

The ABC's of Arc Welding

Weld Decay: Its Cause and Cure

Any stainless steel contains 13% or higher chromium. Because of the large amount of chromium, stainless steels are kept free from corrosion due to the chromium oxide forming a rigid membrane on their surfaces when subjected to such corrosive media as air or oxidizing acids (e.g. nitric acid). Austenitic stainless steel contains (in addition to chromium) nickel, molybdenum, and copper to provide the corrosion resistance against non-oxidizing acids (such as hydrochloric and sulfuric acid) and reducing acids (such as saline solution and sulfurous acid).

The typical austenitic stainless steel, Type 304 (18%Cr-8%Ni), is used for a wide range of applications due to excellent mechanical properties, workability, weldability, in addition to superior corrosion resistance. However, the weld heat-affected zone of Type 304 may be attacked by selective corrosion, when it is exposed to a severe corrosive environment. The attack is called "weld decay," which is caused by intergranular corrosion. Fig. 1 shows weld decay that occurred on both sides of the seam weld of a 304 pipe of a hot dilute nitric process.

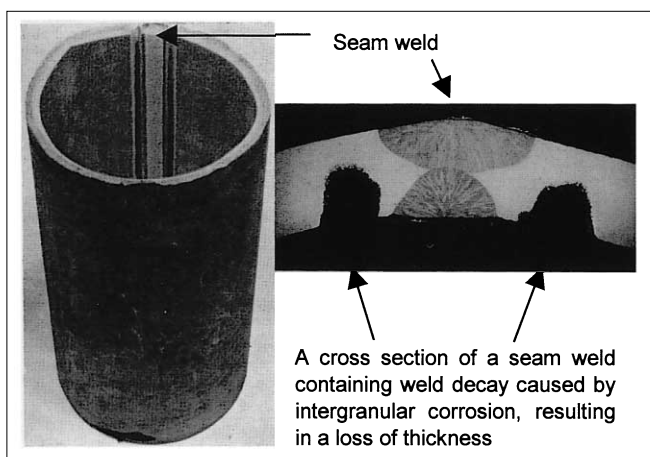
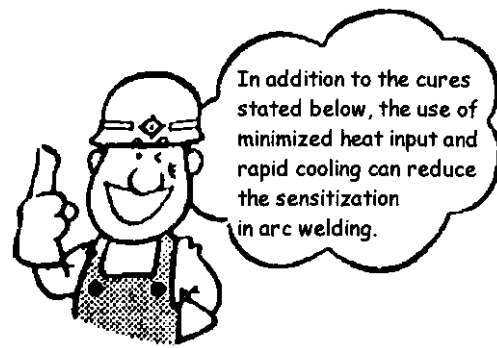


Fig. 1 - Weld decay occurring on both sides of a 304-pipe weld for a hot dilute nitric process line (Source: AWS Welding Handbook)



Weld areas are heated at high temperatures in arc welding. Fig. 2 shows the temperature distribution and the heat-affected zone in a weld.

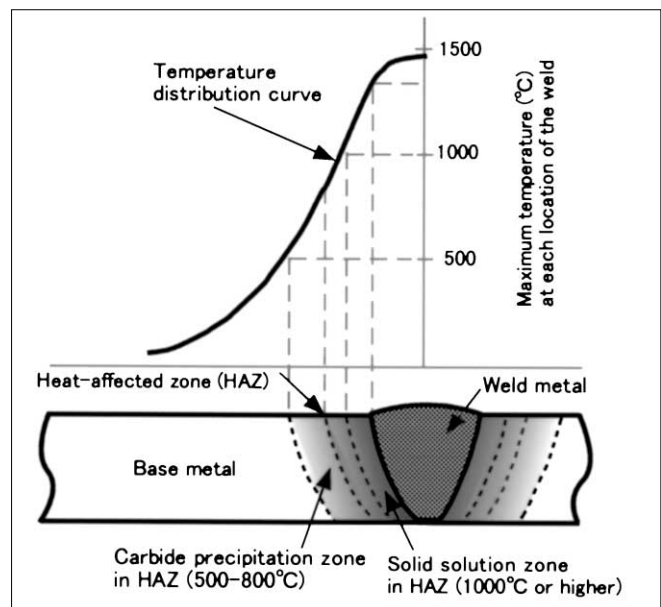


Fig. 2 - Temperature distribution and the heat-affected zone in a 304 stainless steel weld

In the carbide precipitation zone (as shown in Fig. 2) chromium combines with carbon and precipitates chromium carbides at the grain boundaries, depleting the corrosion-resistible, uncombined chromium at or adjacent to the grain boundaries. This phenomenon is called "sensitization," because the areas along the grain boundaries become sensitive to corrosion. In order to control the sensitization of the heat-affected zone, use

- (1) 304L or 316L grade, because lower carbon content decreases the carbide precipitation.
- (2) 347 or 321 stabilized grade, because stronger carbide-forming elements (Nb or Ti) prevent the precipitation of chromium carbides.
- (3) postweld solution annealing treatment in the temperature range of 1000-1150 °C, followed by rapid cooling, which decomposes the chromium carbides and make the chromium resistible to corrosion.