steel Coated by Mn-Co Spinel Doped with a Reactive Element for SOFCs Interconnect Application**

Panya Wiman

King Mongkut's University of Technology North Bangkok

PL:
Plenary Session

PL-01

Innovative Anticorrosion Coatings Made in Thailand

Suttiruk Salaluk,[a] Naruphorn Dararatana,[a] Farzad Seidi,[a]
Ekkarut Viyanit,[b] and Daniel Crespy[a]
[a]Vidyasirimedhi Institute of Science and Technoloy (VISTEC), Rayong 21210, Thailand
[b]National Metal and Materials Technology Center (MTEC), Pathumthani 12120, Thailand
* daniel.crespy@vistec.ac.th

Keywords: Anticorrosion; Corrosion inhibitors; Smart coatings; Stimuli-responsive polymers.

Corrosion continues to be worldwide a major economic and environmental plague. In a century where sustainability starts to become a crucial concern, it is important to discover new technologies which would allow for less pollution and less damage of metallic structures by corrosion.

From the academic point of view, materials scientists worked during the 2000's till now on smart coatings for metals embedding stimuli-responsive capsules. The capsules are typically containing corrosion inhibitors that are released during the corrosion process.

We introduce here a second generation of smart coatings based on polymers containing labile bonds. These coatings can deliver corrosion inhibitors upon onset of corrosion and therefore prevent unwanted leaching of inhibitors in the environment. Furthermore, they decrease significantly the corrosion rate of metals compared with typical passive coatings. Finally, we present materials that can both hinder corrosion and detected corrosion at early stages before the metal is irreversibly damaged.

PL-02

The Risk, the Cost and the Protection of Steel Reinforced Concrete Structures in Marine and Severe Environments – A Review

Pinai Mungsantisuk
Thai Marine Protection Co., Ltd., 555/8 Moo12, Bangphasi, Bang Len, Nakhon Pathom, 73130, Thailand
pinai.m@thaimp.co.th

Keywords: Steel reinforced concrete, Marine environment, Corrosive soil, cathodic protection

The steel reinforced concrete structures have been used around the world since its invention in the 19th century. The combination of concrete's compressive strength, steel's tensile strength and the passive film of steel from alkaline environment make the steel reinforced concrete the great choice for construction material. However, chlorides can induce corrosion of the reinforcing steel in concrete. Many aged steel reinforced concrete infrastructures are in marine environment and corrosive soil which are at risk from chlorides induce corrosion.

The corrosion cost of the infrastructures in these environments is too high to take. The repair and maintenance cost are increasing every year. The deaths, injures, losses of business sales, losses of GDP and job losses can be the consequences of the infrastructure's crumbling. Therefore, the protection system shall be used to mitigate the corrosion problem. The cathodic protection, both sacrificial anode and impressed current systems, has been proven to be one of the best techniques to extend the life of the chloride contaminated infrastructures.

PL-03

Cathodic Protection Systems for Concrete Structure in Marine Environment

Xavier Hallopeau[a,*], Tom Wenzel[b], Boonpradit Pochayanuwat[c], Monchai Bunjong[c]
[a]Freyssinet International & Cie, Rueil-Malmaison, 92500, France
[b]Freyssinet, Singapore, 199555, Singapore
[c]Freyssinet Thailand Ltd, Silom, Bangkok, 10500, Thailand
*xavier.hallopeau@freyssinet.com

Keywords: Marine corrosion, cathodic protection, concrete structures.

Freyssinet Group performs structural maintenance operations using impressed current cathodic protection methods for both new build and repair projects.

The group has proven expertise in cathodic protection for Concrete, Land and Marine applications, as well as in-depth knowledge of the behaviour of the concrete material at the different stages of the project: diagnosis, design, actual working methods and logistical methods adapted to port structures (consideration of the operating context of the structures and specific access conditions).

This paper will review the complete project life cycle of marine concrete structure projects made by Freyssinet Group in the last 5 years. A particular focus will be made on challenging technical aspects, as well as the preferred methods that were adopted to achieve requirements.

PL-04

The Design Optimization for Construction Materials and Corrosion Control for Pressure Containments

Passworn Silakorn
PTT Exploration and Production Public Company Limited
Energy Complex Building A, Floors 6, 19-36
555/1 Vibhavadi Rangsit Road, Chatuchak, Bangkok 10900, THAILAND
* passaworns@pttep.com

Keywords: corrosion control, pressure vessels, pipings, pipelines

The design of pressure containment has been with optimization while maintaining integrity, for pressure vessels, pipings and pipelines. With field experience for more than 25 years, this was performed through corrosion rate simulation and inspection result evaluation.

After getting project design and engineering requirements, it was found that design envelopes were comparable to operating envelopes. Therefore, the design optimization strategy was set to utilize as much as possible the information of actual corrosion rates and inspection results got from field operation for each equipment, and collaborate with simulation results.

Corrosion rates were retrieved from thickness database of the most corrosive, representative equipment and platforms. These corrosion rates were compared to simulated corrosion rate results (taking corrosion inhibitor efficiency into account).

The decision was made amongst expertise in inspection, corrosion and metallurgist. The selection of materials of construction was finally made, along with mitigation e.g. corrosion inhibitor injection location and amount.

For examples, corrosion allowance of Carbon Steel equipment could be reduced based on the information from Pipeline Integrity Management (PIM) and the knowledge of Volatile Corrosion Inhibitor (VCI) efficiency; also, external coating was selected to be cost-optimized type based on subsea visual inspection results. The amount of cost saving has been considered significant.

For the bigger picture, information from corrosion and inspection will be further used in Machine Learning. For example, for more optimization in design and operation, Top of Line Corrosion (TOLC) prediction based on Machine Learning is expected to further reduce corrosion allowance and corrosion inhibitor injection.

IC:
Infrastructure Construction Session

IC-01

Corrosion Damage Evaluation of Port Structure in Thailand's Eastern Economic Corridor (EEC)

Nantawat Khomwan[1,*]
[1]*Department of Civil Engineering, Kasetsart University, Kamphaeng Saen Campus, Nakhon Pathom, 73140, Thailand*
* fengnwk@ku.ac.th

Keywords: Durability, Corrosion, Port, Reinforced Concrete.

This study presents the visual inspection of a reinforced concrete port located in chonburi province after 17 years of exposing to the marine environment. The corrosion damage assessments plays a crucial role in maintenance planning. Then, this study was conducted aiming to standardize evaluation of port. A major cause of deterioration was reinforcement corrosion. Severe corroded reinforcing steel were investigated and result in the formation of rust with a larger volume and staining, cracking, and spalling of the cover concrete. Some reinforced concrete elements were inadequate cover thickness even though high strength concrete was used. This information provide a key parameter in the repair process to minimize loss to the structure. When dealing with a very severe damage structure, the investigative team is often faced with hazardous situation limiting collected data. The results of the study are carried out to help in the decision making process for repair strategy.

