STEM-Corrosion™

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Quality of Product = Quality of Testing

Laboratory testing is the first step in the evaluation of any products, services, and solutions. Though it will be impossible to simulate all field conditions in the laboratory, conditions that mimic as close as possible to the field or conditions more aggressive than field are established. The greatest advantage of the laboratory testing is the ability to repeat tests. This attribute is used to establish the "reliability" and "precision" of the laboratory tests.

ASTM Standard Practice E691, "Conducting an Interlaboratory Study to Determine the Precision of a Test Method" is extensively used to establish "precision" of laboratory methodologies. Over 5,500 Standard Tests Methods have been developed following ASTM E691 and more are being developed. The commonality of all these "Standard Test Methods" is the publication of "Repeatability" and "Reproducibility" of the tests.

- *Repeatability:* P*recision* of test results from tests conducted on identical material by the same *test method* in a single laboratory with all known sources of variability conditions controlled at the same levels.
- *Reproducibility: Precision* of test results from tests conducted on identical material by the same *test method* in different laboratories (ASTM requires data from six laboratories to develop "reproducibility").

What are the advantageous of Standard Test Methods in Evaluating Corrosion Inhibitors?

- Qualification of a laboratory methodology. Currently rotating cage is the only laboratory methodology for which both "repeatability" and "reproducibility" statements are available **(ASTM G202)**. (Rotating cage underwent the rigorous testing as per ASTM E691; On the other hand, other popular laboratory tests for corrosion inhibitors have failed.
- Qualification of a laboratory (if the laboratory can't reproduce the test results presented in Standard Test Method, it is not qualified to conduct the test)

- Qualification of technician conducting the test (if the technician can't reproduce the test results presented in Standard Test Method, the technician is not qualified to conduct the test).

Thus, Standard Test Methods provide a common reference point to qualify a product, service, or solution.

What are disadvantageous of not developing Standard Test Methods or not following Standard Test Methods?

- A company tested 5 inhibitors using 5 non-standard test methods and obtained different ranking of corrosion inhibitors from different test methods. After conducting 25 tests, they could not determine which inhibitor to select (Figure 1).
- The company then had all tests repeated, again using the same 5 corrosion inhibitors, and using 5 non-standard test methods and found that all corrosion inhibitors had inhibitor efficiency when the “repeatability” values were included (Figure 2). The "repeatability" (as represented by large standard deviations) of all tests conducted was poor. After conducting 50 tests, they could not determine which inhibitor to select (Figure 2).
    - The company then switched to standard test methods and conducted the test program as follows:
        - Had a laboratory and technicians qualifying themselves by conducting 1 test under ASTM G202 conditions and found the result was within the "precision" statement of the Standard (Figure 3).
        - Conducted two tests, with no corrosion inhibitors, under the field conditions for which the inhibitors were being evaluated and found the results within the "precision" of the methodology (Figure 3)
        - Then proceeded to test the 5 corrosion inhibitors and found inhibitors #1 and #5 meeting their requirements, i.e., they reduced the general corrosion rates to less than 5 mpy (Figure 3). The duplicate test results were again within the "precision" of the methodology.
    - Thus, using standard test method, qualifying the laboratory and the technician, the company was able to select two corrosion inhibitors by conducting only 13 tests (as opposed to conducting 50 tests using non-standard tests and yet could not identify proper corrosion inhibitors and could not identify the sources of variation in the test results).

Use of Standard Test Methods should be done as second nature in evaluating, qualifying, and selecting corrosion inhibitors and this practice will provide confidence, reliability and, consequently, use of quality corrosion inhibitors in the field for the entire duration of operation.

