Rapporteurs' Report on Coating Fingerprint Satellite Symposium

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IMTCE2016 Under the auspices of **10th International Materials Technology Conference & Exhibition"**
a turnkey industry-academia project that is custom-tailored for oil and gas industry"

Date 17 May 2016
Time 8.30 am to 5.30 pm
Venue Putra World Trade Centre, Kuala Lumpur, Malaysia


Handheld FTIR


Benchtop FTIR

Datuk Ir, Kamarudin Zakaria giving his keynote speech

Introduction

In the Fingerprinting Satellite Symposium (FPSS), the practicality of fingerprinting polymeric coatings was highlighted. Datuk Ir. Kamarudin Zakaria, PETRONAS, Malaysia graced FPSS by delivering a keynote speech. He shared that the paints, coatings & corrosion industries in Malaysia generate a total turnover of over RM20 billion per annum across all industries, from oil & gas, buildings, transmission, transportation, defense and the shipping industries. From the recently published NACE International (National Association of Corrosion Engineers), The International Measures of Prevention, Application, and Economics of Corrosion Technologies (IMPACT) Cost of Corrosion Study in March 2016, the global cost of corrosion amounts to as much as US$2.5 trillion per annum. It stated that between 15 to 35% savings, about US$375 to US$875 billion, of this worldwide value, can be realized by implementing corrosion control strategies. He placed the successful collaboration between industry and academia under the IMM Taskforce on Coatings Fingerprinting as contributing to the long term quality assurance of coatings applied, in particular for the oil & gas industry.

Keynote and Invited speakers from different background (users, applicators, researchers, instrument suppliers) and regions gave their insights concerning coatings fingerprinting. It can be concluded that {**Coating Fingerprint Certificate**, which covers (1) physical analyses [e.g. viscosity, density, color code, non-volatile matter (by mass), mass of Zn metal/Total Zn *etc*] and (2) structural analyses (*i.e.* FTIR)} is a suitable QA/QC tool that enables paint manufacturers and customers to access the quality of the paint products, at the same time ensure that the supplied paint products by the manufacturers were not tampered.

Below are the summaries of each session:

Presentation

1. **Can we fingerprint polymer paints?**
by **Assoc. Prof. Dr. Chan Chin Han from Universiti Teknologi MARA, Malaysia**
Multi-component search across different FTIR softwares shows different possible components in all studied materials (e.g. color pigments, 2-pack epoxy intermediate materials). Hence, coatings formula remains trade secret, even though spectra of Fourier-transform infrared spectroscopy (FTIR) are submitted along with the delivery of the polymeric coatings. Characterizations of the raw materials (viscosity and density) as well as final products (adhesion and dry film thickness) can hardly be differentiated for different grades of materials with exception on the salt spray test. The salt spray test is usually performed before the paint manufacturer submits its product for qualification and tender purpose. In other words, batch-to batch Coating Fingerprint Certificate is practical approach for QA/QC. It is found that, different grades of raw materials from same raw materials supplier do not meet the acceptance criteria for the structural analysis by FTIR [*i.e.* degree of similarity (r) < 0.900]; while the same grade of raw materials (with similar specification) from different suppliers meet the acceptance criteria.

2. **Coating performance: Applicators' perspective.**
by **Mark Hew Yoon Onn from Universal Corrosion Engineering, Malaysia**
For a successful paint application, three parties are involved. They are applicators, inspectors and paint manufacturers. Applicators must adhere to standards and follow technical instruction. Improper mixing ratio (e.g. part A and part B) and incorrect use of thinner may lead to coating failure. The applicator should be aware of the weather, pollution and contamination in which the coating is applied. It is advisable that the application is done indoor. Inspectors, on another hand, must ensure the specifications are met and followed correctly. Equipment quality (such as gas compressor, sprayed gun) and weather (humidity and temperature) are two critical factors determining successful coating application. Lastly, paint manufacturers must assure

high paint quality packed with proper packaging. The **Coating Fingerprinting Certificate** can be used to detect non-conformance of paint at early stage, which may decrease the chances of premature coatings failure.

3. **Advance 2-D IR, FTIR imaging spectroscopic technique in complex polymeric material characterizations**. by **Kenneth Way from Perkin Elmer, Malaysia**

Perkin Elmer collaborated with Tsinghua University to develop 2-D FTIR imaging for complex materials (e.g. polymers, proteins, liquid crystals). In the method, they used heat perubation to study the kinetics of complex materials. In the analysis, synchronous and asynchronous can be used to study the whole range of dynamics changes in the materials. Two examples were given on biopolymers and mutagenesis in drug studies for the 2-D FTIR imaging. The distribution of proteins related to serious or mild infected can be easily observed. Imaging technique allows one to determine the ratio of copolymer and chemical microstructure of polymer blends.