IC-02

Development of the Reactive Silane-Based Surface Impregnating Material for Preventing Deterioration of Reinforced Concrete Structures in Consideration of Thailand Climate

Norimasa Mimura[a*], Shigeru Naraoka[a], Hideto Gyakushi[a], Tomotake Kato[a], Daisuke Yamazaki[a]
[a]SHO-BOND CORPORATION, 7-8, Nihonbashi-Hakozakicho, Chuo-ku, Tokyo, 1030015, Japan

Keywords: Reactive silane-based surface impregnating material, Preventing deterioration, Reinforced concrete structure, Water-repellent layer

A reactive silane-based surface impregnating material can penetrate into the inside of concrete only by being applied to the concrete surface, reacts with the concrete components, modifies the concrete surface to be hydrophobic and forms a water-repellent layer. Due to the formed water-repellent layer, the reinforced concrete structure has the property of suppressing the ingress of moisture from the outside and dissipating the water vapor inside. For this reason, it is possible to block deterioration factors such as chloride ions derived from water and to suppress the carbonation of concrete. Therefore, it is an effective material for measures against deterioration. In addition, although it is a coating material, it does not peel off or float, does not impair the appearance of the structure, and is clear. Therefore, it is easy to check the structure even after construction.

However, in order to exhibit these performances, a water-repellent layer must be formed on the concrete surface layer. After construction, if rainwater is applied with the concrete surface wet, unreacted substances in the middle of the reaction may be washed away. If the unreacted material is washed away, the predetermined performance may not be exhibited. In particular, the possibility is likely to increase in the Thailand climatic environment with many rainy days. Therefore, the development of reactive silane-based surface impregnating material has improved drying characteristics after application so that a water-repellent layer can be formed at an early stage so as not to be affected by rainfall. The reactive silane-based surface impregnating material developed in this way is a product designed to ensure that the specified performance can be exhibited in the Thailand climatic environment.

The durability after construction will be explained by the survey results after construction of actual structures in the Japanese environment where heating and cooling are repeated. In order to prevent deterioration and maintain the appearance, in August 1985, a reinforced concrete structure was constructed with the same reactive silane-based surface impregnating material, and then its durability performance and effects for over 30 years were confirmed by periodic surveys.

In this report, we report the performance of the reactive silane-based surface impregnating material developed in consideration of the Thailand climate and the results of a survey conducted in 2015 after 30 years of construction.

IC-03

Corrosion Protection for Industrial Buildings and Structures in Thailand

Yut Panitanwong[a,*], Pinai Mungsantisuk[b] and Chawis Thongyothee[a]
[a]*The Concrete Products and Aggregate Co., Ltd. (CPAC), 1516 Wong Sawang, Bang Sue, Bangkok 10800, Thailand*
[b]*Thai Marine Protection Co., Ltd. (TMP), 555/8 Moo12, Bang Phasi, Bang Len, Nakhon Pathom, 73130, Thailand*
*yuttanas@scg.com

Keywords: Industrial buildings and structures, Concrete and steel structures, Repairing and Maintenance, Corrosion protection

The Land development Projects in the East coastal in Thailand or "Eastern Sea board Development Program (ESB)" was established in 1982. It caused that the areas of Chonbuuri, Rayong and Chachoengsao provinces had the major industrial estate, a lot of job creation and increasing Thai GDP. After the Industrial estates settled more than 30 years ago, some of buildings and structures either using steel-reinforced concretes and steel structures were deteriorated by various factors such as material degraded, quality of construction, and extreme environmental condition. Poor welding, rust in steel platform, and bolt and nut corrosion could be usually seen in everywhere around the production plant. Moreover, concrete structures in the following condition could be damaged by chemical attacks directly such as the chemical composites from Sulfate, Chloride, and Carbon causing cracking and spalling in concrete structures as well as corrosion in steel reinforcement. The repairing method and maintenance of building structures are necessary to do after finished construction and operating states.

CPAC Lifetime Solution can present the method statement based on engineering principle and the right material selection to Industrial-building structures in areas of upstream and downstream production-factory, warehouse, cooling tower, chemical tank farm, and jetty. The use of marine concrete or using the low ratio of water and cement and increasing covering can be reduced chloride diffusion process in capillary pore of concrete. In addition, the use of corrosion inhibitor mixed together in the mortar potion can be slow down the steel-corrosion process in concrete. It can be used the cathodic protection system such as the impressed current and the sacrificial anode to protect steel structures from corrosion phenomenon. Furthermore, the special coating as moisture curing technology can be applied in repairing works for alternative way.

IC-04

Reinforced Concrete, Corrosion and Galvanic Anode Cathodic Protection – A Review of Best Practice and Strategies for Life Extension of Marine Structures using Galvanic Anode Cathodic Protection

Tom Wenzel[a]*, Xavier Hallopeau[b], Boonpradit Phochayanuwat[c], Monchai Bunjong[c]
[a]Freyssinet Asia, Singapore, 199555, Singapore
[b]Freyssinet International & Cie, Rueil-Malmaison, 92500, France
[c]Freyssinet Thailand Ltd, Silom, Bangkok, 10500, Thailand
*tom.wenzel@freyssinet.com

Keywords: Marine, corrosion, cathodic protection, reinforced concrete, galvanic anode, sacrificial anode

The maintenance and life extension of ageing built infrastructure located in marine environments is a challenge now faced by countries worldwide. Since its earliest modern day commercial applications in the USA commencing in the late 1950′s, cathodic protection of reinforced concrete has become an accepted method of managing and mitigating corrosion induced deterioration of reinforced concrete around the world with impressed current cathodic protection systems having been installed on bridge, marine and other structures throughout the UK, Europe, North and South America, Australia and New Zealand, Japan, Hong Kong and many other countries since the 1990′s.

In more recent times the commericalisation of discrete galvanic anode systems has taken off and the use of galvanic anode cathodic protection to increase the life of localised concrete patch repairs to marine structures has become more common place. This paper reviews current best practice associated with the use of embedded discrete galvanic anodes including discussion on the applicability of current international and national cathodic protection codes and standards, design practice and presents some of the challenges associated with performance criteria and performance monitoring of such systems.

IC-05

Atmospheric Field Exposure of Duplex Stainless Steel to Marine – Offshore and Onshore – Environments

Claes Tigerstrand
Technical Market Development & Customer Service, Outokumpu Stainless AB, Bergsnäsvägen 11, P.O. Box 74, SE-774 22 Avesta, Sweden
Email; claes.tigerstrand@outokumpu.com

Keywords: atmospheric corrosion, duplex stainless steel

This study was done as a collaboration between Kvaerner and Outokumpu. The aim of this study has been to gain knowledge about the atmospheric corrosion resistance of selected duplex stainless steels for two marine exposure sites in Norway, one offshore (partly sheltered at an offshore platform) and one onshore (open condition in a yard close to splash zone).

Offshore exposure site was found to have the most aggressive atmospheric exposure conditions. The investigated duplex stainless steels showed excellent resistance to pitting corrosion. However, super duplex stainless steel (2507) was the only grade that was resistant to crevice corrosion under offshore exposure conditions.

Selecting suitable stainless steel grade for marine environments in the North Sea depends on relevant parameter for the specific application. For structural applications max corrosion attack depth could be considered. For aesthetic use of stainless steel the appearance rating method could be considered instead.