Fig. 1: Report on Corrosion Rate without "Repeatability" Statement

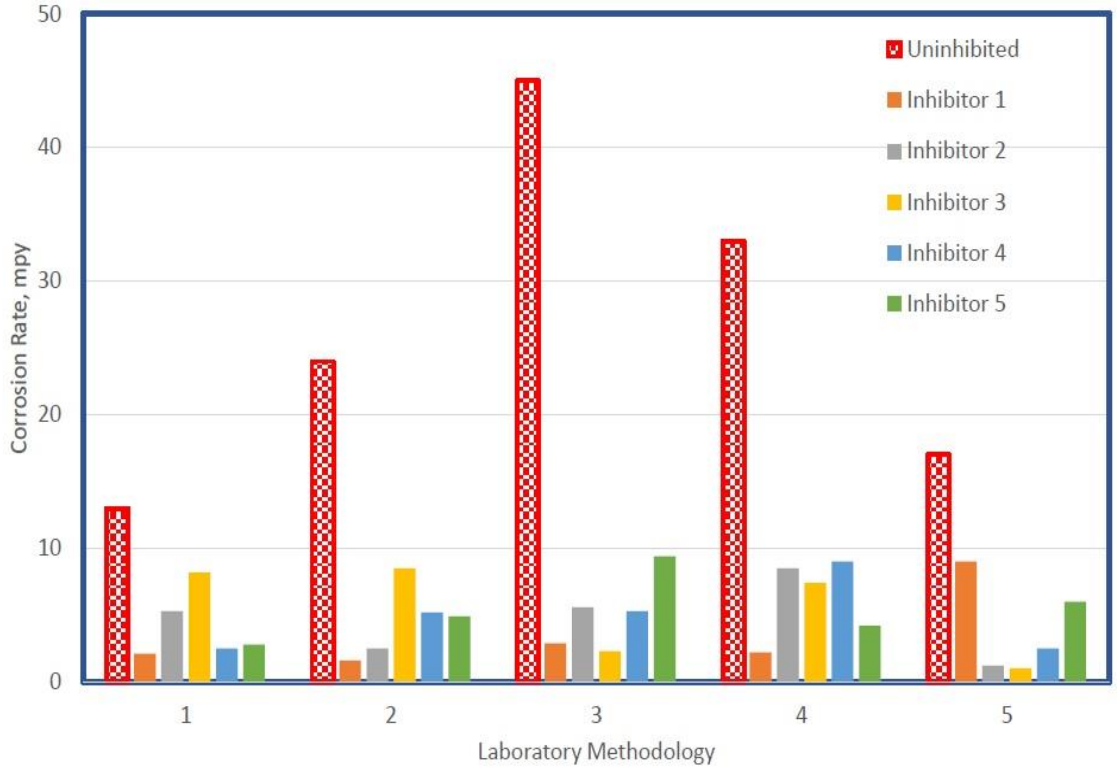


