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REVIEW OF TIG WELDING PAREMETER ON STRENGTH BASIS

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The current study deals with the parametric and microstructural analysis and of AA5052 and AA6061 welded specimen with a TIG (Tungsten Inert Gas) set up. TIG provides one of the most precise and quality welding fastest welding speed can be used in marine, aerospace and ship industries. Current, gas flow rate and distance between electrode and workpiece are the important parameters which are directly affecting the tensile strength of welded specimen and play an important role in metallurgical changes. Wire EDM cutting is used to cut the welded specimen as per ASTM standard. Tensile strength increases by increasing welding current till an optimum value. Micro-Structural changes are investigated Scanning electron microscopy (SEM) and Optical microscope.

INTRODUCTION

The various welding process is present, among the various welding process, Tungsten inert gas (TIG) welding plays a major role in the welding of mild steel or thin sections of non-ferrous metals such as copper alloys, aluminum alloys, magnesium, and stainless steel. TIG input welding parameters are the most important factors affecting the quality of the welding and weld quality is strongly characterized by weld geometry. The choice of the welding depends on several factors; primarily among them are the compositional range of the material to be welded, the thickness of the base materials and type of current. TIG welding has several advantages like joining of dissimilar metals, the absence of slag, low heat affected zone and etc.

Since input parameters play a major role in determining the quality of a welded sample. A plan of experiments based on Taguchi technique has been used to design of experiment, acquire the data and to optimize the welding parameters as well as the process.

An Orthogonal array and analysis of variance (ANOVA) are employed to investigate the welding characteristics of alloy Carbon Steel material and optimize the welding parameters. Properties are Hardness, Impact force; Tensile strength, etc. are taken as responses of the input parameter.

Finally, the comparison tests have been carried out to compare and optimize the best parameters for given alloy steel with the experimental values confirm its effectiveness in the analysis of Tensile strength, Impact strength and Microstructures.

LITERATURE REVIEW

Bajpai et al [1] done an investigation on involving gas metal arc welding to determine the temperature distribution, longitudinal and transverse residual stresses and distortions in joining two thin dissimilar aluminum alloys AA5052 and AA6061 plates. The results are validated against numerical simulations using finite element analysis software ANSYS. Three-dimensional thermo-mechanical finite element model was used to determine transient temperature, residual stress, and distortions. Heat dissipation due to conduction, convection, and radiation was considered. Comparison results show good conformity between experimental and numerical results and that AA6061 plate has higher longitudinal and transverse residual stresses and lesser shrinkage than AA5052 plate.

Ceschini et al [2] Perform Metal matrix composites reinforced with Al_2O_3 particles combine the matrix properties with those of the ceramic reinforcement, leading to higher stiffness and superior thermal stability with respect to the corresponding unreinforced alloys. However, their wide application as structural materials needs proper development of suitable joining processes. The present work describes the results obtained from microstructural (optical and scanning electron microscopy) and mechanical evaluation (hardness, tensile and low-cycle fatigue tests) of an aluminum alloy (AA6061) matrix composite reinforced with 20 vol.% the fraction of Al_2O_3 particles (W6A20A), welded using the friction stir welding process.

Cheng et al;[3] experimented Dissimilar copper/stainless steel metal joints with excellent double-sided forming can be obtained by MIG-TIG double-sided arc welding without grooving and preheating. The joints with welding-brazing and fusion welding modes based on the different joining mechanisms in the SS/weld interface can be found. The brazing stainless steel/weld interface shows a flat morphology, while the fusion SS/weld interface consists of a melted unmixed zone (MUZ) and shows a scraggy morphology. Tensile tests show that fracture occurs at the heat-affected zone (HAZ) at the copper side in all joints, and the optimal tensile strength reaches 229 MPa. All joints exhibit lower tensile strength and larger elongation than the Cu base metal due to softening in the HAZ on the copper side.

Fadaeifard et al [4] performed Double-V butt TIG welding process on two plates of AA6061-T6 using ER5356 filler. The microstructure, mechanical and nanomechanical properties of the joint were evaluated in as-welded and after post-weld heat treatment (PWHT) using XRD, FESEM, EBSD, nanoindentation and tensile tests. The results show that PWHT led to the microstructural recovery of the heat-affected zone (HAZ) in addition to the appearance of β-phase (Al3Mg2) at the grain boundaries of the weld zone. All results indicate that PWHT has created a homogenous microstructure in the weld zone in addition to outstanding improvement in mechanical properties for the weld zone which surpasses the base metal.

N Farmanbar et al;[5] In this study, a new method was proposed to remove the keyhole with the title of "protrusion friction stir spot welding", and the effect of the tool dwelling time on microstructure and mechanical properties of aluminum alloy 5052 sheets was investigated. Welding was carried out at different dwelling times of 3–18 s at a tool rotational speed of 800 rpm. Macrostructure and microstructure examinations indicated that this new method has the ability to create a non-defect metallurgical joint with a homogeneous and fine grain structure.