Finally, a discussion on the influence of warmer tropical marine climates typically encountered in South-East Asia with both dry period with high temperatures and humid rain period compared to the much colder North Sea, a division of the northern part of the Atlantic Ocean.

IC-06

Corrosion Behaviours of $25Cr_3Ni_7Mn_{0.66}N$ Duplex Stainless Steel in Artificial Seawater

Songkran Vongsilathai[a,*], Gobboon Lothongkum[a]
[a]*Department of Metallurgical Engineering, Faculty of Engineering, Chulalongkorn University, Pathumwan, Bangkok, 10330, Thailand*
*Songkran.fm@gmail.com

Keywords: Duplex stainless steel, Corrosion, Electrochemistry, Artificial Seawater

In the seawater or corrosive or chloride containing environments, the duplex stainless steel (DSS) has been alternative material selection of engineering applications such as desalination system, oil and gas offshore, petrochemical plants due to good mechanical properties and corrosion resistance because of its compose of ferrite and austenite phases. However, the developments of decreasing alloy costs to substitute Ni by Mn and N have been challenged. This study investigated corrosion behaviours of $25Cr_3Ni_7Mn_{0.66}N$, a new duplex stainless steel, and compared with a commercial AISI 2205 standard grade via electrochemical approaches in artificial seawater (ASW) according to ASTM D1141. Samples were prepared in the vacuum arc remelting (VAR) furnace with Ar and N shielding gas. In order to balance a ratio of austenite/ferrite to be about 1:1, the hot-forged samples were homogenised by solution annealing at 1050°C. The corrosion resistance of the new duplex alloy was discussed in terms of corrosion current density (i_{corr}), passive current density (i_{pass}), corrosion potential (E_{corr}) and pitting potential (E_p) evaluated from potentiodynamic polarisation curves at a sweep rate of 1mV/s and room temperature. The corrosion behaviours of passive film were studied by electrochemical impedance spectroscopy (EIS) measurement and Mott-Schottky (M-S) analysis. The metastable pitting occurrence was analysed from current-time transient curves at pitting potential for 1 hour. Pit morphology on the corroded phase was revealed by optical metallography (OM) and scanning electron microscope (SEM).

IC-07

On the Nature and the Control of Thermal Oxide Formation on Hot-Rolled Low Carbon Steels

Somrerk Chandra-ambhorn
High Temperature Corrosion Research Centre, Department of Materials and Production Technology Engineering, Faculty of Engineering, King Mongkut's University of Technology North Bangkok, 1518 Pracharat 1 Road, Wongsawang, Bangsue, Bangkok 10800, Thailand.
somrerk.c@eng.kmutnb.ac.th

Keywords: Thermal oxide, Oxidation, Adhesion, Carbon steel, Hot rolling

After the hot-rolling process, the hot-rolled steel with desired geometry and properties is obtained, naturally with the thermal oxide scale formed on its surface. The presence of this oxide must be well controlled. For example, if the hot-rolled steel will be further sent to the cold rolling, the steel with poor scale adhesion is preferred. However, if the hot-rolled steel is directly delivered for the use in this form such as for making a body of an excavator or a chassis of a pick-up truck, the intimate adherence of scale to the steel substrate is needed. The present talk reviews the formation of thermal oxide on iron and carbon steels including the ones produced from the blast-furnace and electric-arc-furnace routes. Factors that affect the oxide formation and scale adherence, i.e. the steel chemistry and the hot-rolling parameters, will be addressed. The scale adhesion assessment using the tensile test accompanied by the Galerie-Dupeux model to quantify the adhesion energy will also be included in the talk.

IC-08

Corrosion Case Studies in Railway Tracks on Steel Bridge Structures

Prapas Mayteepatigul[a,*] and Phitsanu Pholkainuwatra[b]
[a]Divisional Engineer, Bridge Survey Division, State Railway of Thailand, Bangkok, Thailand
[b]Divisional Engineer, Research and Analysis Division, State Railway of Thailand, Bangkok, Thailand
* poth_esmar@hotmail.com

Keywords: Railway Bridge; Steel Bridge; Weathering steel; Steel Structures; Corrosion.

One serious problem of railway bridges is corrosion on steel structures. There are many corrosion problems, which cause deterioration in the steel bridges structure of State Railway of Thailand (SRT). However, the occurrence of corrosion of steel structures depends on various factors such as environment and pollution which are different in each country. This article presents the summary and characteristics of corrosion in the railway steel bridge structures including the experiences of methods of protection for corrosion for bridge structures employed by SRT. In addition, this article presents the physical characteristic of corrosion and the methods of prevention applied to steel bridge structure. Information from this article can be useful for steel structure works.

IM:
Inspection, Maintenance and Corrosion Prevention Session

IM-01

Process Vessel Internal Corrosion Management Solution with Organic Coating

James Nippard[a]
[a] *Belzona Asia Pacific, Sriracha, Chonburi, 20230, Thailand*
*jnippard@belzona.com

Keywords: Organic composite coating, High temperature immersion, Process Vessel, Thermal shock

There is greater focus and demand for coatings to withstand extreme environments and protect vessel and pipelines from corrosion and wear. New oil and gas developments are seeing higher temperature environments. The operating conditions introduce new challenges and require increasingly advanced and innovative coating technologies for internal vessel / pipeline corrosion protection, and resistance to erosion.

This paper aims to present the standard requirement and test criteria to prequalify internal organic coating for Process Vessels which are subjected to corrosion/erosion.

The organic composite coating shall be tested in the most severe Hydrocarbon services requirement such as Pressure cycle, High temperature immersion, Thermal shock,.etc.

The organic composite coating has been considered as the cost-effective protection layer for Vessels / Pipeline rather than using expensive Metal Alloy to extend services life of the facilities.

IM-02

Technology Solution for Corrosion under Cementitious Fireproofing (CUF)

Miles Buckhurst
Jotun AS, Sandefjord, Norway
Miles.buckhurst@jotun.com

Keywords: Fireproofing; Epoxy; Corrosion

Corrosion Under Fireproofing (CUF) is an increasing problem. In years previously it was thought that the use of cementitious fireproofing provided carbon steel with an alkali environment and so prevented corrosion. Unfortunately, this has not been the case and the lack of protection has led, in some cases, to catastrophic and near fatal disasters. An example of this is the case of gas sphere legs, where the majority in the world have been fire protected with lightweight cementitious solutions. The first 3-5 years there is little or no problem, however over time the alkali environment and passivation of the steel is neutralized and eventually becomes a corrosive environment, hidden to a great extent. There are several options when it comes to protecting against corrosion in this situation as there are methods to detect CUF and increase life expectations for Fireproofing and the steel structures that are desired to be protected. This paper looks into these options to increase safety and reduce life cycle cost of industrial facilities.