Fig. 2: Report on Corrosion Rate with "Repeatability" Statement

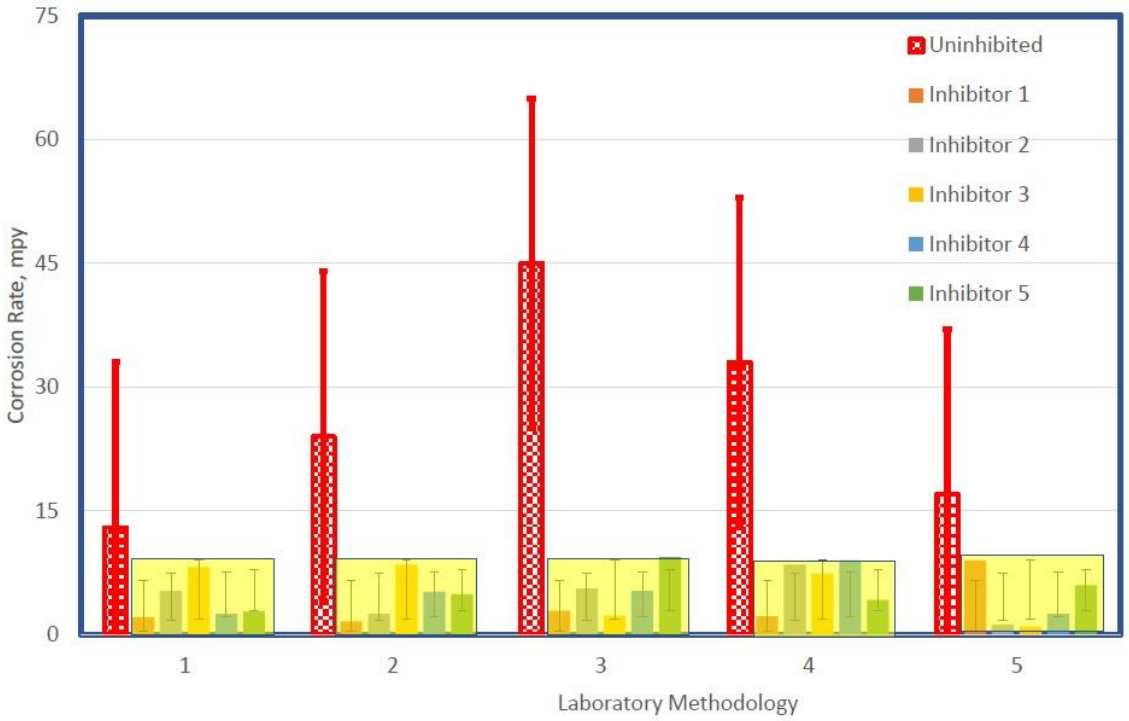
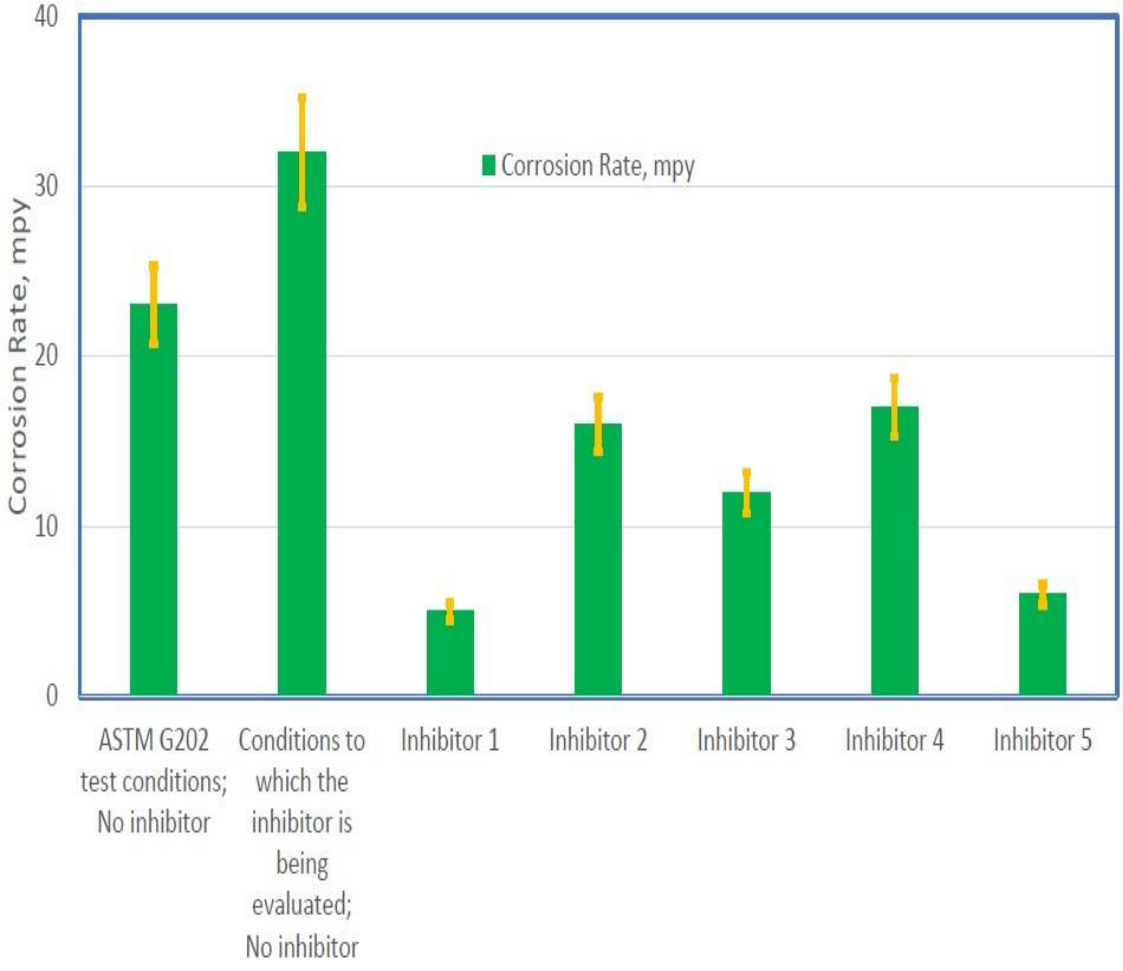


