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A REVIEW OF METAL INERT GAS WELDING ON ALUMINIUM ALLOYS

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ABSTRACT
Welding is the manufacturing method, which is carried out by joining two similar and dissimilar metals.MIG welding is one of the most widely used processes in industry. The MIG welding parameters are the most important factors affecting the quality, productivity and cost of welding.We studied input parameters of welding such as welding current, arc voltage, welding speed, root gap and output parameter are hardness, tensile strength, impact energy, and microstructure.This review is based on optimization techniques and analysis tools used by researchers to optimize the parameters.In this research paper a review has been presented on MIG welding. The previous literature has been discussed along with the future aspects included in the field of MIG welding.

KEYWORDS: MIG, Strength, Mechanical and Metallurgical properties, Review.

INTRODUCTION
Metal inert gas (MIG) welding is also known as Gas metal arc welding (GMAW). The MIG welding process was developed and made commercially available in 1948, whereas the basic concept was actually introduced in the 1920's. Metal inert gas welding is a welding process in which an electric arc forms between a consumable wire electrode and the work piece metal causing them to melt and join. Along with the wire electrode, a shielding gas is supplied through the welding gun which shields the process from contaminants in the air. MIG welding is versatile and having less loss of alloying elements during the process and can be operated as semi-automatic and fully automatic welding. Most metals can be welded with this process and may be welded in all positions with the lower energy variations of the process. [1]

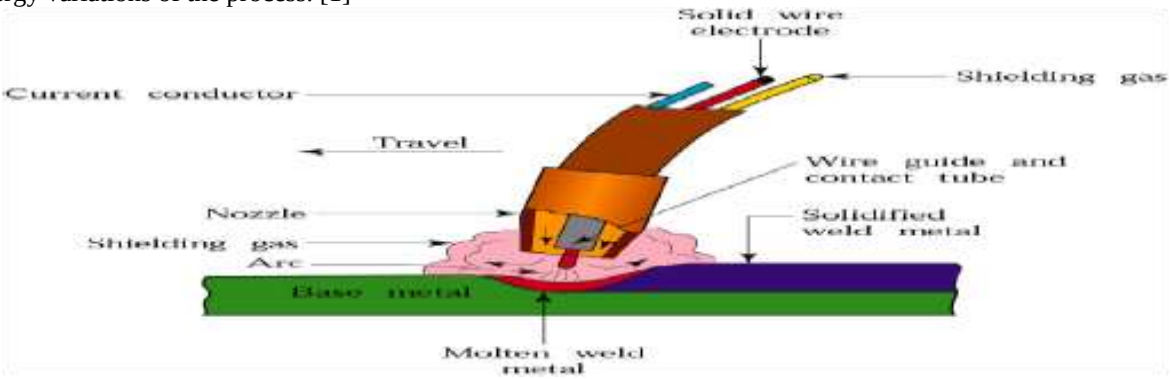

Figure.1 Schematic representation of MIG welding principle

MIG weldingadvantages:
MIG welding process has many advantages that result from the fact that the welding process occurs at the solid state. These advantages are:
One of the top advantages of MIG welding is its simplicity, MIG welding provides better weld pool visibility, there is very little loss of alloying elements, no slag to remove, MIG welding is extremely versatile and can weld

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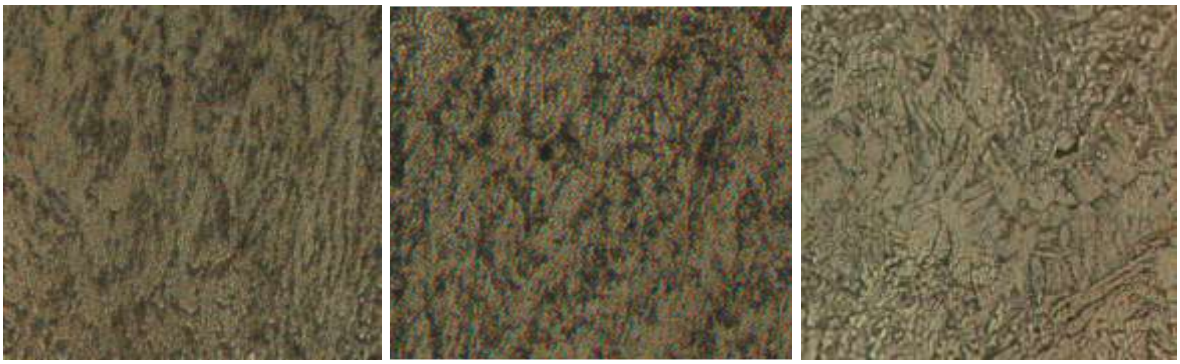
a wide variety of metals and alloys. MIG welding is semi as well as fully automatic, continuously fed wire improves the welding speed, quality of the weld, and overall control.