IM-03

Hydrogen Diffusivities of AISI 304 and AISI 304 Coated by Ni and Au

Krittayot Wannapoklang[a,*] and Gobboon Lothongkum[a]
[a]*Department of Metallurgical Engineering, Faculty of Engineering, Chulalongkorn University, Pathumwan, Bangkok, 10330, Thailand*
*Krittayot.W@student.chula.ac.th

Keywords: Hydrogen diffusivity, AISI 304, Ni and Au coating, Room temperature,

In petroleum industry, AISI 304 has been used as a storage tank of CO-H_2-CH_4-C_2H_4 mixed gases tank at high pressure and low temperature. It was reported that AISI 304 tank failed by hydrogen damage or hydrogen embrittlement, because hydrogen could diffuse in AISI 304. The coating of Ni or Au on AISI 304 were considered to reduce hydrogen diffusivity as well as hydrogen embrittlement. This research studied hydrogen diffusivities of AISI 304 and AISI 304 coated by Ni and Au. The experiments were conducted by an electrochemical technique followed ASTM 148 97 at room temperature. Electroplating was used for Ni and Au coating on AISI 304. X-ray diffraction (XRD) patterns were used for phase identification of coating layer. The thicknesses of AISI 304 and coating Ni or Au layers were approximately 100 and 1 μm, respectively. Hydrogen diffusivities were calculated from the relationship between current density and time curves.

IM-04

Small Bore Connection Inspection Campaign to Reduce Risk of Pipe Work Failure from Vibration and Incorrect Installation

Peera Yongsuwan[a*], Densil Kaewwichai[b] and Wootiphong Chaiyapom
[a] *Prompt Solutions Co..ltd, 99 Nakhon Nai Rd., Boyang, Muang Songkhla, Songkhla, 90000, Thailand*
[b] *Prompt Solutions Co..ltd, 99 Nakhon Nai Rd., Boyang, Muang Songkhla, Songkhla, 90000, Thailand*
*peeray@prompt-solution.com

Keywords: Small Bore Connection (SBC), Likely Hood of Failure (LOF), Pulsation Analysis, Strain Measurement, Finite Element Analysis

The oil and gas industry have a need for reliability and integrity improvement program in small bore connection (SBC) and piping system to prevent from SBC failure both from fatigue and improper installation. This is very important to detect and monitor condition of vibration and evaluate improper installation on SBC, this will be reduced risk of failure from SBC crack and increase the lifetime of SBC and mainline. There were many cases of pipe work failure in oil and gas industry in Thailand, each failure is economically for repair and lunching small bore connection inspection campaign.

Implementing SBC inspection campaign by vibration analysis and engineering assessment. The implementation will start with database assessment, vibration survey on filed, engineering site survey to find likely hood failure (LOF) and final assessment. In some case might need deep detail engineering study such as pulsation and vibration analysis, finite element analysis (FEA), Computational Fluid Dynamic, strain measurement and etc.

Over the last year Prompt Solutions company limited (Prompt) have provide SBC inspection campaign included with piping vibration survey, SBC assessment and non-destructive testing on SBC to reduce risk of SBC failure. Major advantage for this campaign is integrated of inspection technology and engineering assessment. The integrated of inspection will provide the most useful information and effective mitigation plan. The vibration measurement principle base on velocity vibration analysis for transient recording which relate to fatigue indicator then compare with guideline from Energy Institute and/or Beta Machinery Guideline.

Outcome of SBC inspection is risk matrix of each SBC that show result related to each inspection technology and engineering assessment. This campaign has been proving for effective inspection and mitigation result, with success implementation from oil and gas industry.

IM-05

Cathodic Protection of Oil & Gas, Refinery, Petrochemical and Power Plant Facility with Case Studies

Shaikh H Rashid
Himoya Corrosion Technology Pvt. Ltd., B 307 Jindal Tower, 21/1A/3 Darga Road, Kolkata-700017, India
*hct@himoyacorrosion.com

Keywords: Corrosion, Cathodic protection, interference, anode, cathode, etc.

Challenges for Corrosion Engineers, especially for oil & gas, refinery, petrochemical & power plant's facilities where multiple product pipelines, above ground storage tanks, RCC foundations, large diameter cooling water pipelines sharing same corridor or crossing each other within plant battery limits causes corrosion failure due to mutual interferences, such as pipeline leak, tank bottom plate corrosion and as a results production losses are common and routine. Corrosion Protection by Cathodic protection methods are widely acceptable corrosion prevention technology in all industries. Similarly in atmospheric structure such as stairs, steel platform, conveyor belt housing, boiler super structure, and other steel frame structures corrosion failure is a routine phenomenon. Painting and coting is widely acceptable corrosion prevention technology in all industries for atmospheric structures as well as submerged structures. On the other hand for buried and fully submerged steel structures, such as buried cooling water pipeline, product pipeline, above ground tank bottom corrosion protection is another challenge, whether to go with Galvanic/Sacrificial anode cathodic protection system or impressed current cathodic protection system and the second question is whether to go with remote anode or distributed anode system. Effective designing of a proper corrosion protection by cathodic protection system is a challenging task especially when the challenges are not known as well as lack of awareness and limited budget for plant maintenance.

In this paper few case studies will be discussed with the methods used, in accordance with NACE standard and other international standard in consideration with project specification.

The various methods adopted during corrosion survey & cathodic protection system chosen and in application are discussed in this paper.

Acknowledgment: Dr. Ekkarut Viyanit, Head, Coating and Joining Technology (CJT) Lab, National Metal and Materials Technology Center (MTEC)

References:

[1] NACE SP0169 Control of Underground or Submerged Metallic Piping Systems
[2] BS 7361-1:1991 - Cathodic Protection
[3] DNV-RP-B401 – Cathodic Protection Design
[4] Material Performance Magazine
[5] NACE Conference Papers
[6] NACE TM 0497 - Measurement Techniques Related to Criteria for Cathodic Protection on Underground or Submerged Metallic Piping Systems

IM-06

The Inspection for Hot Dip Galvanized Steel Products

Thuangpoom Sataranuwat
Thai Galvanizing Association and Union Galvanizer Co.,Ltd.
Email: ehboys@gmail.com

Keywords: hot-dip, galvanized coatings, ASTM specifications

Hot-dip galvanizing is one of the most economical, maintenance-free corrosion protection systems available. Like any other manufacturing process, hot-dip galvanized steel requires an inspection of the finished product to ensure compliance with applicable specifications. The inspection process requires a clear understanding of both specification requirements and compliance measurement techniques to make an accurate assessment.

For hot-dip galvanized products, a key feature is durability and decades of maintenance-free performance. For any environment, the service life of hot-dip galvanized steel is directly proportional to the thickness of the zinc coating. Thus, coating thickness is an important requirement in the specification and effectiveness of hot-dip galvanizing as a corrosion protection system.

Measuring coating thickness is only one of the many specification requirements in the inspection process. Other requirements include adherence, appearance, and finish.

