

SAW FERRITIC ALL-WELD METAL: ACHIEVING ANSI/AWS A5.23-97 FXXA6-ECM2-M2 MECHANICAL PROPERTIES

Rodolfo Rep, PRODUCT DEVELOPMENT, Conarco-Esab, Argentina

N. Mabel Ramini de Rissone, DEYTEMA - CENTER FOR DEVELOPMENT AND TECHNOLOGY OF MATERIALS, Regional Faculty of San Nicolás, National Technological University, Argentina.

Hernán G. Svoboda, LABORATORY OF METALLOGRAPHY, DEPARTMENT OF MECHANICS, Faculty of Engineering, National University of Buenos Aires, Argentina.

Luis A. de Vedia, INSTITUTE OF TECHNOLOGY PROFESSOR JORGE A. SÁBATO (UNSAM-CNEA), CIC, Argentina.

Estela S. Surian, RESEARCH SECRETARIAT, Faculty of Engineering, National University of Lomas de Zamora, Argentina and DEYTEMA, Regional Faculty of San Nicolás, National Technological University, Argentina.

INTRODUCTION / BACKGROUND SECTION

Previous work performed with ANSI/AWS A5.5-96 E100/110/12018M manual covered electrodes and ANSI/AWS A5.29-98 E91T5-K2, E101/111T5-K3 and E120T5-K4 flux and metal cored wires, have shown that in ferritic high strength C-Mn-Ni-Mo and C-Mn-Ni-Mo-Cr systems, satisfying the required toughness was not difficult, but consistently achieving the tensile strength minimum requirements turned out to be more demanding.

The objective of this work was to study the effect that variations in the alloying content (C, Mn and Cr) of ferritic deposits, of the C-Mn- 1.8%Ni- 0.5%Mo and C-Mn-1.8%Ni-0.5%Mo-Cr systems, produced with the submerged arc welding process, have on their mechanical properties and microstructure.

TECHNICAL APPROACH

Different all-weld metal chemical compositions were obtained through Mn, C and Cr variations in the wire cores, maintaining Ni at 1.8% and Mo at 0.5%. A fully basic non active flux was used. Four 4 mm diameter wires and one 2.4 mm diameter wire, designed to satisfy FXXAX-ECM2-M2 classification chemical requirements, were used to weld eight ANSI/AWS A5.23-97 all weld metal coupons for mechanical testing varying the interpass temperature and/or heat input. All weld metal chemical composition, Vickers hardness (1kg), tensile and Charpy-V impact at -51 °C properties were determined. Microstructural studies were carried out using light and electron microscopy.

RESULTS AND DISCUSSION SECTION

Samples welded in similar conditions, increasing the alloying addition led to higher hardness, yield and tensile strengths. As the strength increased the deposits

classified as F9, F10 and F11. In samples welded with the same wire, the deposit corresponding to the lower interpass temperature showed increased strength.

Using F11 deposit wire, two more coupons were welded with different heat inputs. One ranked as F11 but the other failed due to the presence of a defect (the results were maintained in the paper in order to discuss impact properties). With the highest alloy content wire, weld metal failed to achieve F12 classification probably due to the excessive alloying that promoted brittle fracture without plastic deformation. In correspondence with this result, the largest hardness values were found in the samples that failed the tensile tests.

Charpy-V impact test results were very satisfactory in all cases, with average values between 60 J and 101 J. The lowest recorded individual value was 53 J, well over the minimum standard average requirement of 27 J and the individual minimum of 20 J. It is worth noting that even those samples that failed to pass the tensile test due to excessive alloying, presented high impact values.

The metallographic study showed that for samples welded in similar conditions, as Mn content increased, the area fraction of reheated zone also increased, primary austenitic grain size was reduced (this effect was more marked in samples welded with lower heat input or lower interpass temperatures), AF content increased and PF(G) content reduces in the columnar zone as the primary columnar grain size becomes smaller. FS(NA) remains fairly constant at around 40% area fraction while FS(A) tends to decrease with a slight increase in PF(I). MA constituents increase, with lower values in those samples welded with lower heat input and lower interpass temperatures.

CONCLUSION SECTION

The results obtained in this work showed that in C-Mn-Ni-Mo or C-Mn-Ni-Mo-Cr alloy ferritic weld metal, the main difficulty resides in obtaining adequate tensile strength values rather than in satisfying toughness requirements which could be comfortably obtained, as in the case of SMAW, FCAW and MCAW deposits of the same type., The microstructures of the SAW deposits showed to be similar to those obtained with SMAW and flux and cored wire all weld metal deposits of composition similar to those studied in the present work. The main components in the as welded zone are FS(NA) and AF, followed by FS(A).