4. **Characterization of Zn and non-volatile matter in polymer coating through EDS method towards Coating Fingerprint Certificate.** by **Dr. Mahmood Anwar from Curtin University, Malaysia**

Elemental and physical analyses are among the provided information (in the form of mill certificate) when we purchase metal from industry. It has been long in practice. In polymeric coatings, the similar approach should be implemented. For example, organic zinc-rich coatings, 99.995% pure metallic zinc and more than 94% metallic zinc in their zinc dust have to be revealed in the original mill certificate from the zinc dust supplier. Preliminary studies show that X-ray c/w energy dispersivespectroscopy (EDS) may be useful for timely analysis on metallic zinc purity and concentration.

5. **A world's first coatings fingerprinting: A successful industry-academia collaboration**. by **Nurul Asni Mohamed from Petronas GTS, Malaysia**

The cost of corrosion is as much as $375-875 billion USD per annum according to NACE. Typical QA/QC procedure involves (1) coatings approval control, (2) coatings specification, (3) blaster, painter and coatings inspector certification, and (4) incoming product quality. There is however a missing guideline to the incoming product quality. Coatings fingerprinting is a method of identifying a coating material through laboratory analyses. Coatings fingerprinting has been mentioned in the standards such as ISO20340, NACESP0108, IMP PSPC MSC288(87) and DNVGL-CP-0139 (Dec 2015).

The success of coatings fingerprinting based on epoxy materials has been documented in phase I project. The phase II project is concluding. At the moment, IMM is documenting the fingerprinting standards and will later be made into Malaysia standards and NACE standards. As far as potential implementation issues are concerned, there is no major impact to overall production cost (as low as 2 cents per liter of production with in-house testing and 10 cents per liter for third party laboratory). The **Coating Fingerprinting Certification** resides under IMM and is a long-term solution to cost-effective QA/QC of coatings.

6. **Handheld non-destructive FTIR analysis of a variety of coatings and substrates plus their in-service related spectroscopic changes.** By **Dr. Tang Pik Leung from Agilent Technologies, United Kingdom**

FTIR interpretation depends on interface types. In his talk, he showed a case study of fingerprinting and in-service weathering study. The cost of coating depends on additives and that dictates the performance of the paint. Dr. Tang showed a comparison between diffuse spectra against ATR spectra. According to him, diffuse spectra yield promising results and this sampling method is complementing ATR sampling method for FTIR. ATR sampling method may not be sensitive towards metallic or inorganic component. Application examples are: weathered PVC coating, epoxy cured with and without

7. **Possibility and limitations of FTIR finger printing of paints from a coatings producer's perspective**. by **Herdi Lindstrøm from Jotun AS, Norway**

GC-MS, LC, GPC, ICP-OES and SEM are among the tools for the QC of polymeric coatings. The degree of similarity estimated by FTIR software for the sample FTIR spectrum as compared to Reference FTIR spectrum can be used as the QC tool as well. Examples of FTIR spectra of epoxy material were given. Different types of epoxies can be differentiated using degree of similarity estimated by FTIR software. Jotun is positive and confident that coatings fingerprinting is a good QA/QC tool. Jotun would like to know further on the "How are 3rd-party laboratories performing coatings fingerprinting".

8. **Fingerprint technique as a means of ensuring specification compliance**. by **Andrew Smith from Akzo Nobel Pty Limited, Australia**

A brief QC tests conducted was given such as specific gravity, mass solids, ash contents, FTIR trade on the binder. Coatings fingerprinting is for comparison purpose and is not for chemical analysis. The certificate must be produced immediately after each batch of the paint production. There are still some challenging issues to be address for the success in implementation of coating fingerprint certification.

9. **Shell Malaysia's insights on Coating Fingerprint Certificate implementation in Malaysia.** by **Ir. Ong Hock Guan from Shell, Malaysia**

Ir. Ong elaborated Shell practice and current position. At the moment, the coatings fingerprinting is not a requirement in Shell project although it is included in Technical Specification of Shell Global Solutions International B. V. (Shell GSI) (2009) for Design and Engineering Practice (DEP 30.48.0031-Gen) on Protective Coatings for Onshore Facilities. Ir. Ong mentioned that it was probably good because the vendors for Shell also have to comply to PETRONAS qualification specification. One of the contributing factors to coatings failure is due to surface preparation. According to Ir. Ong, Shell at the moment is in neutral position but positive towards coatings fingerprinting. Shell does not check the consistency of batch-to-batch supply of paints and only new coating formulas need coating fingerprinting. Currently, Shell is looking at the development of thin coating that is more moisture-tolerant and surface-tolerant.

