



Effect Of Welding Speed On Mechanical Properties Of A-Tig Welded Aluminium 2219 Alloy

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ABSTRACT

The storage tank of launch vehicles is a kind of complex welding structure in the field of aerospace, and the requirements of material strength, toughness, corrosion resistance, and weldability are very high. However, 2219 aluminium alloy can meet these requirements, which have made it an indispensable structural material in the field of aerospace, especially for tanks.

2219 aluminium alloy was mainly used in the propellant tanks of domestic aerospace vehicles.

However, there are several challenges in the welding of 2219 aluminium alloy: high welding porosity, low joint strength coefficient, poor back of weld and large welding deformation. The new welding technology under condition of direct current electrode negative A-TIG (DCEN A-TIG) welding using a special active agent (AlF₃, LiF, KF-AlF₃, K₂SiF₆) had eliminated the welding porosity of 2219 Aluminium alloy. The weakest part of the DCEN A-TIG welding joint was the fusion zone. (42914)

OBJECTIVE

The variation of welding speed on tensile property, hardness and fracture toughness is to be observed for 2219 alloy.

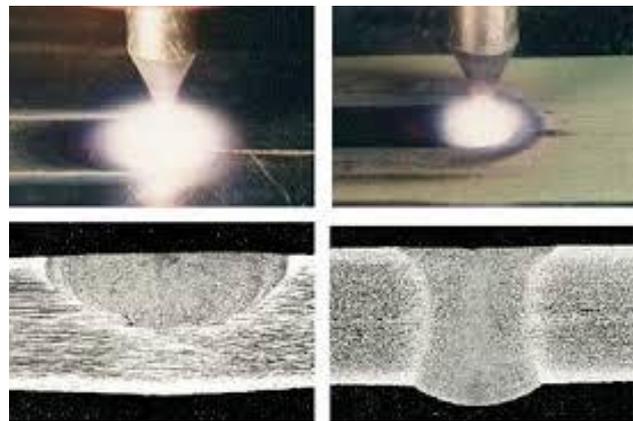
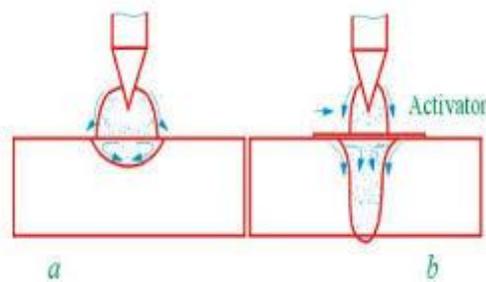
INTRODUCTION.

Conventional TIG welding of large thickness 2219 aluminium alloy plate (4mm) requires large welding current as well as the use of multi-pass welding process. The welding joint strength coefficient of the 2219 aluminium alloy is seriously reduced (42914) and the welding deformation is increased.

DCEN welding is an ideal method to weld 2219 aluminium alloy. Stable arc with the method of DCEN resolves unstable welding of aluminium alloy. The way of DCEN for aluminium alloy welding induces excessive heating in the base material, increases the depth of penetration and rate of heat utilization, reduces the welding current, and eventually saves energy. (42914)

ACTIVATED-TIG

Activated tungsten inert gas (A-TIG) welding, is an arc welding process that uses a non-consumable tungsten electrode to produce the weld. The weld area is protected from atmospheric contamination by an inert shielding gas (argon or helium), and a filler metal is used. In A-TIG welding, a thin layer of activated flux would brushed on to the surface of the joint to be welded. Active agent would be prepared using the four kinds of flourides (AlF_3 , LiF , KF-AlF_3 , K_2SiF_6) packed in powdered form. (DOI 10.1007/s00170-017-0356-4)



