The Effect of Laser Welding Parameters on Pitting Corrosion Behavior of AL-6XN Superaustenitic Stainless Steel

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Introduction

AL-6XN superaustenitic stainless steel (SASS) is a candidate alloy for manufacture of Advanced Double Hull (ADH) surface ships because of its high resistance to localized corrosive attack. Arc welding has been a major fabrication step for construction of SASS-ADH ships. However, conventional arc welds featuring higher heat input are vulnerable to accelerated corrosion associated with Mo microsegregation. As a potential replacement, laser beam welding shows promise of minimizing the microsegregation and hence improving the corrosion performance owing to its low heat input associated with high solidification rate. Therefore, an investigation of the laser welding process on corrosion behavior of AL-6XN is imperative for its application basis.

Procedure

A series of autogeneous laser welds were produced using a CO_2 laser with laser power ranging from 6 to 14 kW and translation speed ranging from 18 to 400 in/min. The ASTM G 48-97 critical pitting temperature (CPT) test was conducted for the evaluation of pitting corrosion susceptibility of AL-6XN base metal and the laser welds. Optical microscopy and SEM were used to identify the pitting initiation. Analytical Electron Microscopy (AEM) was performed to acquire chemistry profiles of alloying elements across dendrite cores of laser welds.

Results and Discussion

The CPTs of AL-6XN base metal and an autogeneous TIG weld were evaluated as 74°C and 39°C, respectively. It was found that laser power and laser translation speed influenced the pitting behavior of the laser welds. The CPT increases corresponding to either reduced laser power and/or an increased laser translation speed, which corresponds to lower heat input. Reducing the heat input of the laser welds leads to an increase in pitting corrosion resistance. Pits preferentially occur in the weld region adjacent to fusion boundary and propagate into the surrounding microstructure. Microstructural analysis showed that pitting attack tended to initiate in the dendrite cores of the laser welds. AEM characterization revealed that the local lack of Mo in the dendrite cores is the root cause of the pitting attack.

Conclusions

The pitting corrosion behavior of the laser welds was influenced by the laser processing parameters. Pitting corrosion resistance is increased by decreasing the heat input, i.e. the combination of lower laser power and higher translation speed. Pitting attack tends to initiate preferentially in the dendrite cores of the weld due to the Mo microsegregation.

Keywords: Superaustenitic stainless steel, microsegregation, laser welding, pitting corrosion