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A REVIEW PAPER ON TUNGSTEN INERT GAS WELDING OR (GTAW) ON STAINLESS STEEL

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ABSTRACT

As we know that now days Welding is widely used in industry for permanent joining. There are various welding processes having various properties and specifications. From which TIG(Tungsten inert gas) welding is one of the best welding process used in of joining of similar and dissimilar metals. Tungsten Inert Gas (TIG) is an electric arc welding process, which produces an arc between a non-consumable tungsten electrode and the work to be welded. TIG is used very commonly in areas, such as rail car manufacturing, automotive and chemical industries heat exchangers parts. Stainless steel is extensively used in industries as an important material, because of its excellent corrosion resistance. Austenitic stainless steels are widely used in the application of aircraft engine parts, heat exchangers, furnace parts etc. It contains both chromium and nickel. Nickel and chromium aids stability of austenite over wide range of temperatures and high corrosion resistance respectively. 316L austenitic stainless steel is low carbon (0.03%) steel, developed from 316 austenitic stainless steel and contains carbon (0.08%). The causes of decreased contents of carbon, minimizes the problem of harmful carbide precipitation during welding. In this paper we are discussed about past research paper on TIG welding. This paper is aimed to give brief about various research has been done on TIG which is very helpful for future research on TIG welding by highlighting important conclusion and results.

KEYWORDS: *Tungsten inert gas, Welding ,Dissimilar metal welding ,Stainless steel, Tungsten inert gas welding Mechanical properties, Microstructure, optimization.316 austenitic stainless steel. Marangoni convection, Arc constriction effect.*

INTRODUCTION

The Tungsten inert gas welding is the one of the best welding process used to permanent joining of the metals. When the tungsten electrode comes near (before 2mm or 3mm) to the work piece an arc is generated. The arc melt the work to be welded. To avoid atmospheric contamination the shielding gases (argon or helium) used. In the atmosphere oxygen and nitrogen are available which react with weld pool and form the oxides. Argon is more widely used than helium because it is heavier gas, producing better shielding at lower flow rate. The shielding gas remove the air surrounding the arc and weld pool. The process may be operated autogenously (without filler) or filler may be added by feeding a consumable wire or rod into the established weld pool. The arc is struck either by touching the electrode with a metal tungsten piece or using a high frequency unit. Stainless steel is widely used in sheet metal fabrication, especially in automotive, chemical and rail coach manufacturing, mainly due to its excellent corrosion resistance and better strength to weight ratio. Stainless steel is a generic name covering a group of metallic alloys with chromium content in excess of 10.5 percent and a maximum carbon content of 1.2 percent (according to European Standard EN (10088) and often includes other elements, such as nickel and molybdenum.

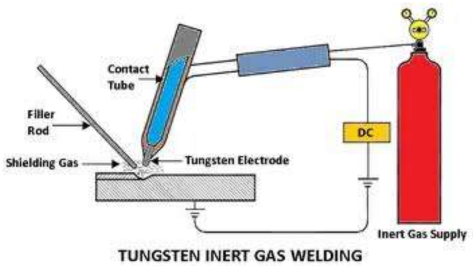

Fig1: TUNGSTEN INERT GAS WELDING.

TUNGSTEN INERT GAS WELDING ON STAINLESS STEEL:

There are various experiment and research has been done TIG welding .some research and experiment are following:

E.TABAN et al. [6] investigated the microstructural and toughness properties and mechanical properties of the gas metal arc welded 6 mm thick modified X2CrNi12 SS with two different heat input and concluded that the grain size has dominant effect on impact toughness. Grain coarsening has no adverse influence either on tensile properties or on a bend properties but the heat affected zone impact toughness for sub-zero temperature generally decreases and this depends on the amount of grain coarsened microstructure and eventual precipitates present.

Kuang-Hung Tseng et al. [12] investigated on Development and application of oxide-based flux powder for tungsten inert gas welding of austenitic stainless steels. The experiment reported in this study involved using a new activated flux developed by the National Pingtung University of science and Technology to systematically investigate the influence of oxide based flux powder and carrier solvent composition on the surface appearance, geometric shape, angular distortion and ferrite content of austenitic 316L stainless steel tungsten inert gas welds .experiment reported in this study involved using a new activated flux developed by the National Pingtung University of science and Technology to systematically investigate the influence of oxide based flux powder and carrier solvent composition on the surface appearance, geometric shape, angular distortion and ferrite content of austenitic 316L stainless steel tungsten inert gas welds.

G.R.Mirshekari et al. [13] investigated on Microstructure and corrosion behaviour of multipass gas tungsten arc welded 304L stainless steel. The purpose of this study is to discuss the effect of single pass and multipass gas tungsten arc welding on microstructure, hardness and corrosion behaviour of 304L stainless steel. They concluded that the microstructure of fusion zones exhibited dendritic structure contained lathy and skeletal ferrite.