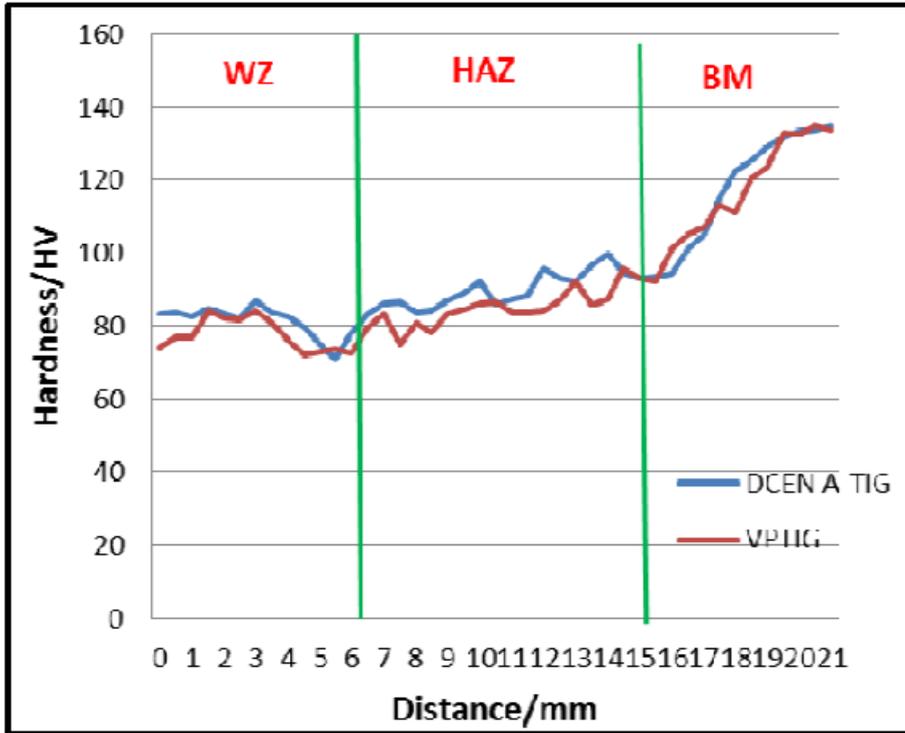
PROBLEM

Conventional TIG welding of 2219 aluminium alloy have high welding porosity, low joint strength coefficient, poor back of weld and large welding deformation. The hardness of Heat Affected Zone (HAZ) of the joint was higher than that of weld zone (WZ). The hardness was lowest near or at the fusion line. (42914)

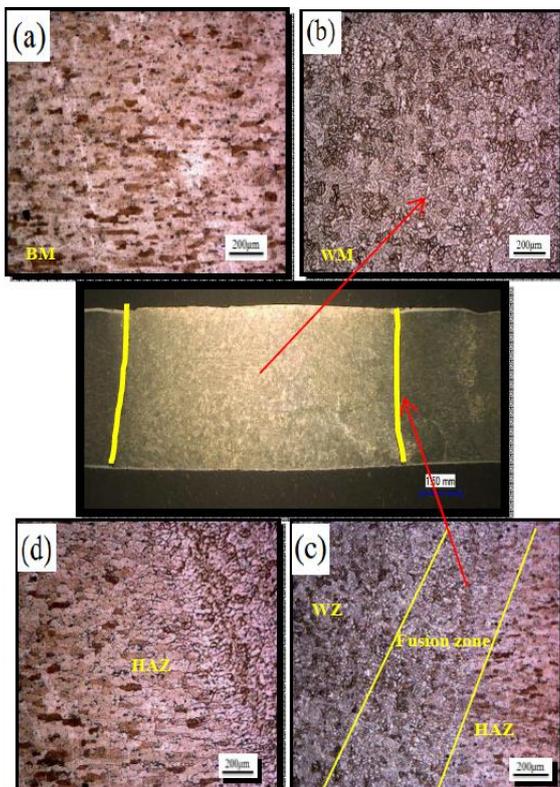
The measurement of micro hardness can reflect the fine change of microstructure of the joint, especially the hardness of heat affected zone (HAZ). The hardness of HAZ of the joint was higher than that of weld zone (WZ) and was lowest near fusion zone. (42914)

However, on the contrary, with the distance from the fusion line, the peak temperature of welding thermal cycle decreased gradually, the influence of the welding thermal cycle on the HAZ decreased, the hardness increased. After solution treatment, the base metal (BM) has a lot of fine and dispersion strengthened phase, the hardness of BM was the (42914).