The requirements for hot-dip galvanized coatings are found in three ASTM specifications;A123/A123M,A153/A153M,and A 780/A 780M. The difference between these specifications is the type of steel product covered by each. A 123/A 123M covers structural steel, pipe and tubing, flat bar, and wire. A 153/A 153M includes small castings, nails, nuts, bolts, washers, and small parts centrifuged after galvanizing to remove excess zinc. And A 780/A 780M covers repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings

IM-07

Effect of Alkaloids Extracted from *Crotalaria spectabilis* Stem on the Corrosion Inhibition of Mild Steel in 1M H_2SO_4 Solution

Hari Bhakta Oli[1], Dilip Singh Bohara.R[1], Birendra Bahadur Bista[1], Amrita Chapagain[1], Anju Kumari Das[1], Nabin Karki[2] and Amar Prasad Yadav[3*]

[1]*Amrit Campus, Tribhuvan University, Kathmandu, Province 03, 44600, Nepal*

[2]*Bhaktapur Multiple Campus, Tribhuvan University, Kathmandu, Province 03, 44800, Nepal*

[3]*Central Department of Chemistry, Tribhuvan University, Kathmandu, Province 03, 44618, Nepal*

*E-mail: amar2y@yahoo.com

Keywords: Crotalaria spectabilis, Green inhibitor, Mild steel, Potentiodynamic Polarization.

The degradation of materials due to spontaneous surface phenomenon is termed as corrosion. Galvanization and method of alloying has become common method to enhance the lifespan of steels. But, those are sacrificial corrosion protection methods. Alkaloid extracts of Crotalaria spectabilis plant as a green corrosion inhibitor on mild steel in 1M H_2SO_4 was studied using weight loss, OCP and potentiodynamic polarization method. The inhibition efficiency of extract varied with concentration of extract and duration of the immersion of mild steel in corrosive medium. The maximum efficiency 90.38% was shown in the optimum concentration at room temperature. The effect of temperature and immersion time on the corrosion behavior of mild steel was also studied. The maximum efficiency of 91.29% was obtained at 45 ℃ and efficiency is highly decreased at 65 ℃. The inhibition efficiency was found to increase with increasing concentration of the extract. It was further confirmed by potentio-dynamic polarization method, which showed a maximum efficiency of 92.86% in the 1000 ppm concentration of inhibitor solution. More effective inhibition concentration was found to be above 600 ppm and with 6 hrs of immersion time. The result showed that the Crotalaria spectabilis stem extract act as a mixed type inhibitor and show good and efficient inhibition on the mild steel in 1M H_2SO_4 solution.

OG:
Oil, Gas, Refinery and Petrochemical Session

OG-01

Failure of Instrument Gas Tubing and Re-thinking for the Solutions

Kamonwan Ruangpattanatawee
PTT Exploration and Production Public Company Limited, Thailand
Energy Complex Building A, Floors 6, 19-36
555/1 Vibhavadi Rangsit Road, Chatuchak, Bangkok 10900, THAILAND
*kamonwanr@pttep.com

Keywords: instrument gas tubing, stress corrosion cracking

Failures of instrument tubing continue to be a concern. Historical incidents reveal that two major causes leading to the tubing leakage incidents. The first one is a corrosion due to material selection and foreign particle contaminations on the tubing surface. Another one is a crevice corrosion underneath the tubing support. Failure analysis were carried out many times and it was concluded that the failures were because of pitting and crevice corrosion, but no evidences of chloride stress corrosion cracking (SCC).

904L is specified for tubing material instead of 316L in company specification. However, usage of 316L tubing and tubing failure cases still present in some turnkey skids and some deviated projects for short design life wellhead platforms for cost saving purpose. In some failure cases, the failure of 316L tubing occurred rapidly just prior to commissioning and start up. Corrosion underneath the tubing support is also reported in several cases even when 904L was used. Therefore, with updated technology and materials available, alternative solutions to solve both integrity and spend smart aspects are being studied.

OG-02

Chloride Stress Corrosion Cracking (Cl-SCC) and Where to Find It in Petrochemical Plant

Weerawat Terdthaichairat*
PTT Global Chemical Public Company Limited, Thailand
*weerawat.t@pttgcgroup.com

Keywords: Chloride-Stress-Corrosion-Cracking (Cl-SCC), Thermal Spray Coating

In petrochemical industries, variety of corrosion and environmental-assisted cracking damages are the main concerned issues for plant integrity and maintenance. Chloride-Stress-Corrosion-Cracking (Cl-SCC) is one of the concerned damage mechanism particularly for downstream process plant where constructed material is austenitic stainless steel and serviced under chloride-contaminated process. Typically, Cl-SCC is susceptible to occur in stressed austenitic stainless steel which serviced in aqueous environment with chloride contamination. High stress point such as heat-affected zone (HAZ) of weldment and cold-formed elliptical head are the main concerned points that contained high residual stress which induced Cl-SCC to occur there. To prevent Cl-SCC damage in the plant, among of stress reduction, environmental control and higher Cl-SCC resistance material application are the typical methods to consider. Heat treatment of cold-formed elliptical head has been proved that can decrease Cl-SCC susceptibility to the equipment. Thermal spray coating with higher resistance material and shot-peening method on austenitic stainless-steel specimens were tested and investigated in laboratory test by boiling MgCl2 resulted in greatly Cl-SCC resistance enhancing to the specimens. Thermal Spray Coating with Alloys C-276 was selected to apply on oxygen analyzer probe which was found severe Cl-SCC damage on the probe after 2 months of operation in severe Cl-SCC condition of waste heat boiler. The investigated result was shown that the probe with coating can survive in the condition longer than before and no sign of leaking had been found for 1 year of operation.

OG-03

Offshore Well Casing Splash Zone Remediation and Repair Alternatives

Chanat Sirisoonthorn
Chevron Thailand Exploration and Production, Ltd.
Email; CSAH@chevron.com

Well integrity issue on surface casing of aging facilities has been experienced during the recent years, especially in Gulf of Thailand which has more than six hundred surface casings operated since day one. Statistically, the vulnerable areas always located on splash zone which is the most challenging working area for maintenance team in the aspect of safety, economy and complexity between topside crews and divers. This project covers the pros, cons and selection of remediation and repair alternatives for surface casing at splash zone and implementation in order to prevent loss of containment event, affecting to environmental and business impacts.

The project includes remediation methodology (Epoxy Sleeve(diver-less) and Composite Wrapping) to prevent external corrosion from sea water and repair methodology (Welded Leak Box Repair (underwater welding), Cold Bonding, Under Water Composite Wrapping and Customized Mechanical Clamp) to resume pressure contain ability of surface casing. The comparison of each alternative has been engineering analyzed and proved through mock-up tests and real-world implementations to ensure practicality, effectiveness and economic justification. Also, the selected alternative should not create post-activity problem in the future such as obstructing rig to perform Plug & Abandonment activity. After evaluating, Customized Mechanical Clamp is the most outperforming alternative for repair scenario due to less time consuming, sequence complexity, total cost assessment and equipment capability and Epoxy Sleeve (diver-less) is the best remediation option to extend casings' service life at splash zone.

Moreover, the study also considers on a new diver-less concept to assist repair and remediation at splash zone by innovating "Dry habitat chamber" for topside crews to safely work under water which could save diver cost tremendously. This technology will play a significant role to expand well integrity solutions for many surface casings by reducing diver operation cost.

Regarding to the study and implementation, Thailand has successfully secured the well integrity through remediation and repair over ten surface casings and continued by Epoxy Sleeve(proactive) and Customized Mechanical Clamp (reactive). The concept of splash zone remediation and repair can be applied for any pressure containing and non-pressure containing equipment in the different configuration.

