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OAK RIDGE Y-12 PLANT

MARTIN MARIETTA

CRADA Final Report
for
CRADA Number Y-1293-0213

Development of Filler Metals for Welding of Iron Aluminde

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MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

Final Report
for
CRADA No. Y1293-0213
with
Devasco, Inc.
for
Development of Filler Metals for Welding of Iron Aluminide Alloys

Abstract

Attempts were made to develop a coating formulation for shielded metal arc (SMA) welding electrodes for iron aluminide alloys. Core wires of various compositions were produced by aspiration casting at ORNL and coating formulation development was conducted by Devasco, Inc. It was found that, except for weld deposit compositions containing less than 10 weight % aluminum, all weld deposits exhibited extensive cold cracking and/or porosity. It was concluded that current coating formulation technology limits successful iron aluminide deposits to less than 10 weight % aluminum.

Objectives

The objectives of the CRADA were to develop a shielded metal arc (SMA) coated welding electrode for use with various iron aluminide alloys. The approach was to:

- Develop techniques for producing core wire of appropriate composition by aspiration casting (ORNL),

- Develop flux formulation for supplied core wire to produce usable SMA electrodes (Devasco), and

- Evaluate the resulting SMA electrodes in terms of weldability and resistance to hot and cold cracking (ORNL).

The detailed objectives were met, i.e. core wire was produced, flux formulations were developed, and the resulting electrodes were evaluated, but the overall objective was not met, in that even after several iterations of core wire/flux combinations, the resulting electrodes all produced weld deposits with gross cold cracking and/or porosity, with the exception of low aluminum (<10 weight %) deposits.

The only obvious benefit to the sponsoring DOE program is that it was learned that, at least with current coating formulation technology, SMA electrodes for welding iron aluminide alloys cannot be produced to give weld deposits containing greater than 10 weight % aluminum.

Technical Discussion

(Contains no proprietary data or protected CRADA information)

Aspiration-cast core wires of various compositions, including aluminum levels in the range 10-30 weight %, were successfully produced at ORNL. For coating formulation, trials were conducted on two different heats of core wire supplied by ORNL, heat FAPY and heat EF009-4-0958. A coating formulation that had exhibited good arc characteristics on other core wire, was applied to heat FAPY in order to obtain a bench mark for aluminum recovery in the deposit. The coating mix contained a large amount of ferro-aluminum to offset the loss of aluminum from the core. Although this was done, there was only a 36% recovery of available aluminum in the weld deposit, resulting in less than 10 weight % aluminum.

This same formulation was applied to heat EF009-4-0958, which contained 32.79% aluminum. With the increased level of aluminum in the deposit, weldability was adversely affected and the deposit contained gross cracks and porosity. A modification of this formulation was tried but with the same results. The last trial conducted was a modified aluminum SMA electrode coating. Although this coating works well with aluminum core wire, it did not work well with the FeAl core wire. Weldability was good, with a somewhat stable arc and good restrike, but the bead had gross porosity. On an attempted one layer overlay, porosity was prevalent. The center of the bead, just under the surface, was like a honey comb. Evidently Al_2O_3 is being formed so fast that it is cooling the bead surface prior to the gas escaping. A chemistry sample could not be prepared because of the porosity.

No inventions were made or reported. Commercialization possibilities are not considered viable. There are no plans for future collaboration.

Conclusions

The extremely reactive nature of iron aluminide alloys when passed through a welding arc makes it infeasible to produce a shielded metal arc (SMA) welding electrode which yields a weld deposit composition containing greater than 10 weight % aluminum.

DISTRIBUTION

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