. Therefore the weld zone near the fusion line of the joint was most soft



JOINT HARDNESS DISTRIBUTION BETWEEN VPTIG & A-TIG(42914)



Microstructures of DCEN A-TIG welding: (a) BM, (b) WZ, (c) Fusion zone ,(d) HAZ(42914)

The DCEN A-TIG of the 2219 aluminium alloy was mainly fractured at the weld zone near the fusion line.



Tensile specimen of DCEN A-TIG welding(42914)

The hardness of WZ near the fusion line was the minimum and in the tensile test it was seen that the fracture of the joint was near the fusion line where the tensile property was the worst. The fusion zone between the weld zone and the heat affected zones was inhomogeneous in chemical composition and organization. The fusion zone was also located in the geometrical changes caused by stress. Therefore, the fusion zone was also prone to break(42914).

MATERIALS AND METHODS

The welding material to be used would be 2219-T6 aluminium alloy plate measuring 300 mm × 100 mm × 4 mm. The filler metal will be ER2319 measuring 3.2 mm in diameter. Active agent would be prepared using the four kinds of fluoride (AlF₃, LiF, KF-AlF₃, K₂SiF₆) packed in powdered form. First, all specimen surfaces were ground with an abrasive paper to remove impurities, followed by cleaning with acetone. Second, the active agent was dissolved in alcohol and stirred into a paste, and coated on the surface of the welding area.

PROPOSED WELDING PARAMETERS

Welding current (DCEN A-TIG)	135A
Wire feed rate	1300mm/min
Wire diameter	1.6mm
Shielding gas Argon	Argon (99.999% purity)
Gas flow rate	11 L/min
Electrode diameter	3.2 mm

Main elements of welding joint (wt. %)

	Si	Cu	Mn	Zn	Ti	Zr
2219	0.2	5.8~6.8	0.2~0.4	0.1	0.02~0.15	0.1~0.25
ER2319	0.2	5.8~6.8	0.2~0.4	0.1	0.1~0.2	0.1~0.25

DCEN

A-TIG	0.068	6.32	0.27	0.013	0.10	0.12
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ACTIVE AGENT

The active agent would be four fluoride (AlF₃, LiF, KF-AlF₃, K₂SiF₆) mixed component.

Active agent would be directly coated on the parent metal.

PROCEDURE

A steel rail would guide the welding electrode and shielding gas regulator by the help of a motor travelling at a desired constant speed along the plate to be welded.

Experiment would be conducted with the following welding speed :

0.1 cm/s ,0.3 cm/s, 0.6 cm/s,0.9 cm/s ,1.2cm/s.

The distance between the nozzle and workpiece and the electrode extension would be 20 mm and 10 mm respectively. All other parameters of welding would be kept constant and welding speed would only be changed.

Impurities are to be removed by abrasive paper and would be cleaned with acetone.

The active agent would be dissolved in alcohol and stirred into a paste, and then coated on the surface of the welding area.

PLAN OF WORK

The specimen would be welded with a root gap distance of 1mm with welding speeds corresponding 0.1, 0.3, 0.6, 0.9 and 1.2 mm/s.

The sample after welding would be tested for tensile strength at Universal testing machine and the maximum force would be compared for different speeds.

The fracture toughness of the different weld specimen will be compared with the help of Charpy test.

The hardness of the weld specimens will be found out using Brinell hardness test.

TENSILE TESTING

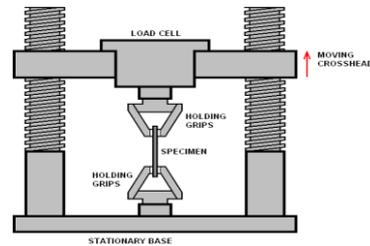
The basic idea of a tensile test is to place a sample of a material between two fixtures called "grips" which clamp the material. The material will have known dimensions, like length and cross-sectional area. We would then begin to apply weight to the material gripped at one end while the other end is fixed.

Tensile test results would include the ultimate tensile strength, yield strength, Young's modulus.