Subodh kumar et al. [14] Investigated the Effect of heat input on the microstructure and mechanical properties of gas tungsten arc welded AISI 304 stainless steel joints. Three heat input combinations designated as low heat, medium heat and high heat were selected from the operating window of the GTAW process and weld joints made using these combinations were subjected to microstructural evaluations and tensile testing so as to analyse the effect of thermal arc energy on the microstructure and mechanical properties of these joints.

A.K.Lakshminarayanan et al. [7] studied the effect of welding processes such as shielded metal arc welding, gas metal arc welding and gas tungsten arc welding on Tensile and Impact properties of the ferritic stainless steel confirming to AISI 409M grade. From this investigation it is found that gas tungsten arc welded joints of ferritic stainless steel have superior tensile and impact properties compared with shielded metal arc and gas metal arc welded joints and this mainly due to the presence of finer grains in fusion zone and heat affected zone.

A.VinothJebaraj et al. [10] has studied Influence of microstructural changes on impact toughness of weldment and base metal of duplex stainless steel AISI 2205 for low temperature applications.DSS weld joints were fabricated using gas tungsten arc welding process with controlled welding parameters. Ferrite austenite ratio in the weld zone, heat affected zone and base metal was assessed by quantitative metallographic image analysis. The impact test results were correlated with the fractured surface and the microscope of the tested specimen.

Activated Tungsten inert gas welding(A-TIG):

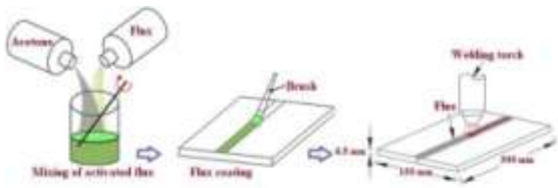

Fig: 2. A-TIG welding process.

Tungsten inert gas welding is the best and popular welding process. In this welding excellent weld bead is obtained without any defects. As compared to another welding process such as gas metal arc welding, plasma or submerged metal arc welding, there is a problem of deep penetration. Therefor it reduce ability of welding of thick structure in a singal pass. The principal disadvantages of TIG its to limited penetration ability in a single pass, poor tolerance to some material composition and the low production. To improve the penetration of TIG welding, thorough analysis has been done. Theoretical studies supplemented with experimental investigations suggest that the weld penetration is dominated by surface tension temperature gradients over the pool. The presence of some surface-active species that increase the melt surface tension with temperature induces thermo-capillary flows deep into the weld and results in deeper penetrations A-TIG process can achieve in a single pass, a full penetration weld in stainless steel up to 10mm thickness without the use of bevel preparation and the addition of filler Wire.

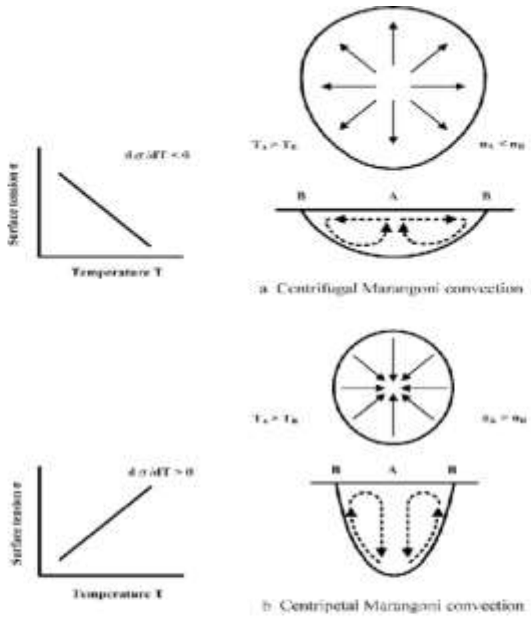

Figure 3. Marangoni convention.

A-TIG welding, firstly developed by the E.O.Paton Electric Welding Institute in the year 1960. The conventional TIG Welding has no ability of deep penetration so A-TIG welding is used. In A-TIG welding a very thin layer of activated flux is used on the metal to be weld as shown in figure.2. The activated flux changed the convection movement in the weld pool form centrifugal to centripetal as shown in fig.3. This indicated that the surface tension gradient introduces centripetal Marangoni convection in the molten pool. In A-TIG, the temperature coefficient of surface tension on the molten pool changed from a negative to a positive value. So, the surface tension at the pool centre was higher than at the pool edge. In this condition, the fluid flow of the molten pool surface easily transfers from the pool edge to the centre and then downward .In case of conventional TIG welding, angular distortion increases continuously with increase in current. It is clear that for any value of current maximum distortion in A-TIG is quit lower than the all the value of TIG welding. So distortion is not the problem against increase in current density A-TIG welding is used to increase the weld penetration. In A-TIG welding fluxes are mixed with solvent and applied on the weld plate before welding as shown in fig.3. These fluxes constrict the welding arc and increase the penetration compared to normal TIG welding process. Various fluxes like of

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MnO_2, TiO_2, MoO_3, SiO_2, and Al_2O_3 are used for the A-TIG welding processes for the various materials. Oxide based flux powder mixed with methanol and ethanol provided good spread ability and convertibility. Smooth and clean surface were achieved by using oxide base flux. The penetration depth and bead width were increased using different values of current.