10. **Coatings failures: Consequences, recommendations & analysis.** by **Rehan Ahmed from PETRONAS Carigali, Malaysia**

Rehan Ahmed cited a few major incidents from 2006 Alaksan oil spill and 20% of coatings failure are due to improper design specification and poor product formulations. There is also a lack of regulations / law enforcement. For solutions, we need retailed planning (segregate online vs offline based on criticality), and perform

11. **Maintenance Coating and Cost of Failure.** by **Mr. M. Farid Mohamed from Petronas GTS, Malaysia**

According to M. Farid Mohamed, PETRONAS ECMP uses priority based on criticality to monitor the coatings performance. They listed down prioritization based on increased plant integrity. The process starts with planning, do, and check.

Several questions were raised during the dialogue session, as follows:-

Q1 According to Pn. Nurul, oil & gas companies are looking into asset life extension. This includes predicting the remaining life of existing coating. Pn. Nurul sought detail on the aging characterization using handheld FTIR from Dr. Tang (Agilent), whether FTIR can differentiate between good and bad coatings, as well as quantifies the remaining lifetime of a coating.

Dr. Tang replied that by using an accelerated aging of a coated steel panel, e.g. epoxy coating, under controlled environment, one can perform FTIR analysis on many spots at different aging time and conditions. In later stage, we could estimate the lifetime of the coating using PCA-based model.

Q2 Ir. Ong Hock Guan from Sarawak Shell Sdn. Bhd. asked Farid Mohamed (PETRONAS) on the applicability of risk-based assessment to the actual description plan for maintenance, e.g. blasting. Does PETRONAS follow the report by Materials, Corrosion and Inspection engineer or they still do conventional maintenance, e.g. 5-year blasting on the whole structure? Ir. Ong further queried about how PETRONAS overcomes the issue of conventional maintenance.

Farid Mohamed replied that to overcome the issue, the stakeholders from inspection, maintenance from civil and asset owner needs to meet up and discuss. Based on discussion, they could get a good flow and act further.

Q3 Jotun sought clarification on (a) the FTIR fingerprinting of inorganic components in paints, (b) library build or generation of Reference spectra, and (c) compliance between third party laboratory and paint manufacturer.

Assoc. Prof. Dr. Chan Chin Han replied that the inorganic components in paints may be IR inactive; thus one needs to evaluate other compliances in instead of only looking at the FTIR fingerprinting. For example, certificate of % purity of zinc by metal manufacturer for organic zinc and inorganic zinc to be appended with **Coating Fingerprint Certificate.** For the generation of Reference spectrum, every paint manufacturer who is involved in the project needs to generate a Reference spectrum by averaging a minimum number of 9 spectra from top, middle and bottom of the mixing tank. This reference spectrum is to be submitted for qualification test and shall be kept by the end user, e.g. PETRONAS or Shell. Pn Nurul added that PETRONAS would like to have their own library on the FTIR Reference spectra.

Q4 Mr. Andrew Smith from Akzo Nobel Protective Coatings asked Ms. Nurul Asni Mohamed from PETRONAS GTS that everybody strives to do the right thing, but who is actually responsible to the coating failure?

Pn. Nurul replied that PETRONAS has never claimed insurance or aim at any parties when coating fails. Paint manufacturers and applicators point finger towards each another for premature coatings failure. Implementation of **Coating Fingerprinting Certificate** should enhance reproducibility of batch-to-batch paint, which will leads to quality assurance in coatings performance.

From the right: Puan Nurul Asni Mohamad from PETRONAS, GTS; En. Mohd. Azmi Mohd. Noor from PETRONAS, Upstream HSE; Datuk Ir. Kamarudin Zakaria, PETRONAS, Vice President of Group of HSE & Operational Excellence; Prof. Dato' Dr. Mansor Salleh, University Kuala Lumpur; Ir. Max Ong Chong Hup, Norimax Sdn Bhd

FPSS audience

Group photo

A quarterly magazine PP 18691/01/2015 (034114) / ISSN 2289-9030

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Issue 14

July 2016

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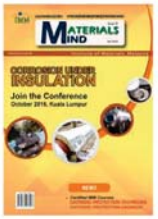

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EDITORIAL

Message from Managing Editor of Materials Mind (term: 2016 – 2018)

A new team of Materials Mind committee has been working on Materials Mind, the IMM quarterly magazine, starting 18th March 2016 (after 26th Annual General Meeting of the IMM). It is my honor to work with the committee members from industry and academia with vast experience in publication.

Materials Mind, with readership of over 8,000 in print and online, is an ideal platform for various committees to promote and report the events and activities of the institute. Readers will have first-hand information on IMM's involvement in the supporting events as well. Technical reports are also published periodically on industry-related topics for the benefits of the readers. For those with higher aspirations to fulfill, there is a wide range of IMM courses designed to meet industrial standards.

Finally, special thanks to all advertisers for this issue of Materials Mind. We are looking forward to working closely with our new and regular sponsors/advertisers in IMM's events and publications. Once again, online articles of Materials Mind can be accessed at www.iomm.org.my

Enjoy the magazine...

Dr. Tay Chia Chay
Managing Editor