The Influence of welding parameters on weld quality and tensile strength of aluminium alloys AA6063 and AA5052

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Abstract

This is the final report of a SIMR Joining Technology Centre project concerning MIG-welding of aluminium. Welding aluminium alloys exhibit several difficulties, especially in terms of porosity. Today experience in the field evinces the necessity for education of the differences compared to welding of steels. Extraordinary measures have to be taken to avoid contamination of the weldment, especially of hydrogen containing elements such as moisture. Hydrogen readily dissolves in liquid aluminium forming high levels of porosity upon solidification if not avoided. Porosity in aluminium weldments decreases strength, particularly in terms of fatigue strength. Every aluminium alloy must be treated separately in the choice of filler metal and factors to consider are for example: strength, weldability, appearance and susceptibility to corrosion. Alloys in this investigation were selected to AA6063 and AA5052. The aim was to investigate welding aspects of these alloys in terms of the effect of weld parameters such as wire feed speed, welding speed, voltage, shielding gas, gun angle and surface quality of the weldments. Weldment quality was defined in terms of porosity, penetration, spatter, cracking, precipitation profile and tensile strength. Process optimisation work in mechanised welding is central for the investigation, what concerns choice of filler metal and appropriate cleaning demands. For AA6063 the filler metals AlMg3, AA5554 (OK Autrod 18.13), and AlSi12, AA4047 (OK Autrod 18.05), were used. For AA5052 the filler metal AlMg5, AA5356 (OK Autrod 18.15), was used. Shielding gases used were: ARGON, MISON Ar (Argon + 0.03% NO), HELON 30 (Argon-Helium30) and MISON He30 (Argon-Helim30 + 0.03% NO). Joint geometry was selected to lap joints of 3 mm sheet metal for AA6063 and 2.5 mm for AA5052. The weldments of the aluminium alloys AA5052 and AA6063 with the filler
metals used in this investigation obtained high weldment quality when the
welding procedure was correct. Spatter was most easily avoided on AA6063 by
using the filler metal OK Autrod 18.18. Pulsed welding reduced spatter
significantly on both AA5052 and AA6063.
The porosity level was generally low if appropriate welding procedures were
followed. High heat-input and high deposition rates (high wire feeding and/or
low welding speed) were advantageous for low levels of porosity. Helium in the
Argon shielding gas resulted in nearly porosity free weldments. A low welding
voltage had favourable impact on the level of porosity.
Penetration varied significantly over the length of the weldments when the arc
instabilities were experienced. The heat-input and deposition rate (low wire
feeding and/or high welding speed) had a strong effect on both arc stability and
penetration. High voltages decreased penetration significantly, despite the
increased heat input. Helium in the Argon shielding gas resulted in a
significantly increased penetration.
Strength of weldments was found to be at about 50% of the parent metal and the
strength of HAZ could be approximated to 70% of parent metal for AA6063 and
90% for AA5052. High porosity levels decreased tensile strength significantly.
The Precipitation profile variations due to variations of heat-input had a
negligible effect on tensile strength, and softened zones could not be detected in
the thin sheet metal welding of aluminium practised in this project.