Challenges:

- The design and constructability sequence are the most challenging issue since it is the pioneer project to study and implement remediation and repair jobs at splash zone areas. The feasibility, cost control and safety concern should not show any stoppers.
- Working at splash zone area is risky and costly. Good planning and back-up plan are required to avoid unexpected event leading to unsafe working condition or delay of diving operation (major cost of the project).

Comments:

- This study and implementation were the first time in Thailand that we explored the opportunity to prevent re-drill the well to continue operating and maintaining surface casing integrity in the aspect of proactive and reactive methods. The results showed the effectiveness and practicality including real spending to achieve the job. It can be applied to pressure or non-pressure containing part at splash zone area, benefiting to any BU that have the same integrity issues.

OG-04

How to Address Corrosion Under Insulation (CUI) Issues in Petrochemical Plants? – A Systematic Approach

Tanapat Kaewmaneekul*
GC Maintenance and Engineering Company Limited (GCME),
Rayong, 21150, Thailand
*E-mail address: tanapat.k@pttgcgroup.com

Keywords: CUI inspection methodology, Qualitative assessment parameters, Susceptible areas, Proper inspection and/or monitoring methods

Corrosion under insulation (CUI) is one of the most well-known phenomenon and major concern in petrochemical plants. It has undoubtedly been occurring for as long as piping and equipment have been insulated for thermal conservation or process control. Normally, CUI is defined as the external corrosion occurring when water trapped beneath the insulation. The forms of damage include localized loss of thickness in carbon and low alloy steels and chloride stress corrosion cracking in austenitic and duplex stainless steels.

This talk will elucidate the systematic approach to address CUI issues. The CUI inspection methodology is developed to assess the likelihood, determine the susceptible areas and recommend the proper inspection and/or monitoring methods. Besides, the optimum qualitative assessment parameters and rating score will also be introduced. This methodology benefits to plants in terms of to increase the integrity and reliability, and to reduce the cost for inspection and monitoring.

OG-05

The Advancement of Non-destructive Testing Technologies in the Oil & Gas Industry

Puripong Klamdith[a,*]
[a]*GC Maintenance and Engineering Company Limited,*
Muang Rayong, Rayong, 21150, Thailand
*Puripong.k@pttgcgroup.com

Keywords: NDT, Non-destructive testing, Array technology, Full matrix capture

Nowadays, non-destructive testing (NDT) play an important role in assuring integrity and safety of the components in oil and gas industry. Since NDT does not cause any permanent changes in the material being inspected, it is valuable technique to detect, characterize, or measure the presence of damage mechanisms. The NDT technology has rapidly improved over the years by the advancement of digital and signal processing technology.

This article describes recently state-of-the-art inspection technologies for surface (surface eddy current array) and subsurface (phased array ultrasonic testing with full matrix capture) flaws detection, corrosion under insulation inspection (pulsed eddy current array) and eddy current array for non-ferromagnetic heat exchanger tube inspection. The key benefits are discussed.

OG-06

Case Study of Cathodic Protection System for Steel Used in Buried/ Immersed Environments or Concrete Structures in Oil and Gas Refinery

Sarun Choomchaiyo [a *]
[a]*Aurecon Consulting (Thailand), 11th Floor, Unit 1101, Pakin Building, 9 Ratchadapisek Rd, Din Daeng Bangkok Thailand 10400*
*Sarun.choomchaiyo@Aurecongroup.com

Keywords: Corrosion Mitigation, Cathodic Protection (CP), Monitoring and Inspection.

A major cause of unscheduled plant shutdowns in aging infrastructure is corrosion of steel in buried or immersed environments or steel reinforcement in concrete structures.

To prevent corrosion problem and minimize the risk of unscheduled maintenance due to costly failures, ultimately risking possible plant shutdown and environmental pollution.

Cathodic protection (CP) is one of the corrosion mitigation methods employed in oil and gas plants. After commissioning the CP system, the interval monitoring and inspection shall be conducted to maintain and extend service life in accordance with international standard practices.

The following case studies had been found during inspection at oil and gas refineries:

- Incorrect monitoring and interpretation of CP potential reading
- Underprotection and overprotection problems
- Unbalancing protection level
- Insulating flanges shorted
- Interference and stray current from adjacent systems

OG-07

The Study of Using Thermoscan for CUI Detection

Kittapart Wiriyachanta and BCP inspector team
Bangchak Corporation Thailand, 210 Soi Sukhumwit 64, Sukhumvit Road, Phra Khanong Tai, Phra Khanong, Bangkok 10260
Email: Kittapart@bangchak.co.th

Keywords: Corrosion under insulation, Non-destructive testing, Thermoscan

Corrosion under insulation (CUI) of insulated pipe and equipment is the one of most frequent failures which occurs in refinery plant and other process facilities. Normally, CUI detection is very difficult because it cannot be observed by the naked eyes. The highly effective CUI inspection at present is visual inspection by dismantling cladding and insulation at high risk location. However, this practice has yielded inaccurate results, and comes with high inspection cost. Therefore, the purpose of this study project is to find out new CUI inspection technology with higher detection accuracy and lower inspection cost.

The 5 techniques which studied in this project based on API583 standard and results of study found that “Thermoscan technique” is the most effective technique with lowest CUI inspection cost. The accuracy can be increased to 95.8% and inspection cost reduced by 60,000 USD per year. However, this technique also has some limitations which need to be concerned during inspection activity.

To conclude, the use of Thermoscan technique with awareness of its limitations can mitigate the probability of CUI failures as well as CUI inspection cost. The values of this study project are increase in integrity, reliability of refinery asset and safety of process operation of the plant.

OG-08

Development of Water Base High Emissivity Ceramic Coating for Scale & Fouling Prevention and Energy Saving at High Temperature Application

Nikom Chawalitkijmongkol* and Santiwong Boonrueng
Thaioil Energy Services Co., Ltd (Head Office)
*Email: nikomc@thaioilgroup.com

Keywords: High Emissivity Coating, Scale Formation, Energy Saving in Furnace

Oxidation scale formation is generally found in furnace tube which is made of carbon steel and alloy metal. In addition, fouling, especially oil fuel, is usually found in furnace. Over time processing in firing furnace, scale and fouling is thicken outside the furnace tube of process. Increasing firing rate is required to overcome the heat resistance of scale and fouling layer. High emissivity ceramic coating for scale and fouling prevention is an acceptable approach. Moreover, high emissivity ceramic coating can increase an ability to absorb heat, especially in radiant zone, of the process tube. It was proved that high emissivity ceramic coating can prevent scale and fouling formation using commercial high emissivity ceramic coating in Thai Oil's furnace. In addition, energy saving also can be achieved due to higher heat adsorption in radiant zone. However, cost of commercial coating is key concerns. Thai Oil has developed In-House water base high emissivity ceramic coating. Emissivity of developing high emissivity ceramic coating is greater than 0.90. Adhesion of the developing coating film is higher than 12 MPa. It was confirm that the developing coating film can resist thermal shock from 650 to 300 DegC.

