STEM-Corrosion™

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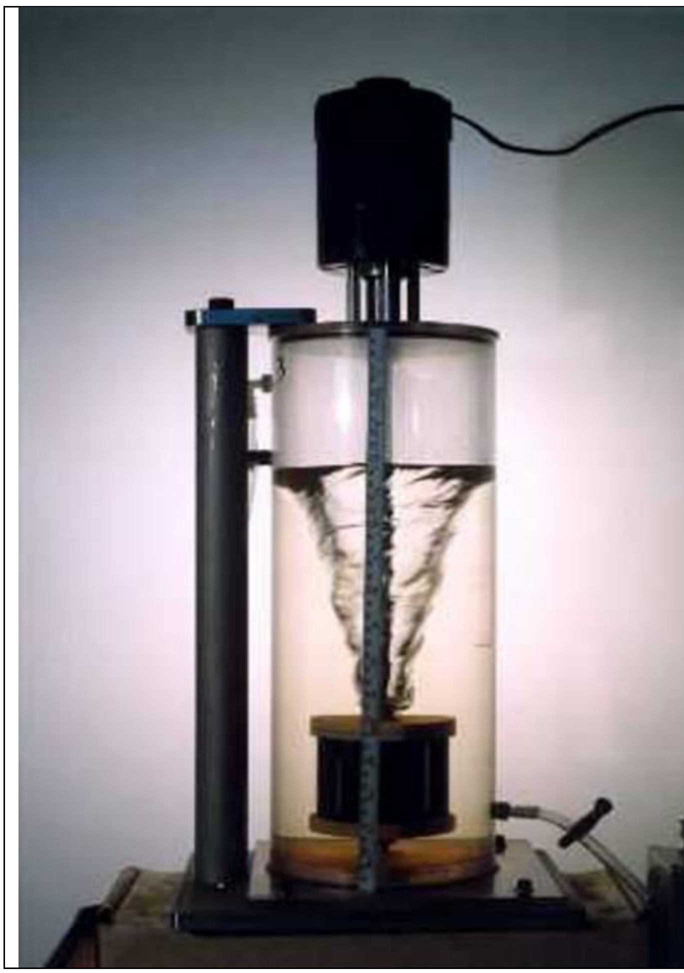
Laboratory Evaluation of Corrosion Inhibitors using Standard Test Methods



Corrosion inhibitor is a chemical substance or combination of substances that, when present in the proper concentration and forms in the environment, reduces the corrosion rate. The extent it reduces the corrosion rate depends on transportability, efficiency, availability, and secondary inhibitor properties (TEAS).

For reliability and economic reasons, oil and gas industry must report efficiency of corrosion inhibitors in reference to Standard Test Methods (STM).

Standard Test Methods are developed by standards-making organizations (such as ASTM International) based on interlaboratory tests (in which a minimum of six laboratories must participate). The interlaboratory tests are used to develop "repeatability" and "reproducibility" statements (also known as "Precision and Bias" Statements).

Top Influencer of This Newsletter:

Sheldon W Dean

My Story

Reflecting on the more than sixty years that I have been interested in electrochemistry, I realized I have had a very diverse and challenging career. I have been involved in many issues in the fields of corrosion science and engineering. My initial work was to study the mechanisms of various corrosion processes to guide alloy development work. Later I changed my field to corrosion engineering, with the goal of improving the performance and safety of plant equipment.

My Style

Because of my background in corrosion research, I developed a style that incorporated a wide range of disciplines when approaching a real-world problem.

There are often several approaches that can be explored to solve corrosion problem. Alloy selection is usually the initial approach when dealing with a corrosive environment, but occasionally other approaches can be better choices. Environmental cracking is a common cause of failure, and the selection of alloys that resist this form of failure is a commonly used approach. However, in some cases alternative steps such as stress relief heat treatment, may be sufficient to prevent the problem.

When dealing with an actual failure, the process of failure analysis is usually the key to determining the most effective solution. The use of surface analysis techniques such as energy-dispersive X ray spectroscopy can provide valuable information. Metallography of the failed component is usually a very important step. Obtaining both chemical and mechanical property information is also very informative. Fractography is also very revealing when dealing with cracks in metals.

Combining all of the information about the failed component together with the history of the item will lead to a reasonable decision on the cause of the failure, and that can provide a basis for remedial action.

Pinnacle Moment

In a career spanning more than sixty years it is difficult to select a single pinnacle moment. However, one case stands out as an unusual failure. A world scale hydrogen plant that used refinery gas to feed the reformer and produce high purity hydrogen gas experienced cracking in piping near the exit point of the plant. The cracks were transgranular in nature and exhibited some branching, but also showed striations in some locations. The pipes contained a two-phase mixture of liquid and gas. The pipe material was Type 304L stainless steel. Although chloride stress corrosion cracking looked like a possible mechanism, the chloride levels were much too low to support that process. Fatigue was also considered, but there was no obvious source of stress cycling. A decision was made to replace the piping with a higher strength alloy that would provide better resistance to fatigue, and that also had good resistance to chloride stress corrosion cracking, UNS N06625. This replacement has shown good performance for many years with no further cracking.

Greatest Contribution

Follow up work on this cracking failure was carried out to determine if an alternative material could be found that would be less expensive. An experimental program was developed that used cyclic stressing together with anodic-polarization to hasten the cracking process. This approach was successful in causing cracking that resembled the cracks found in the failed piping. Slow strain rate testing under the same conditions did not result in stress corrosion cracking. This demonstrated that the cracking process was a corrosion fatigue mechanism. Specimens of UNS N06625 alloy did not fail when tested using this method. A lower nickel alloy, UNS S32205 also did not crack when tested similarly, thereby meeting our goal of finding a less expensive material of construction.

Advice to Industry

When faced with a difficult problem, using resources such as ASTM International, NACE International, and MTI to discover if other people have encountered similar situations. In the case discussed above, we found that this problem had been observed by other companies that used refinery off gas as a source for a reforming process. Contacts found through ASTM International provided the laboratory resources to carry out the testing. This approach gave us good results at a minimum cost and high reliability.