Force (N) = load (N) × acceleration ($\frac{m}{s^2}$)

Stress (MPa) = $\frac{force (N)}{area (mm^2)}$
 = $\frac{force (N)}{cross-sectional\ area\ of\ indenter (mm^2) [compression]}$
 = $\frac{force (N)}{cross-sectional\ area\ of\ sample (mm^2) [tension]}$

Strain (%) = $\frac{length (mm)_{new} - length (mm)_{original}}{length (mm)_{original}}$
 = $\frac{\Delta L (mm)}{L_0 (mm)}$

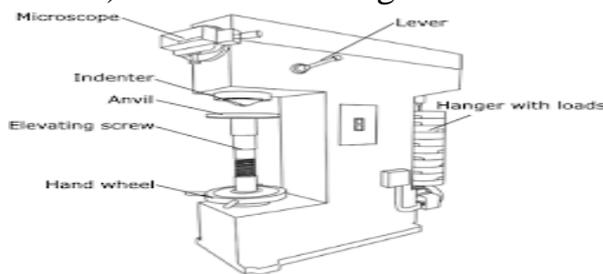


HARDNESS TESTING (BRINELL HARDNESS TESTING)

In **Brinell hardness test**, the size of indentation left by the indenter would be measured. **Brinell’s method** uses a spherical indenter. The **Brinell hardness (HBW) results** from the quotient of the applied **test force (F in newtons (N))** and the surface area of the residual indent on the specimen (the projection of the indent) after withdrawing the **test force**.

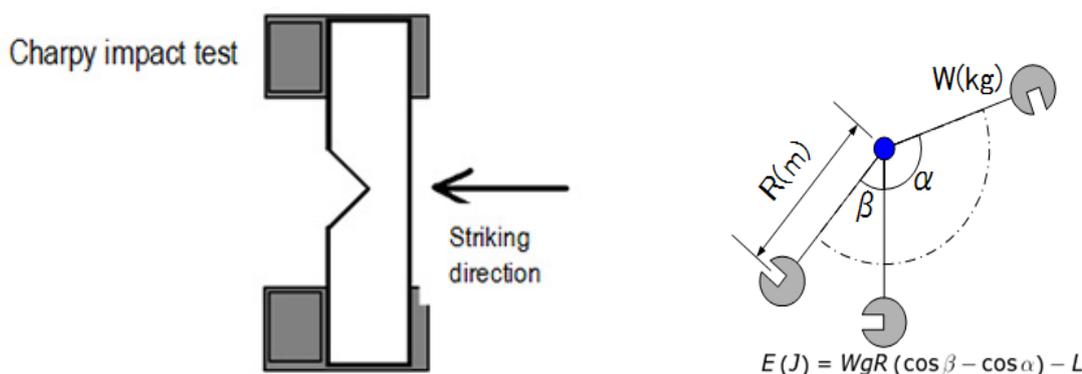
$$HBW = \text{constant} \times \frac{\text{test force } F}{\text{surface of the indentation}} = 0.102 \times \frac{2F}{\pi D^2 (1 - \sqrt{1 - d^2/D^2})}$$

$$d = \frac{d_1 + d_2}{2} \text{ (average indentation diameter)}$$



FRACTURE TOUGHNESS TESTING

A **fracture toughness test** will be conducted with the help of **CHARPY IMPACT TEST**. A test specimen having a V-shaped notch will be placed on the holder and the notched section would be in the centre of the holder. The specimen would be broken by striking the back of the notched section with the hammer. The fracture energy would be determined from the swing-up angle of the hammer and its swing-down angle. The Charpy impact value (kJ/m²) would be calculated by dividing the fracture energy by the cross-section area of the specimen. The higher the impact value of a material is, the higher the toughness or tenacity of the material is.



EXPERIMENTAL SET-UP

The setup to be used during the experiments includes shielding gas regulator, welding machine and a motor which would carry and guide the welding gun and travel with the desired constant speeds along the plates to be welded. The motorized unit would have an adjustable speed setting ranging from 1 to 10.

ESTIMATED COST OF THE PROJECT

The project is estimated to cost around 6000-8000 rupees including the filler metal and the plates. The cost would also include any other expenditure related to testing of the welds in different laboratory.

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