just the facts

Corrosion Resistance of Welded Joints

BY LYNDSEY DECKARD

Welding a joint may affect the corrosion resistance of that joint. Even with careful filler metal matching, a welded joint may be subject to differential corrosion. That is, the weld metal and/or heat-affected zone (HAZ) may corrode faster than the base metal or the base metal may corrode faster than the weld metal and/or HAZ. This is true because the weld zone varies in chemical composition, metallurgical structure, and residual stress levels. There are means by which to test the corrosion of welded joints.

These methods are detailed in Volume 1, Ninth Edition, of the *Welding Handbook*, as follows:

A welded joint and the base metal may corrode uniformly over the entire surface, termed *uniform* or *general corrosion*. Alternatively, the welded joint may be susceptible to different types of preferential attack, as shown in Fig. 1. The figure schematically represents a macroscopic view of a weldment. Figure 1A shows uniform corrosion in which all zones of the weldment corrode at the same rate. The weld metal may corrode more, as depicted in Fig. 1C, or less, as shown in Fig. 1B, than the base metal because of different chemical compositions or microstructures, or both. In addition, as shown in Fig. 1D and 1E, the heat-affected zone may be susceptible to corrosion attack in a specific region as a result of metallurgical reactions during welding.

More than one type of corrosion depicted in the figure may occur in the same welded joint. Moreover, microscopic attack, such as intergranular corrosion and pitting corrosion, can occur at any location in a welded joint.

Several factors influence the corrosion resistance of welded joints. These factors should be included in the test report when recording the results obtained in the corrosion tests of welded joints. These include

1. Chemical composition and structure of base metal and weld metal;
2. Welding process and procedure, especially shielding;
3. Dimensions of the welded test plate and the corrosion specimens removed from the plate;
4. Composition, phase, and temperature of the corrosive media; and
5. Details of any galvanic or impressed current cathodic and anodic electrical system used.

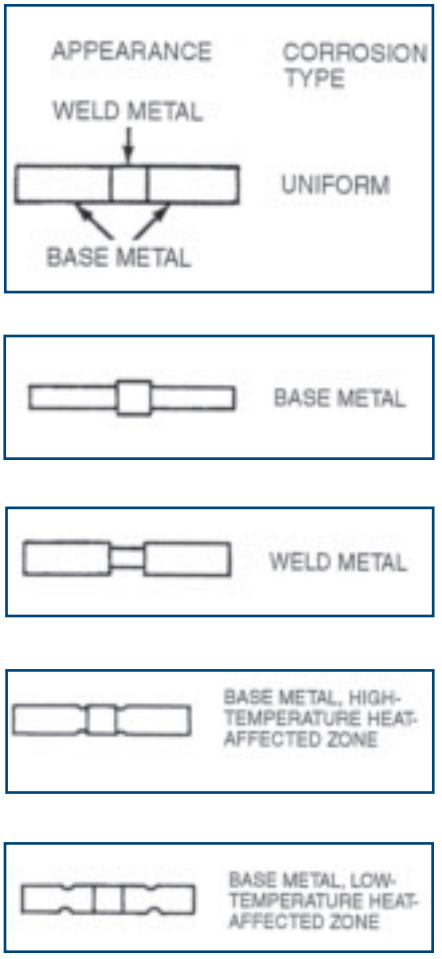

Fig. 1 — Types of corrosion in a welded joint.

Weight Loss Test

The most common method of evalating corrosion resistance is to measure the weight lost during exposure to the corrodent. A sample is prepared and carefully weighed. The surface area that will be exposed to the corrodent is measured after masking off support locations or other areas that would not be exposed directly. Masking should leave a known volume so that the effective weight can be adjusted accordingly. The sample is then subjected to the corrodent for a measured amount of time under either standardized conditions (e.g., see *Standard Practice for Modified Salt Spray (Fog) Testing*, ASTM G 85-98) or actual conditions, such as immersed in the ocean. The weight loss is converted to an average corrosion rate using the following formula:

$$R = \frac{Kw}{ADt}$$

where

R = average corrosion rate in depth of attack per unit time, mils/day (mm/day);

K = constant;

w = weight lost by the specimen during the test, ounce (oz) [gram (g)];

A = total surface area of the test specimen, in.^{2} (mm^2);

D = density of the specimen material, oz/in.^{3} (g/mm^3); and

t = duration of exposure, seconds (s).

This formula is intended primarily for general corrosion. However, selective corrosion can also occur in the weld metal or heat-affected zone. Since these areas are small in comparison to the total weld area, the average corrosion rate, R, may appear small. Therefore, corrosion test specimens should be examined visually for selective attack, and any localized attack should be reported.

Another technique used to determine whether preferential corrosion has occurred is to expose an unwelded sample of the same dimensions as the welded specimen. If the corrosion rates of the welded and unwelded specimens are approximately equal, no preferential attack is indicated. If one rate is significantly higher than the other, preferential attack should be suspected. A careful visual inspection should always be conducted regardless of the ratio.❖

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