Experimental Study on Activated Tungsten Inert Gas Welding- A Review paper

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ABSTRACT

Tungsten Inert Gas Welding (TIG) is welding process which is used in those applications requiring a high degree of quality and accuracy. However, this welding process has disadvantage of less productivity. To overcome this disadvantage Activated Tungsten Inert Gas Welding is found. Experiments were performed on 304L stainless steel plates using A-TIG welding process. TIG welding fixture was designed and developed for getting fixed arc length and different welding speed. Different kinds of fluxes, TiO_2, SiO_2, CaO, MnO_2 and Al_2O_3 were used to investigate the effect of A-TIG welding process on weld geometric characteristic and distortion of weldments. A-TIG welding was carried out with different process parameters are used like welding current (60-140 A), speed (100-150 mm/min), arc gap (2 mm), gas flow rate (10 L/min), tip angle (75 degree), electro diameter (4 mm). Inverted Optical microscope with image analyzer was used to capture microstructure of weldment. A-TIG welding process parameters optimization was performed by multiobjective optimization technique named as Gray Principal Component Analysis (G-PCA). The optimum process parameters were found to be 140 A current, 100 mm/min speed and mixture of SiO_2 and TiO_2 flux.

Keyword: - *TIG and A-TIG welding, TIG welding fixture, G-PCA*

1. INTRODUCTION

The Tungsten Inert Gas (TIG) welding process (or GTAW) is used when a good weld appearance and a high quality of the weld are required. An electric arc is formed between a tungsten electrode and the base metal in this process.

It was also found that flux formulation for activated TIG welding was rare. Higher thickness of plates can be welded by single pass in A-TIG welding without filler metal. The penetration depth was got higher at lower cost. Tensile and impact toughness tests were carried out on weld metal. It indicated that the value of mechanical properties was obtained high in A-TIG welding process. The heat of the arc melted and vaporizes part of this flux during welding process. The penetration of the weld bead was increased greatly

II. CONSTRUCTION, WORKING AND PROCESS OF A-TIG WELDING

TIG welding makes use of a shielding gas like argon or helium to protect the welding area from atmospheric gases such as oxygen and nitrogen, otherwise which may cause fusion defects and porosity in the weld metal. TIG equipment consists of a welding torch in which a non-consumable tungsten alloy electrode is held rigidly in the collet.

Pressure regulator and flow meters are used to regulate the pressure and flow of gas from the cylinder. The work pieces to be joined are cleaned to remove dirt, grease and other oxides chemically or mechanically to obtain a sound weld. This will avoid atmospheric contamination of the solidifying metal thereby increasing the strength of the joint.

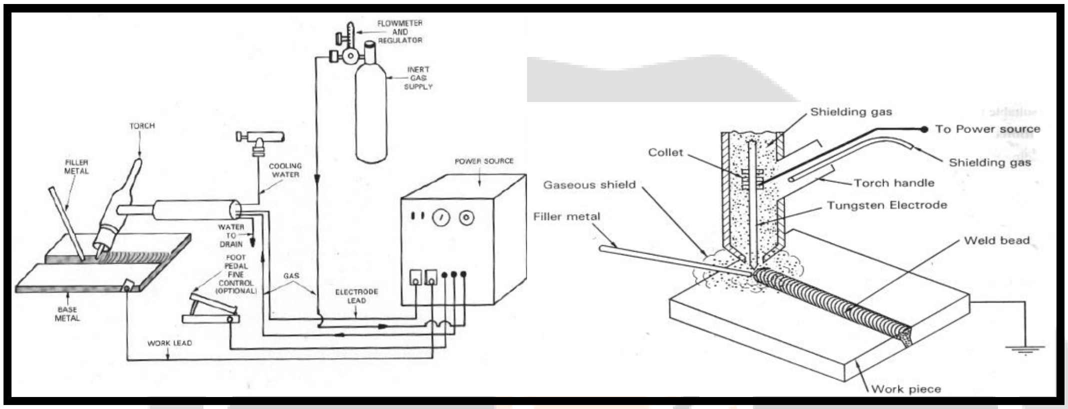

Fig. 1: Construction, Working and Process of A-TIG Welding

2. Literature review:

Kuang –Hun Tseng et al. [1] TIG process in austenitic stainless steel. 316L stainless steel was used as base metal in A-TIG welding process. Powder form of MnO_2, SiO_2, MoO_3, TiO_2 and Al_2O_3 were used as activated flux. It was mixed with acetone and applied on the surface of base metal as paste form using paint brush. The experiments were carried out with and without activated fluxes at electrode diameter of 2.4 and 3.2 mm.

