The Role of Iron in Determining the Ballistic and Corrosion Performance of Welded Aluminum 2519

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EXTENDED ABSTRACT

Aluminum 2519 is currently being considered for use on the US Marines, Advanced Amphibious Assault Vehicle (AAAV) due to its low density, high strength, and excellent weldability. This relatively new alloy (registered in 1985) is similar to the aluminum-copper binary Alloy 2219 (6 wt.% Cu), except that it has been alloyed with a small amount of magnesium (0.10 wt.% Mg) for improved strength. Iron is present in this alloy as an impurity, normally found at levels around 0.20 weight percent (0.30 wt.% Fe max). Because iron is partitioned significantly during solidification (k=0.03), it has the capacity to generate large quantities of eutectic constituent particles that can influence mechanical properties and corrosion behavior. Iron can also affect the liquation behavior in the heat-affected zone (HAZ).

In the present study, experimental heats of 2519 were made having different iron and copper contents, varied within established compositional limits. Cast material was rolled and heat-treated to a T87 temper, then welded and analyzed for microstructure, tensile properties, ballistic performance, and corrosion potential. The base metal microstructure was found to have increasing amounts of an elongated iron-containing constituent phase (β-Cu_2FeAl_7) and less of the spherical θ-$CuAl_2$ phase.

All of the experimental alloys examined were found to exhibit extensive HAZ grain boundary liquation near the fusion line (Gutscher and Cross-2002). In particular, the iron-lean experimental alloys behaved similar to what has been reported for 2219 alloys (Kou-2000). Iron-

rich experimental alloys, however, developed large pools of liquated metal forming an iron-rich constituent phase, α-$(FeCu)Al_6$.

The base metal corrosion potentials, taken from polarization curves measured in 58.5 grams/liter NaCl solution (+ 10 mL/L H_2O_2), were found to shift to more electro-negative values with higher iron content, and less electro-negative values with higher copper content. It is to be expected that the addition of copper should make the alloy less anodic. Iron may serve to make the alloy more anodic by removing copper from solution, tying it up in the form of constituents. Free corrosion potential measurements made across weldments showed that the HAZ and weld metal remain cathodic relative to the base metal.

Initial ballistic testing, with 0.308 caliber ammunition, has shown the low-iron alloy weldments to exhibit extensive plastic deformation, with no auxiliary cracking. Testing of iron-rich alloys is currently in progress. It is anticipated that the presence of the coarse and elongated iron-rich phases will reduce the weldment ductility and ballistic performance. These results, together with the microstructural and corrosion analyses, will be presented and discussed in detail.