

Manufacturing and Inspection of Liquid Carbon Dioxide Trailers

Background

Liquid CO₂ Road tanker is generally a non-vacuum insulated cryogenic vessel that is isolated with foam insulation. Such a road tanker is manufactured under respect of ADR §6.8.2.6.1 that refers to the EN 14398-2 “Cryogenic vessels. Large transportable non-vacuum insulated vessels. Design, fabrication, inspection and testing” + Amendment A2 published in 2008.

Risks of manufacturing

During the past years it has been observed that Austenitic-ferritic stainless steel “Duplex” is more and more used for manufacturing such types of road tankers for following reasons:

- A duplex (or austenitic-ferritic) stainless steel is one that has a mixture of two different metallurgical phases within its microstructure. The mechanical properties of Duplex are higher than the equivalent austenitic grades, their yield strength is about the double of those of classical grade. Thanks to their austenite-ferrite microstructure, duplex stainless steels present attractive corrosion properties
- Duplex stainless steel presents excellent cost/properties ratios particularly in critical applications including: oil and gas, chemical industry, pulp and paper industry, water systems, desalination plants, pollution control equipment, chemical tankers.
- for non-vacuum insulated cryogenic trailer usage of Duplex stainless bring better payload by reducing plate thickness and tare weight

But manufacturing by forming and welding cryogenic vessels made of austenitic-ferritic stainless steel would require additional attention points.

Recommendations

Regarding welding It should be emphasized that the welding of duplex stainless steel is not particularly difficult. But it is different from other steels. In fact, the weldability and welding characteristics of duplex stainless steels are better than those of ferritic steels, although not generally as good as austenitic steels. However, the properties of a duplex weldment are strongly affected by the welding parameters such as heat input.

Duplex steels usually solidify with a fully ferritic structure with austenite formation and growth during cooling. Rapid cooling from high temperatures may still result in high ferrite levels in the weld metal and adjacent base metal. Slow cooling from high temperature may still result in loss of ductility in the heat affected area of the weld. These 2 phenomena can lead to brittle area on vessel and weld.

Forming of dished end:

- Cold Forming Due to the high proof strength of Duplex material, greater working forces are required when compared to Austenitic steel.
- Hot Forming The strength of Duplex material is low at high temperatures. Hot working should be followed by a complex quench annealing process to recover mechanical properties.

Additional recommendations for manufacturing

Therefore, correct manufacturing, welding and inspection procedures should be followed in order to obtain an acceptable structure and properties.

Additional information

EN 14025 “Tanks for the transport of dangerous goods - Metallic pressure tanks - Design and construction” have specific requirements for design, manufacturing, testing and inspection of vessels made of austenitic-ferritic stainless steel by referring to EN 13445-2 for welding activities and EN 13445-4 for forming of dished ends to ensure limited hardening that could badly impact ductility on formed heads.

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