Endurance Technologies & Alonizing

When Stainless Steel Fails

Alonized steel performs well in high-temperature environments where even stainless steel fails.

Stainless steels are often considered the final answer to every kind of corrosion problem. But there are those situations in which stainless steel, because of its metallurgical or chemical properties, is almost certain to fail (e.g. catastrophic sulfidation of high-nickel stainless materials).

Austenitic grades of stainless steel are used because of their excellent resistance to high-temperature oxidation. Generally, the higher the temperature to which the metal will be exposed, the higher the nickel content of the alloy must be.

For example, a type 201 stainless (16/18% nickel) can withstand a continuous operating temperature of 1550°F while a type 310 stainless (19/22% nickel) can withstand continuous service temperatures as high as 2100°F.

Alloys with greater nickel contents can withstand even higher working temperatures. There is a limit, however, to the maximum amount of nickel that can be used in an alloy exposed to high-temperatures sulfidation.

With nickel contents of 25% or more, the nickel will preferentially combine with sulfur to create a low-melting temperature nickel sulfide eutectic.

The nickel sulfide eutectic has a melting temperature of 645°C. However, at temperatures as low as 550°C, sulfur will begin to penetrate the nickel alloy, causing rapid embrittlement.

Once the eutectic forms, the nickel is preferentially melted out of the alloy, leading in many cases to catastrophic corrosion and failure.

Alonizing stainless steel will passivate the surface of the material, tying the nickel into an iron-aluminum alloy and preventing the formation of the eutectic.

In an experimental plan in South America in which a technique for direct reduction of iron ore was being studied, one of the components was a 1" IPS schedule 160 pipe made of a high nickel proprietary alloy. During a 17-hour period in which this piece was exposed to high-temperature sulfur bearing gases, the pipe wall was completely penetrated in a number of places.

The replacement piece was Alonized and the pipe remained sound and unaffected by many subsequent exposures to the same reagents at the same temperatures.

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