OG-09

Overview the Materials Selection for Engineering Work Practice

Pattima Rattanatrakool*
GC Maintenance and Engineering Company Limited (GCME),
Rayong, 21150, Thailand
*E-mail address: Pattima.r@pttgcgroup.com

Keywords: Material Selection Diagrams (MSD), Heat & material balance, P&ID, PFD, Corrosion Allowance, Inside and Outside Battery Limits (ISBL/OSBL)

The material selection diagram (MSD) is an engineering drawing, which shows material selection information and specification of the piping and equipment in a process unit/facility. Process Engineer, Material Engineer and the metallurgist of project normally develops the MSD from simplified Process Flow Diagrams (PFDs).

The MSDs are important documents and generate in the first process work practice for the engineering works. One MSD document consists of equipment, piping and unit package that is specified the materials type, corrosion allowance, corrosion conditions, international standard references, and special requirements in NOTE for a specific project.

On this session will present to the key parameters of MSD for consideration. The frequency question is *"Is necessary to require the MSD for FEED Project?"* For engineering work practices in FEED, EPCa, EPCm, PMC projects require the MSDs for all projects. The MSD and the material selection philosophy document should have the heat & material balance, PFD, BEDD and process descriptions for the consideration.

In technically, the MSD shall be reviewed by metallurgist and process engineer together. It is very important to the FEED project and all disciplines.

PG:
Power Generation Session

PG-01

Stress Analysis and Corrosion Fatigue Test of the Propeller Blade in Cycloidal Drive

Swieng Thuanboon
Royal Thai Navy, 2 Arunamarin Rd. Bangkokyai Bangkok 10600
Email; swieng@hotmail.com

Keywords: Cycloidal Drive, Voith Schneider Propellers

The Cycloidal Drive or Voith Schneider Propellers (VSP) are widely used in the ship with safety and extreme maneuverability requirements. On the Cycloidal Drive, the rotor is mounted below the ship's hull and rotate about a vertical axis. The resultant force of all blades can be generated freely in any direction. One of Thailand's ship is prone to propeller blade break down at the root of the blade. The failure analysis shows that the blade is subjected to corrosion fatigue. The objective of this research is to investigate type of corrosion and the stress on the propeller blade at the different the rotor speed. Microstructures of blade have been investigated for corrosion study. For stress analysis, the investigation has been carried out as 3-D nonstationary flow around the propeller using ANSYS Fluent 15.0 with the Shear-stress transport (SST) k-ω turbulence model. The calculation stress will be used to predict fatigue life cycle of blade. The results show that blade material is manganese aluminum bronze and is subjected to dealloying corrosion at beta phase. The maximum stress occurred at the junction between the shaft, which mounted in a rotor casing and protruded blade as a cyclic load between tension and compression. Blade will subject to stress more than 400 MPa when rotate at 350 degree, this high stress is greater than yield point of manganese aluminum bronze which is used for blade material. Fatigue life cycle of blade is about 7 years.

PG-02

Corrosion Behaviour of Stainless Steels in Molten Nitrate Salt

P. Kettrakul[a,*], N. Kanjanaprayut[a, b], P. Treewiriyakitja[a, b], S. Joy-A-Ka[c], T. Siripongsakul[a] and P. Promdirek[a,*]

[a]High-Temperature Corrosion Research Centre, Department of Materials and Production Technology Engineering, Faculty of Engineering, King Mongkut's University of Technology North Bangkok, Bangkok, 10800, Thailand

[b]Corrosion Department, TFII, King Mongkut's University of Technology North Bangkok, Bangkok, 10800, Thailand

[c]Material Properties and Failure Analysis Laboratory, Material Properties Analysis and Development Centre, Thailand Institute of Scientific and Technological, 12120 Pathumthani, Thailand

*E-mail address: piyorose.p@eng.kmutnb.ac.th

Keywords: Molten nitrate salt, hot corrosion, concentrating solar power, Stainless steel

Due to the most cost-effective renewable electricity technology and plentiful supply, concentrating solar power (CSP) is currently being a new candidate for providing the majority of the renewable energy in Thailand. When the heat transfer fluid (HTF) such as nitrate salt have been used for energy storage, the materials degradation in CSP components is often concerned with hot corrosion in molten salt. The objective of this research is to study the corrosion behaviour of ferritic and austenitic stainless steels such as AISI430 and AISI304 in conventional and modified molten nitrate salt (60%NaNO3/40%KNO3+5%NaCl). The physico-chemical and electrochemical characterisations were then investigated. It was found that there was effect of NaCl on the corrosion rate, showing higher corrosion rate. According to the surface morphology and electrochemical results, the mechanism of hot corrosion of stainless steels was further discussed in this research.

PG-03

Corrosion Reduction by Feed Water Treatment Program AVT-R to AVT-O at BLCP Coal Fired Power Plant

Kaewmanee Netrkaew
BLCP Power Plant 9, I-8 Road, Map Ta Phut Industrial Estate, Muang, Rayong, 12150. Thailand.
*kaewmanee_nk@blcp.co.th

Keywords: Water Treatment, All Volatile Reducing, All Volatile Oxidizing

Corrosion failure can directly affect the reliability and efficiency of the power plant. It could cause unplanned maintenance which will create extraordinary expenses from maintenance activities and lost revenue. The major corrosion problem could occur in main equipment including Boiler tubes, Super heaters and reheaters, Turbines, Condensers and Feed water heaters.

There are a number of possible causes of corrosion failure including ineffective control of water chemistry, wrong design or even, improper selection of material.

High quality Boiler water feed and high quality of condensate return will minimize waterside deposit accumulation inside boiler system.

BLCP Power Station has two Subcritical Boiler units and in early Y2017 water feed treatment program was changed from All Volatile Reducing (AVT-R) to All Volatile Oxidizing (AVT-O)

The change to the Feed water treatment program was made with the expectation that direct and indirect costs associated with operation will be reduced ie. Start-up time, water consumption, chemical and fuel cost. It's also expected that the revenue from operation will be increased from selling power after the obligation under the power purchase agreement is met so called outside CAH.

In August 2018, after water feed treatment program had been changed from AVT-R to AVT-O, the Chemists' report revealed that all expected results are met i.e. during normal operation, Iron corrosion product in both Boiler units were reduced from 10ppb to less than 5ppb, start-up time was reduced from three hours to one hour due to less suspended result of Iron corrosion product measured. Lastly, HP Feed water Heater flushing was reduced to less than one NTU within one hour at 25% load.

Currently, water quality of Feed water and Boiler water are satisfactorily achieved with EPRI guideline control as 2 of 5 ppb.

