Flux-Assisted GTAW of Superaustenitic Stainless Steel

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Abstract

The U. S. Navy is investigating the use of non-magnetic stainless steels for fabricating advanced double-hull (ADH) surface combatants. Fabrication of a stainless steel ADH presents a number of unique welding challenges. The proposed dimensions of the cell-like modules (3 feet by 3 feet) may not permit welder access to the cell interior. In this event the inner hull shell may be joined to the longitudinal web by penetrating through the shell into the web material or some type of groove joint design. Welding of stainless steels can also result in microsegregation of selected elements with potential of reducing the corrosion resistance of the weld metal. Finally, welding of stainless steels can generate fumes that exceed worker health and safety requirements determined by OSHA.

The NSWC, Carderock Division is evaluating alternative welding processes to address these issues. One promising alternative is the gas tungsten arc welding process (GTAW) used in conjunction with a penetrating flux. Successful development of this process for ADH construction would allow the shell-to-stiffener welds to be fabricated from the exterior of the shell. Additionally, the GTAW process produces very low levels of welding fumes with the potential of satisfying the proposed OSHA reduction of Cr(VI) levels.

Preliminary welding trials were conducted to evaluate the effect of the FASTIG SS-7™ flux, originally developed by the Navy Joining Center for GTAW of 300 series stainless steels, for increasing penetration in AL6XN plate material. The results of autogenous bead-on-plate welds demonstrated that the flux produced the same penetration enhancement in both materials.
Additional bead-on-plate welding trials were conducted over a range of current settings to identify parameters to achieve complete penetration in ½-thick AL6XN plate. The results of this work showed that complete penetration could be achieved using the flux

in combination with the buried-arc mode (welding with tungsten below the surface of the material) of GTAW at a current setting of 499A and a voltage of 17.0V. The increase in penetration was on the order of 121% more with flux than without flux. Finally, welding parameters were developed for 2-piece T joints in ½ inch thick Al-6XN. Last the joint properties of the weldments were characterized.