Process parameters

The MIG welding experimentation depends on a number of variables that can affect the output response. The welding process parameters mainly affect the geometry of the weld bead such as the penetration, bead reinforcement, bead width and the deposition rate, which is the weight of the metal deposited per unit of time. These parameters are as follows: welding current, welding voltage, travel speed, wire electrode size, type of shielding gas, electrode extension, electrode angle, and weld joint position. A proper selection of welding parameters will increase the chances of producing welds of a satisfactory quality.

LITERATURE SURVEY

B. K. Srivastavaet al., [2010] studied about the effect of preheating and postheating on mechanical properties of metal. Welding is used in ships, bridges, pressure vessels, industrial machinery, automobile, rolling stock and many other fields. Weldability of steel refers to the maximum hardness of the heat affected zone (HAZ) and the cold cracking susceptibility of welds. When steel is welded non uniform heating and cooling in weld metal and in base metal generates harder Heat Affected Zone (HAZ), cold crack susceptibility and residual stress in weldment. The best way to minimize these defects is to slow the heating and cooling rate of the base metal and weld heat affected zone. There are many methods for reducing the effects of above problems and one of them is preheating and/or post heating. Pre heating and/or Post heating have been widely employed in welding operation for preventing cold cracking. This study presents the effect of preheating and/or PWHT on mechanical behaviour or maximum HAZ hardness, cold cracking susceptibility and residual stresses of various steel types. **[1] G Haragopal et al., [2011]** studied about the Taguchi method of design process parameters to optimize mechanical properties of weld specimen for aluminium alloy (Al-65032), which is used for construction of aerospace wings. Main process parameters considered are gas pressure, current, groove angle and pre-heat. L-9 orthogonal array, experiments were conducted and optimization condition was obtained along with the identification of most influencing parameters using S/N analysis, mean response analysis and ANOVA. **[2] I. A. Ibrahim et al., [2012]** suggested that Gas Metal Arc Welding (GMAW) process is leading in the development in arc welding process which is higher productivity and good in quality. In the study, the effects of different parameters on welding penetration, microstructural and hardness measurement in mild steel that having the 6mm thickness of base metal by using MIG welding are investigated. Main three welding parameters in this study are arc voltage, welding current and welding speed. The arc voltage and welding current were chosen as 22, 26 and 30 V and 90, 150 and 210 A respectively. The welding speed was chosen as 20, 40 and 60 cm/min. The penetration, microstructure and hardness were measured for each specimen after the welding process and the effect was studied. Arc voltage and welding speed are the most influencing factors that affect the value of depth of penetration. The microstructure showed the different grain boundaries of each parameter that affected of the welding parameters. **[3]**



(210 A, 22V, 20cm/min) ***(210 A, 22V, 40cm/min)*** ***(210 A, 22V, 60cm/min)***

Figure.2 Microstructure of welded parts

P. Sivraj et al., [2014] studied the effects of post weld heat treatments, namely artificial ageing and solution treatment followed by artificial ageing, on microstructure and mechanical properties of 12 mm thick friction stir welded joints of AA7075-T651 aluminium alloy. The mechanical properties, such as yield strength, tensile strength, elongation and notch tensile strength, are tested and compared with the microhardness and microstructural features. The scanning electron microscope is used to find out the surface defects. The solution treatment followed by heat treatment cycle is found beneficial in improving the tensile properties of friction stir