Fig. 3: Report on Corrosion Rate with "Reproducibility" and "Repeatability" Statements



Raising Star of This Newsletter:

Tesfa Haile

My Story

I started my career as a Biological Scientist in my homeland, Eritrea, where I completed my B.Sc. degree from the University of Asmara. As a young professional full of dreams and ambition for a new experience and better opportunities, I arrived in Canada in 2002. I continued my studies in Canada and earned a Ph.D. in Civil & Environmental Engineering, specializing in microbiologically influenced corrosion (MIC) from the University of Western Ontario, London, ON.

My life in Canada had been an adventure in both my personal and professional life. After working in academia, private and public organizations as a researcher, an R&D Scientist, Adjunct Professor, Lead Technical Projects Manager, and Corrosion Consultant in Canada and abroad for private and public firms for 20 years, I decided to jump into the entrepreneurial world and established a company (Genesis Data Solutions Inc.) in 2019.

Since then, as a Managing Director, I have been building a team of data analytics and domain subject matter experts in corrosion and process optimization that can provide unique data-enabled decision-making consultancy services to several industries. The challenges as a new immigrant to this land of opportunities for sure have shaped me for the better. My team has been working with oil & gas companies that require corrosion and integrity management solutions, and I am excited to expand our services to other industries that required data-enabled solutions soon.

My Style

2020 was a tough time for SMEs. I established Genesis Data Solutions considering the digital future the globe is facing and the need for unique, cost-effective, and reliable solutions. I consider myself as a servant leader who puts his team first, is flexible, collaborative, and innovative. The colleagues and team I have built are a living testimony to the above traits.

Things That Excite Me to Continue in the Industry

Ability to collaborate with colleagues with different knowledge and skill and contribute to different fields. I am the author and co-author of over fifty articles

published in Journals and conference proceedings in corrosion, fouling, and MIC monitoring, mitigation, and modeling. In addition, I have also made contributions through NACE International including chairing and vice chairing TEG 341X (Materials & Integrity in Oil Sands) and co-development of the TEG-370 (Pipeline Corrosion Management).

Changes I would Like to Make in the Industry

I have helped industries affected by corrosion including the oil & gas, water & wastewater, among others develop green solutions for **corrosion/fouling/MIC control**, develop sensors, characterize corroded samples, conduct failure analysis, assess the susceptibility of pipelines and facilities to corrosion/fouling/MIC, and analyze complex oil & gas data make sense utilizing state-of-the-art digital data collection, data processing, data visualization, and data modeling tools. Currently, Genesis's team of corrosion and data analytics professionals is developing data-enabled corrosion management software suits for the oil & gas industry that can save up to 20% in maintenance costs.

Advice to Attract Youngsters to the Industry

The time has come for the industries affected by corrosion to digitalize their operation and seek digital solutions to their materials and integrity challenges. Digital solutions can save operators in both time and cost associated with shipping samples to labs for analysis, avoiding non-value-adding processes, or reducing the number of assets to be inspected through avoiding redundant pipelines/facilities with similar operating conditions. Corrosion data collection can be automated. Data interpretation can be performed in a digital platform utilizing digital software and tool. Digital corrosion management tools can process complex oil & gas sensors/corrosion sensors data effectively and quicker. Overall pipelines/facilities managed digitally become more productive and more predictive through preventing loss of containment, optimizing corrosion inhibitor injection, and more. In conclusion, digital technologies are adding value to upstream oil & gas operations by reducing costs, driving production efficiencies, and improving decision-making time.