E. R. Imam Fauzi et al [6] studied to compare the microstructure characteristics and mechanical properties of AA6082 in T6 condition of tubular joints fabricated by tungsten inert gas welding (TIG) and metal inert gas welding (MIG) processes. The effect of welding processes was analyzed based on optical microscopy image, tensile testing, and Vickers micro-hardness measurements. The results showed that the tensile strengths of the TIG-welded joints were better than those of the MIG-welded joints, due to the contribution of fine equated grains formation with narrower spacing arms. In terms of joint efficiency, the TIG process produced more reliable strength

Gharavi et al;[7] In this work, the corrosion behavior of welded lap joints of AA6061-T6 aluminum alloy produced by friction stir welding process has been investigated. Corrosion properties of welded lap joints were studied by cyclic polarization and electrochemical impedance spectroscopy tests.

Hariri et al; [8] This study attempts to find an optimum combination of the welding tool rotation rate (ω) and traveling speed (υ), concerning the corrosion and mechanical properties of Friction Stir Welded (FS Wed) AA5052 Aluminum alloy. The effect of the tool speeds on the FS Wed AA5052 is investigated via potential dynamic polarization, open circuit potential (OCP) monitoring, a test of the susceptibility to intergranular corrosion, weight loss, tension, and micro-hardness tests. Optical microscope and Scanning Electron Microscopy (SEM) were employed for studying morphology and analyzing the probable intergranular attacks.

Hejazi et al; [9] studied the relationships between microhardness and microstructure, macrostructure and mechanical properties of friction stir welded joints AA6061-T913 were studied. Three equations were suggested to predict the grain size, ultimate tensile strength and yield strength from the hardness throughout the weld. The two-dimensional contour of grain size and three-dimensional maps of ultimate tensile and yield strengths were plotted according to the proposed equations. Also, the location of macroscopic zones was estimated based on hardness distribution.

Howey et al; [10] determined Effects of deformation routes on the evolution of dislocation density, microstructure, texture and mechanical properties of AA5052 aluminum alloy during equal channel angular pressing (ECAP) were investigated in this research. The results of the microstructural study showed that homogeneous ultrafine grain structures with an average grain size of less than 500 nm were developed after 6 passes ECAP regardless of route of deformation.

Huang et al [11] Micro friction stir welding (FSW) were successfully performed to join the ultra-thin 6061-T4 sheet with the thickness of 0.5mm. The optimum plunging depth of 0.05mm was obtained and the reduction ratio was lower than 0.2%. Based on better dynamic flow induced by the tri flat pin, the good surface appearance at the wider process window was obtained, while the grain size at the nugget zone was finer than that by the taper pin. Increasing welding speed caused that tensile property increased firstly and then decreased with high welding speed than 500mm/min.

Jayshree [12] find Aluminum in pure form has comparably less strength, though some of its alloys are stronger than structural steels. 6061Al alloy is so strong and hence used in aggressive conditions like aerospace applications. Possessing these superior properties, the defects like porosity, hot cracking and stress corrosion cracking during welding of aluminum alloy is yet to be optimized. This paper focus to determine the favorable welding conditions for Tungsten Inert Gas (TIG) welding of 6061Al alloy based on Taguchi's design of experiments.

Kumar et al;[13] in This paper describes an experimental approach to study the effect of welding current on butt joint of 3 mm thick commercial 1050 aluminum plate. Bead geometry, microstructure and tensile strength of the weld joint are analyzed to evaluate the mechanical properties of the weld joint. Analysis of bead geometry shows increment in the depth of penetration and width of melt zone with the increasing welding current. Microstructural analysis of the weld joint reveals columnar dendritic structure in fusion zone while mixed columnar and equiaxed dendritic structures in HAZ. Tensile test results confirm the improvement of mechanical strength with an increase in welding current. However, porosity and incomplete joint penetration adversely affect the mechanical strength of the weld joint.

Kumar et al;[14] Aluminum alloy of AA5052 has wide acceptance in marine, aircraft, gas tankers, sheet metal work, fuel lines because of high strength to weight ratio. Unlike the fusion welding process, friction stir welding (FSW) is one of the solid-state welding processes where the coalescence between two metals is produced by generating frictional heat between non consumable tool and base material.

Kumar et al; [15] performed AA5052/ZrB_2 composites with different volume percent (i.e. 0, 3, 6, 9 and 10 vol.%) ZrB_2 particles were developed by in-situ reaction of molten AA5052 alloy with two inorganic salts K_2ZrF_6 and KBF_4 at a temperature of 860 °C. The in-situ composites were characterized by DTA, XRD, SEM, TEM for reaction analysis and morphology. Their mechanical properties like hardness and tensile properties were evaluated using standard methods. Morphology studies show that the grain size of the Al-rich phase reduces due to the presence of ZrB_2 particles. Microstructural studies also reveal the uniform distribution of second phase particles, clear interface, good bonding, dislocations and morphology of ZrB_2 particles.