MECHANISM OF A-TIG WELDING:

1.Marangoni effect: During TIG welding the surface tension gradient is negative and the convection movements are centrifugal and it leads to shallow penetration. The addition of activated flux induce an inversion of the convection currents changing the sign of the surface tension gradient, resulting convection movements changed to centripetal. Hence, the penetration depth increases.

2.Arc constriction effect: The flux acts as an insulating layer reducing the current density at the outer radius of the arc column and thus increases the current density at the centre, increased magnetic force which leads to strong convective flow downwards in the weld pool and thus to significantly increased weld depth. The flux powder (Titanium dioxide) also causes the formation of an anode spot on the surface of the joint which attracts the electrons from the cathode (Tungsten electrode) causing deeper penetration. c) Negative ion formation at the edge of the arc could increase current density at the centre of the anode and thus increase the weld depth. It increases the production rate by three times as compared to manual TIG process and it gives consistent quality and excellent bead appearance.

DISSIMILAR METAL JOINING:

There are various experiments have been done and there failures associated with dissimilar metal. Also improvement to eliminates defects.

Shaogang Wang et al. [24] investigated on Characterization of microstructure, mechanical properties and corrosion resistance of dissimilar welded joint between 2205 duplex stainless steel and 16MnR. Mechanical properties of joints welded by the two kinds of welding technology are satisfied. However, the corrosion resistance of the weldment produced by GTAW is superior to that by SMAW in chloride solution. They concluded that GTAW is the suitable welding process for joining dissimilar metals between 2205 duplex stainless steel and 16MnR.

Chih-Chun Hsieh et al. [26] studied Precipitation and strengthening behaviour of massive Dž ferrite in dissimilar stainless steels during massive phase transformation. The purpose of this study is to discuss the micro structural evolution and mechanical property of the weld metal in the dissimilar stainless steels during the gas tungsten arc welding (GTAW) process. The massive precipitates and austenite phases were observed in the weld metal during the dissimilar stainless steels welding process.

N. Arivazhagan et al. [25] investigated on AISI 304 austenitic stainless steel to AISI 4140 low alloy steel dissimilar joints by gas tungsten arc, electron beam and friction welding. The results of the analysis shows that the joint made by EBW has the highest tensile strength (681 MPa) than the joint made by GTAW (635 Mpa) and FRW (494 Mpa). Moreover, the impact strength of weldment made by GTAW is higher compared to EBW and FRW.

Chih-Chun Hsieh et al. [30] investigated on Precipitation and strengthening behavior of massive ferrite in dissimilar stainless steels during massive phase transformation. The purpose of this study is to discuss about the micro structural evolution and mechanical property of the weld metal in the dissimilar stainless steels during the GTAW process. The amounts of ferrite in the stainless steels weld metal also maintained a higher value after dissimilar welding.

N.Arivazhagan et al. [29] studied Investigation on AISI 304 austenitic stainless steel to AISI 4140 low alloy steel dissimilar joints by gas tungsten arc, Electron beam and Friction welding. For each of the weldments, detailed analysis was conducted on the phase composition, microstructure characteristics and mechanical properties. The results of the analysis shows that the joint made by EBW has the highest tensile strength than the joint made by GTAW and FRW.

CONCLUSION:

There are various research carried on TIG welding in the past . Some of the important results are mentioned below.

1.Hardness is lower in the HAZ region compared to the weld metal and base metal regions irrespective of welding technique.

2.Joints fabricated by GTAW process exhibited higher impact strength values and the enhancement in strength value is approximately 10% compared to SMAW joints and 20% compared to GMAW joints.

3.It is recommended that low heat input should be preferred when welding AISI 304 stainless steel using GTAW process because of the reason that besides giving good tensile strength and ductility, the size of the HAZ and the extent of grain coarsening obtained in the weld joint is less.

4.The hardness of weld metal is lower than that of base metal by all the joints and it is also observed that the hardness values of weld metals increase with welding speed increase. It can be seen that most of the research works done to study metallurgical properties of various types of stainless steel on GTAW process. Varieties of stainless steel also finding more and more applications in rail, automobiles, and chemical industries, in depth studies of TIG welding of those varieties on different aspects mentioned above, assumes a lot of significance.

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