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To:	All Surveyors/Auditors
Applicable to flag:	All Flags
Subject:	**An Overview of Welded Joint Corrosion: Causes and Prevention Practices**
Reference:	**Welding**

An Overview of Welded Joint Corrosion: Causes and Prevention Practices

Corrosion, by definition, is a degradation of material due to its chemical or electrochemical reaction with its environment. While this is a problem for metals in general, particular care should be taken when dealing with welded joints. Corrosion can still occur even when the proper metal and filler metal have been selected, all standards have been followed and welding has been done properly.

Corrosion is caused by three basic factors, which independently or combined are responsible for the damage: the material, the environment, and the stress and load. Due to varying chemical compositions, possible residual stresses, and the discontinuity of shape at the weld joints, all of these factors can be an issue when one observes the nature of a welded joint.

Overview of Corrosion Causes and Mechanisms in Welded Joints

Corrosion in welded joints is primarily caused by a combination of manufacturing and metallurgical factors. These include, but are not limited to, deficient weldment design, poor welding practice, various weld defects (both tolerated and unacceptable that were missed during nondestructive testing), cracks and residual stresses and various metallurgical reasons.

A welded joint structure has three distinct zones, each with different mechanical and structural characteristics. The fusion zone is the section where the base metal and the filler metal have mixed, each of which can have a substantially different chemical and structural composition. Between the fusion zone and base metal is the heat-affected zone (HAZ), which has different structural properties than the base metal. This varied structure is one of the main causes of corrosion in welds due to the different composition and electrical potential, and the residue strain that is always present in a joint from the heat induced deformation during the welding.

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This means that even if all precautions are taken to prevent corrosion, misunderstanding these structural and geometric changes can still lead to various, often unexpected, forms of corrosion in that particular section.

Some of the typical corrosion mechanisms in welds are galvanic corrosion, stress corrosion cracking (SCC), fretting corrosion, cavitation corrosion, high temperature corrosion, various forms of localized corrosion (e.g., pitting and crevice corrosion), corrosion fatigue and hydrogen-induced cold cracking.

Since all of the corrosion mechanisms mentioned here are electromechanical in nature, they require the presence of an electrolyte such as water, which make pipelines particularly vulnerable.

Galvanic Corrosion

While not exclusive to welded joints, this is a mechanism caused by the different chemical composition of base metal and the metal in the fusion zone.

While some metals can be welded autogenously (i.e., with the same filler material as the base material), most of the time the composition of these materials are slightly different, usually to ensure that the mechanical properties of the welded joint are consistent with the rest of the weldment.

When the latter is the case, weld metal tends to have a different electric potential than the base metal. This difference in potential, along with the presence of an electrolyte, is the main prerequisite necessary for galvanic corrosion. This is the same principle used in standard batteries: two metals form a galvanic pair, and electrons travel from the anode (in this case a metal with the lower electric potential) to the cathode, and positive ions travel in the opposite direction. While this mechanism creates voltage in batteries, in welded joints it preferentially corrodes the material with the lower potential.

For example, in the case of most aluminum alloys, the weld metal and the HAZ become nobler in comparison to the base metal, which means that the base metal is prone to galvanic corrosion. A similar effect can be present when austenitic filler metal is used for reparatory welds of field machinery constructed from high-strength low-alloy (HSLA) steel.

Welding Practices that Minimize Corrosion

While weld corrosion is almost impossible to prevent entirely, there are several methods that can minimize its effect and occurrence.

Materials must be carefully selected in such a way that they are as chemically compatible as possible relative to the operational environment.

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A properly cleaned and treated surface has fewer physical defects that can be a point of origin for some forms of corrosion. Careful selection of the cleaning and treatment method is important to prevent impurities on the surface or to inadvertently create a porous finish.

Undercuts, crevices and an inadequate shape of the weld face and weld root can be a cause for several different corrosion mechanisms, notably cavitation, pitting and crevice corrosion.

In order to avoid these problems, there are several steps that must be taken. Proper penetration and deposition of the root weld must be done. If using shielded arc metal welding or automated powder welding, then slag must be removed after each pass. The surface finish must be uniform and smooth, with an oxidized surface that serves as protection from further corrosion.

A properly chosen post weld heat treatment can release some or all residual stresses and protect the joint from some forms of corrosion. It can also release some of the trapped hydrogen and partially homogenize the material, thus reducing the difference in electric potential. In addition, passivation treatment can protect stainless steels from corrosion since it removes surface contaminants and creates a new homogenous passive oxide film on the surface.

REFERENCES:

- Welding

ATTACHMENTS: No.

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