Kumar et al; [16] High strength aluminum alloy AA7075 (Al–Zn–Mg–Cu) is a precipitate hardenable alloy widely used in the aerospace, defense, marine and automobile industries. Use of the heat treatable aluminum alloys in all these sectors is ever-increasing owing to their excellent strength-to-weight ratio and reasonably good corrosion resistance. The shortage of corrosion resistance

Li et al; [17] 2219 aluminum alloy was mainly used in the propellant tanks of domestic aerospace vehicles. Porosity was often observed during the VPTIG welding joint of the 2219 aluminum alloy. The new welding technology under the condition of direct current electrode negative A-TIG (DCEN A-TIG) welding using a special active agent (AlF_3, LiF, KF-AlF_3, K_2SiF_6) had eliminated the welding porosity of 2219 aluminum alloy. DCEN A-TIG welding and VPTIG welding of 2219 aluminum alloy were performed. Compared with VPTIG welding, the current decrease of DCEN A-TIG welding had greatly reduced the thermal effect on base metal and heat-affected zone

Liang et al [18] in this experiment tungsten inert gas (TIG)-cold metal transfer (CMT) hybrid welding process is proposed. Compared with the conventional TIG-metal inert gas/metal active gas (MIG/MAG) hybrid welding method, the characteristic of TIG-CMT welding process is that there is no interaction between the two arcs. The addition of TIG can improve the wet ability of molten metal. The microstructure in the hybrid joint is coarser than that in conventional CMT joint, and the microhardness in weld metal (WM) of the hybrid joint is higher than that of conventional CMT joint

Mathai et al; [19] in this experiment Dimensional accuracy of features generated by electro-discharge machining (EDM) is influenced by process parameter combination as well as process instability. In the present study, an attempt has been made to study the effect of process parameters viz. pulse ON time, tool path offset, scanning speed, pulse OFF time and gap voltage on overcut, internal edge radius and achieved cavity depth during planetary EDM of Ti-6Al-4V.

Mohanavel et al; [20] This research article exhibits experimental and numerical results of TIG welding of AA6061. TIG welding process parameters like gas flow rate, welding current and welding speed was optimized using the Taguchi technique for joining AA6061 plates. The combinations of parameters were carefully selected with the objective of producing a weld joint with maximum impact strength. Experimental tests were performed with four levels of parameters according to L_{16} orthogonal array

Naik et al; [21] The main criteria discussed in this paper concern the welding optimization parameters and tensile strength of duplex stainless steel 2205 by tungsten inert gas welding based on Taguchi method and analysis of variance. Taguchi method of orthogonal L9 design experiment is carried out using an orthogonal array for defining the problem occur on the welding process and to reduce the error occurred in the neural network for the prediction of output.

Pandivelan et al; [22] This paper investigates and enlights the formability of AA 5052 sheets by the effect of various parameters like feed rate, the rotational speed of the tool (RPM), vertical step down, and diameter of the tool. Taguchi's L9 orthogonal array-based design of experiments was conducted and a favorable combination of parameters was identified to enhance the formability in terms of wall angle test.

Singh et al [23] The purpose of this review was to look into various techniques that may improve the weld penetration and weld quality in a TIG welding. In this review, we discuss the influence of various types' methods such as ATIG (Activated Flux TIG), FBTIG (Flux Bounded TIG), PCTIG (Pulsed Current Tungsten Inert Gas) Welding. It was observed during the review that use of flux or fluxes and pulsed current method improve the weld penetration with weld quality.

Singh et al [24] In this investigation, an attempt has been made to study the experimental comparison of friction stir welding process and TIG welding process for 6082 – T6 aluminum alloy joints. Most commonly used method for welding of aluminum alloy is the TIG welding process. TIG welding process produces the sound joints but the newly developed method friction stir welding process gives better joints than the TIG welding process. The effect of two welding processes on mechanical and metallurgical properties is studied in this research work.

CONCLUSION

From the available literature, it can be seen that though some work has been reported on the influence of welding parameters on impact strength and tensile strength. Measurement of the welding strength has so far been made to systematically to optimize the process variables with a view to obtain favorable responses. Moreover, various welding technique is present but it cannot be characterized as a strength-based it typically includes impact strength and tensile strength. Therefore, there should be research endeavor to apply multi-objective optimization techniques in order to achieve a reasonably high value of impact strength and tensile strength. Finally, need to compare the welding optimal responses to know the best output in the same parameter.

For a constant given current, slower travel speeds proportionally provide larger bead and higher heat input to the base metal because of the longer healing time. The high input increases the weld penetration and the weld metal deposit per unit length and consequently results in a wider bead contour.

Former are welding current, gas flow, and welding distance parameters will affect the weld characteristics to a great extent. Because these factors can be varied over a large range, they are considered the primary adjustments in any welding operation. Their values should be recorded for every different type of weld to permit reproducibility.

Two dissimilar welds for commercial purpose has been not discussed in past literature. Welding Parameters for two different grades aluminum are not optimized in past literature.

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