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Standardization of Inhibitor Efficiency and Secondary Inhibitor Properties Evaluation Methodologies

Addition of corrosion inhibitors is the time-tested and proven strategy to control internal corrosion of oil and gas production, transmission, storage, refinery, and distribution infrastructures.   Despite their wide usage, standards for evaluating various corrosion inhibitor efficiency are sparse (Table 1). There is agreement that development of true consensus standards would be beneficial.

Table 1: Categories of Standards to Evaluate Corrosion Inhibitor Efficiency in the Laboratory

Standard category		
Test Method (Gold)[a]	Practice (Silver)[b]	Report/Guide (Bronze)[c]
• ASTM G202	• ASTM G184 • ASTM G185 • ASTM G208	• ASTM G170 • NACE 1D182 • NACE 1D196 • EFC WPR 11 • EFC WPR 39

[a]*Standard Test Methods provide clear direction for using a methodology, clear dimension of test apparatus and various accessories, step-by-step procedure, conditions of using the standard, and, more importantly, anticipated test result. The anticipated results are determined based on interlaboratory (round-robin) tests and are based on "repeatability (what is the variation in the result if the same operator repeats the same test following the same procedure) and "reproducibility (what is the variation in the result if multiple operators repeat the same test following the same procedure).*

[b]*Standard Practices present specific aspects of a methodology, step-by-step procedures to conduct tests using the methodology, and specific limitations of the methodology.   However, they do not provide anticipated result.*

[c]*Standard Guides or Technical Reports (Bronze) are just state-of-the-art documents providing general guidelines on various aspects of the methodologies.*

To develop standard test methods, a Joint Industry Project (JIP) was established. The objective of Phase 3 of the JIP is to develop Standard Test Methods (STM) with precision statement – based on repeatability - for eight (8) methodologies identified in Phases 1 and 2.

Precision statements can be developed based on two criteria:

- Repeatability: Variation in the results by the same person carrying out a test under same conditions using same apparatus and following same procedure.
- Reproducibility: Variation in the results by different people carrying out a test under same conditions using similar apparatus and following same procedure.

The eight (8) methodologies are:

1. 1 – liter Rotating cage (for inhibitor efficiency).
    a. Current Standard Test Method G202 requires 7.2 liters volume vessel and is not economical, practical, or reasonable volume for routine screening tests.
    b. In Phase 3 of the JIP, precision will be established for the 1-liter rotating cage.
2. Rotating Cylinder Electrode (for inhibitor efficiency)
3. Bubble test (for inhibitor efficiency)
    a. NACE 1D196 attempted to develop precision statements for about 25 years, albeit unsuccessfully.
4. Atmospheric Rotating Impeller methodology (for inhibitor efficiency)
5. Bi-cell (for under-deposit corrosion),
6. Inverted rotating disc electrode (for partitioning of corrosion inhibitors from oil phase to water phase).
7. Electrochemical Quartz Crystal Microbalance (for evaluating efficiency of corrosion inhibitors to control top of the line corrosion (TOC) and vapor phase corrosion (VPC) or volatile corrosion inhibitors (VCI)).
8. Laboratory methodology to determine inhibitor film thickness.

The major benefits of the JIP are that the sponsors gain improved confidence in their laboratory testing of corrosion inhibitors from more thorough understanding of collective, consensus practices.

Overall, the JIP sponsors will improve their confidence in the following important aspects of their internal corrosion management and mitigation programs:

1. To confidently carry out corrosion inhibitor testing in their companies for the 23 applications based on the knowledge and experience of other participating sponsors as well as taking into consideration selection, application, and monitoring activities.
2. To develop, refine, or improve their company inhibitor program.
3. To use appropriate best practices to test corrosion inhibitors.
4. To effectively interact with chemical vendors and guide them to receive the best products and services.
5. To compare their best practices with industry's best practices.
6. To enhance efficacy of corrosion inhibitors in their operation and efficiency of data collection on inhibitor performance.

7. To better understand the gap in the evaluation of efficiency and secondary properties of inhibitors and to focus their future efforts on standardization.
8. To provide technical justification on what tests need to be carried out for a given application.
9. To provide technical justification on what test results are irrelevant to a given application.
10. To provide technical justification to phase out unreliable laboratory methodologies.

The JIP will specifically bring the following benefits to chemical suppliers:
1. To influence the development of industry best practices based on their expertise and experience.
2. To effectively interact with clients and guide them to evaluate corrosion inhibitors using appropriate methodologies for their applications.
3. To provide justifications for not using certain methodologies in some applications.
4. To promote the effectiveness of their products based on industry best practices.

Specifically, the benefits of Phase 3 of the JIP include:
- Ability for industry to select appropriate chemicals in a quantitative and defendable approach.
- Ability for chemical suppliers to provide information about their products based on screening tests under standard conditions.
- Ability for end users to pre-select chemicals from several suppliers taking into consideration of the precision of the laboratory methodologies used to test the chemicals.
- Ability for end users to narrow down and select appropriate chemicals considering their operating conditions.
- Ability for both end users and chemical suppliers to reduce the number of tests to be performed.
- Ability for chemical suppliers to bring new products to the market in an accelerated process.
- Ability for end users and chemical suppliers to routinely test the chemicals during application.