TechTalk

Understand welding failures in 347H body material.

Metallurgy and Its Effect on Weld Quality

Heavy oil processing applications frequently use ASTM A182 F347 and F347H material for pipe and valve bodies. Unfortunately, standard material specifications are not restrictive enough to avoid linear indications stemming from the welded root pass. MOGAS' R&D Engineering group used optical and scanning electron microscopy to study the material limitations and develop a strategy that has been shown to successfully eliminate these failures.

Challenge with Standard Material Specifications

The specification sheet for ASTM A182 F347 (Alloy 347, UNS S34700) indicates it is an austenitic stainless steel with good general corrosion resistance. It has excellent resistance to intergranular corrosion after exposure to temperatures in the chromium carbide precipitation range of 800 – 1500°F (427 – 816°C). The alloy has good oxidation resistance and creep strength to 1500°F (816°C). It also possesses good low temperature toughness. ASTM A182 F347H (Alloy 347H, UNS S3409) is the higher carbon (0.04 – 0.10) version of the alloy. It was developed for enhanced creep resistance and for higher strength at temperatures above 1000°F (537°C). In most instances, the carbon content enables dual certification.

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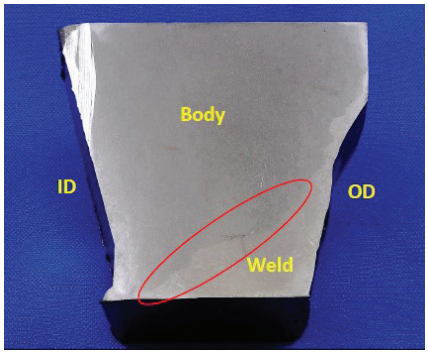
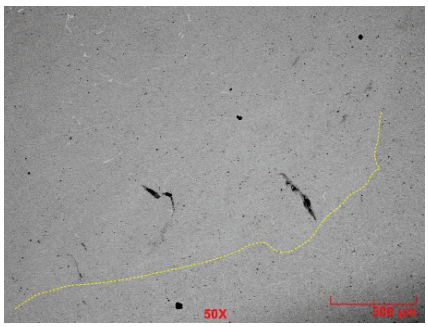
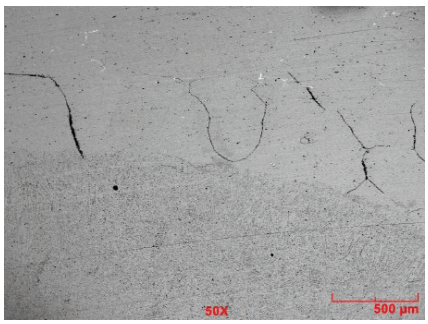


Cross-section showing the area along the fusion line examined microscopically.



Cracks observed in the HAZ at 50X.



Another area along the fusion line showing cracking at 50X.

Although this material is specified in some applications where critical (such as pressure containing) welds will be required, practical studies conducted by MOGAS in partnership with some customers have determined that successful welds are difficult if certain material requirements are not controlled beyond what the specification allows.

A detailed Engineering study was conducted by MOGAS and found that cracking in the Heat Affected Zone (HAZ) of a weld using ASTM A182 F347H may occur even if procedures are followed. Such cracking could be a safety hazard. Undetected cracks may propagate, ultimately resulting in a fire should a breach occur. In these studies, full chemistry of a particular sample was tested using atomic emission spectroscopy at three locations; on the surface, below the surface at ¼ forging thickness, and the center of the forging. The chemical compositions were the same at all three locations. Furthermore, they all met ASTM A182 F347H specification. This detailed study showed that cracks could form after welding even if well-established material specifications and weld procedures were followed. ASTM A182 F321, another common stainless steel grade for this application, would have similar issues since its structure and heat treatment requirements are alike.

MOGAS Solution

Weld procedures were closely studied with a sample from different forgings having different heat lots. It took this further study by MOGAS to determine that chemistry and heat treatment must be controlled tighter than permitted by standard specifications. Without these tighter controls, weld defects will increase thus creating additional delays and expenses for everyone. It should be pointed out that MOGAS has incorporated these enhanced material specifications on all request for quotes where butt welded ASTM A182 F347/347H or F321 is called for.