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welds of AA7075-T651 aluminium alloy. **[4] R. Kumar and Satish Kumar et al., [2014]** analysed the effect of different input parameters such as welding current, arc voltage and root gap on the mechanical properties during the Metal Inert Gas Welding (MIG) of mild steel 1018 grade. The microstructure, hardness and tensile strength of weld specimen are investigated in this study. The selected three input parameters were varied at three levels. Nine experiments were performed based on L9 orthogonal array of Taguchi's methodology, which consist three input parameters. Analysis of variance (ANOVA) was employed to find the levels of significance of input parameters. Root gap has greatest effect on tensile strength followed by welding current and arc voltage. Arc voltage has greatest effect on hardness followed by root gap and welding current. Microstructure of weld metal consists of fine grains of ferrite and pearlite. **[5] V. Chauhan and Dr. R. S. Jadoun et al., [2015]** investigated about theScope of arc-welding, which have increased in the various engineering field like aerospace, nuclear, and underwater industries where complex geometry and hazardous environments necessitate fully automated systems. Even traditional applications of arc welding such as off-highway and automotive manufacturing have increased their demand in quality, cost, accuracy, and volume to stay competitive. As a result, process parameters are needed to improve the existing process of welding. Metal inert gas (MIG) welding process has successfully used for joining similar and dissimilar metals. In this study dissimilar metals, stainless steel (SS-304) and low carbon steel plates are joined by MIG welding successfully. Three parameters of MIG welding viz. current, voltage and travel speed are taken for the analysis. A plan of experiments based on Taguchi technique has been used to acquire the data. The analysis for signal-to-noise ratio was done using MINITAB-13 software for higher-the-better quality characteristics. The significance of each parameter was studied by using the ANOVA (Analysis of variance). Finally the confirmation tests were performed to compare the predicted values with the experimental values which confirm its effectiveness in the analysis of tensile strength of the joint. **[6] Pranesh B. Bamankaret al., [2015]**studied about MIG welding and effects of parameters on it. MIG welding is one of the most widely used processes in modern industry. Welding process parameters affects the quality and productivity of welding. Various optimization techniques are used to optimize the process parameters. This study is based on optimization techniques and analysis tools used by researchers to optimize the parameters. Also many researcher carried study on various response parameters like depth of penetration, bead width, bead height, micro-hardness, micro-structural study etc.**[7] FuhengNie et al., [2016]** studied about the microstructure and mechanical properties of pulse metal inert-gas (MIG) welded dissimilar joints between 4 mm thick wrought 6061-T6 and cast A356-T6 aluminum alloy plates. In testing the tensile strength of the joints reaches 235 MPa, which is 83% of that of 6061 aluminum alloy, and then decreased with the increase of travel speed while keeping other welding parameters constant. The microstructure, composition and fractography of joints were examined by the optical microscopy (OM), scanning electron microscopy (SEM) and electron probe microanalysis (EPMA). Grain boundary liquation and segregation occurred in the partially melted zone (PMZ) on 6061 aluminum alloy side, and brittle Fe-rich phases were observed in partially melted zone on A356 aluminum alloy side. The minimum microhardness appeared in heat-affected zone (HAZ) near A356 aluminum alloy substrate. **[8] K. Nandagopal et al., [2016]**examined the effect of Gas tungsten arc welding. In this paper Gas Tungsten Arc Welding (GTAW) is carried out between the two dissimilar materials titanium (6Ale4V) and aluminium 7075 with filler material as aluminium AA 4047. There are twenty five samples of welding to study the mechanical and metallurgical properties. This welding is carried out with three set of process parameter with five levels of values. The mechanical properties are measured for work piece. Taguchi is used to optimize the process parameters to attain the optimal joint strength and quality of joint in the welded samples and to identify the most influencing process parameters in this welding process. ANOVA method is used to determine the percentage contribution by each process parameter. The surface defects have been investigated for the weld samples. Scanning electron microscope (SEM) and Energy-dispersive X-ray analysis (EDX) is carried out to measure the nature of the matrix and chemical element. **[9] NabenduGhosh et al., [2016]** examined the visual inspection and X-ray radiographic test in order to detect surface and sub-surface defects of weld specimens made of AISI 316L austenitic stainless steels. Effect of welding parameters like current, gas flow rate and nozzle to plate distance on quality of weld in metal inter gas arc welding of AISI 316L austenitic stainless steel has been studied through experiments and analyses. Butt welded joints have been made by using several levels of current, gas flow rate and nozzle to plate distance. Mechanical properties of the weld have been investigated in terms of yield strength, ultimate tensile strength and percentage of elongation of the welded specimens. The observed data have been interpreted, discussed and analyzed by using Grey - Taguchi methodology. **[10] G. Asala and O.A. Ojo et al., [2016]** investigate about the susceptibility heat affected zone. The susceptibility of heat affected zone (HAZ) to cracking in Tungsten Inert Gas (TIG) welded Allvac 718Plus superalloy during post-weld heat treatment (PWHT) was studied. Contrary to the previously reported case of low heat input electron beam welded Allvac 718Plus, where HAZ cracking occurred during PWHT, the TIG welded alloy is crack-free after PWHT, notwithstanding the presence of similar micro-constituents that caused cracking in the low input weld. Accordingly, the formation of brittle HAZ intergranular

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micro-constituents may not be a sufficient factor to determine cracking propensity, the extent of heat input during welding may be another major factor that influences HAZ cracking during PWHT of the aerospace superalloy Allvac 718Plus **[11] S. D. Ambekar et al., [2015]**investigates about the effect of welding parameters. Gas metal arc welding is one of the conventional and traditional methods to join materials. The optimization for Gas metal arc welding process parameters (GMAW) of Martensitic Stainless steel work piece AISI 410 using Taguchi method is done. This paper presents the effect of welding parameters like welding speed, welding current and wire diameter on penetration. The confirmation test is conducted and found the results closer to the optimize results. These results showed the successful implementation of methodology.**[12]**

CONCLUSIONS

- Wide research had done on parametric optimization of MIG welding.
- Many researcher studied different response parameters like micro-hardness, microstructure, depth of penetration and heat affected zone (HAZ) of welded specimen.

- In this literature survey have been concluded that current is most common effective parameter in welding.
- Heat treatment on welded specimen has greater effect on metallurgical properties.

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