PG-04

Investigation of Cl-SCC of a Stainless Steel Bellow in Boiler Penetration Seals

Jutaporn Chaicherm[1,a] , Yossapon Deesupub[1] ,
Thee Chowwanonthapunya [2,b*]
[1] IS Industrie (Thailand) Ltd. Bangkok 10800, Thailand
[2]Faculty of International Maritime Studies, Kasetsart University, Sriracha, Chonburi 20230, Thailand
[a]j.chaichalerm@is-industrie.co.th , [b]* thee.c@ku.th

Keywords: Cl-SCC , Stainless Steel , Fractography , EDS spectra

The failure of the stainless steel bellow used in the expansion joint system was investigated using metallographic studies. The investigation at the fracture surface clearly indicated the highly branched intergranular cracks. The presence of chloride was also evidently revealed by the EDS spectra. Thus, all of evidence suggested that Cl-SCC from the combination of the presence of chloride and residual bending stress was responsible for the failed stainless bellow.

PG-05

Development of AISI 430 Stainless Steel Coated by Mn-Co Spinel Doped with a Reactive Element for SOFCs Interconnect Application

Panya Wiman, Thamrongsin Siripongsakul, Somrerk Chandra-ambhorn*
High Temperature Corrosion Research Centre, Department of Materials and Production Technology Engineering, Faculty of Engineering, King Mongkut's University of Technology North Bangkok, 1518 Pracharat 1 Road, Wongsawang, Bangsue, Bangkok 10800, Thailand.
*somrerk.c@eng.kmutnb.ac.th

Keywords: Anodic electrochemical deposition, Mechanical adhesion interface, Spinel SOFCs interconnect

At the working temperature of about 800°C, ferritic stainless steels are promising materials to be used as an interconnect in solid oxide fuel cells. This is because the ferritic stainless steel has a thermal expansion coefficient similar to that of the single cell. Furthermore, with appropriate surface modification, the electrical conductivity of the steel in service, which is the major property for this application, can be improved. One of the surface modification methods is coating typically with spinel or perovskite. Further, it is well known that the addition of the reactive element to stainless steel tends to improve the scale adhesion, thus avoiding the formation of air gap between those two parts which can drastically increase the electrical resistance of the steel used at high temperatures.

The objective of this talk is to present the progress of our work concerning the Mn-Co spinel coating on AISI 430 ferritic stainless steel. The reactive element, i.e. Ce, is added to the coating layer. Characterisation of the coated layer and its adherence to the steel substrate will be presented.

กฟผ.

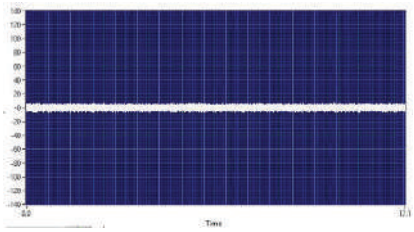
เพื่อชีวิตที่ดีกว่า
กฟผ. 50 ปี

50 ปี แห่งความมุ่งมั่น เพื่อชีวิตที่ดีกว่า

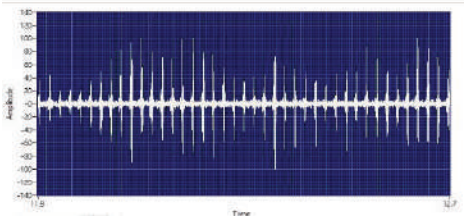
เพราะเรา...ตระหนักดีว่าพลังงานไฟฟ้าไม่เพียงสร้างความสะดวกสบายในชีวิตประจำวัน
แต่ยังเป็นพลังผลักดันคนไทยทุกชีวิตให้ไปถึงเป้าหมาย...ผลักดันศักยภาพของประเทศให้ก้าวทันการเปลี่ยนแปลงของโลก
ตลอด 50 ปี เราเชื่อมั่นและภูมิใจว่าสิ่งที่เรามุ่งมั่นทุ่มเท ลงมือทำ สร้างความมั่นคงทางพลังงานไฟฟ้า
และทางเลือกชีวิตที่ดีกว่า ยั่งยืนกว่าสำหรับคนไทย

ULTRASONIC DETECTION

PREDICTIVE MAINTENANCE BY ULTRASONIC SOUND



Normal



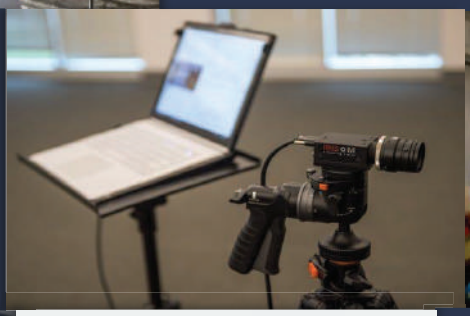
Abnormal

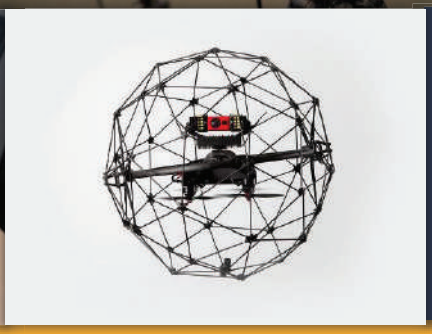
PULSED EDDY CURRENT

No need to removeinsulation/fireproofing

MOTION AMPLIFICATION

Visualize Vibration





UAV INSPECTION

Improve Onboard Safety for Inspectors

ELIOS

Inspect & Explore Indoor and Confined Spaces

Advanced NDT Service

- Pulsed Eddy Current (PEC)
- Acoustic Emission Testing (AE)
- Tube Inspection (RFT/ECT/IRIS)
- Phased Array Ultrasonic Testing (PAUT)
- Corrosion Mapping
- Rope Access Inspection

Inspection Consulting

- CUI Inspection Consulting
- Root Cause Failure Analysis
- Fitness-For-Service
- Inspection Training

Inspection Management and Execution Service

- Risk-Based Inspection (RBI)
- Conventional NDT
- UAV Inspection/Elios
- Spring Hanger Inspection
- QA/QC Inspector

Integration Condition Monitoring Service

- Vibration Analysis
- Multi-Channel Vibration Diagnostic
- IR Thermography
- Integration Condition Monitoring
- Motion Amplification (MA)
- Ultrasonic Detection

Contact : Chanadda.S@pttgcgroup.com , Tel. 66(0)856507505
Website : http://www.gcme.co.th

Corrosion Service

Corrosion Service is a testing service of PTT Innovation Institute providing corrosion of steel testing, corrosion inhibitor evaluation, corrosion residue analysis, and technical consultancy.

The effects of corrosion can be costly and devastating, so it commonly conducts testing before damage occurs, often during changing condition and product design to help corrosion management.

Corrosion of Steel Testing

Corrosive Study
- Material Selection
- Chemical Compatibility

Technique
- LPR Technique
- Weight Loss Technique

Corrosion Inhibitor Evaluation

Performance Evaluation
- Bubble Test
- Pre-partitioning Rotating Cylinder Electrode Test (PRCET)
- Autoclave Test

Physical Properties
- Solubility Test
- Emulsion Tendency
- Foaming Test
- Compatibility Test
- Thermal Stability Test

Corrosion Residue Analysis

- **Metal Analysis**
- **Composition Analysis**
- **Corrosive Agents Analysis**
- **Corrosion Inhibitor Residue Analysis**
- **Microbiologically induced corrosion (MIC) test**








Contact : ***Innovation Institute***
Narathip.p@pttplc.com, Tel : 02-537-3000 ext. 18443