Ming et al. [2] The base metal was polished using 240 grit abrasive papers and cleaned by acetone. SiO_2 or TiO_2 was applied on the surface of base metal to be welded using brush. It was also found that arc voltage was increased with increasing current using of SiO_2 flux. Penetration depth was increased using both fluxes.

Tseng et al. [3] conducted the experimental study for development and application of oxide based flux powder and carrier solvent composition in ATIG welding process. Austenitic 316L S.S and balance Fe was used as base metal of 6mm thickness. It was concluded that the penetration depth and bead width were increased using different values of current. It was also found that reduced the angular distortion using weld parameters.

Morisada et al. [4] evaluated the development and simplified active flux in TIG welding for deep penetration. SUS304 S.S of 10 mm thick plate was carried out for welding. It was concluded that the oxygen content was decreased with increasing gas flow rate. It was controlled by nozzle cap and shielding gas flow rate. The penetration depth was increased by using helium as shielding gas in increasing order.

Harikannan et al. [5] presented the optimization of process parameters in activated TIG welding. S32205 DSS of 6 mm thick plate was used as base metal. It was concluded that the electrode gap was affects the aspect ratio. The optimum parameters were found to be electrode gap of 1 mm, travel speed of 130 mm/min, current of 140 A and voltage of 12 V. The different range of aspect ratio was acceptable range which was optimized by using method.

Bertheir et al. [6] investigated the influences of addition of an activating flux in TIG welding. Austenitic stainless steel 304L of 4 mm thick plate was used as base metal. The mixture of TiO_2, Cr_2O_3, V_2O_5, MgF_2, and MgCl2 were used as activated fluxes.. It was concluded that inversion of tension gradient surface was seen of the weld bead while using the fluxes.

Bhaduri et al. [7] investigated the mechanism of creep rupture strength of weld joint in A-TIG welding process. 316L (N) SS plate of 6 mm thickness was used as base plate. A thin coating of fluxes was applied on the surface of base metal. It was concluded that higher creep rapture strength was found in A-TIG joint than multi pass-TIG joint. Less creep cavitations was observed in A-TIG joint than multi pass TIG joint.

Ahmadi et al. [8] presented the effect of activated flux in TIG welding. 304L austenitic stainless steel of 6 mm thick plate was used as base material. 400 grit silicon carbide abrasive papers was used to remove impurities of base plate and then cleaned by acetone. It was concluded that penetration depth was increased while using both fluxes. It was also found that width of weld bead was decreased. Delta ferrite content of weld metal was increased in ATIG welding process. Mechanical properties of weld metal were also improved while using ATIG welding process.

Nogi et al. [9] presented the effect of active flux on the Marangoni convection in ATIG welding. SUS304 stainless steel plate of 10 mm thickness was used as base metal. It was conclude that penetration depth was increased but it was decreased with increased Cu_2O, NiO, Cr_2O_3 and SiO_2 fluxes. The depth to width ratio was increased with oxygen content in the range of 70-300 ppm. Marangoni convection was seen weak with increased oxygen content of weld plate. It was also found that maximum penetration depth was seen while using TiO_2 flux.

M. Vasudevan et al. [10] investigated microstructure and impact toughness of weld metal in A-TIG and TIG welding process. P91 steel plate of 12 mm thickness was used as base metal. The mixture of SiO_2 and TiO_2 was used as activated flux. It was conclude that the TIG weld was higher toughness than A-TIG weld. It was also found that A-TIG weld was required prolonged post weld heat treatment at 760^0 C for 2h. A-TIG weld was improved toughness after carried out PWHT at 760^0 C for 3h.

Chuang et al. [11] Austenitic 316L stainless steel with 5mm thickness was used as base metal. Powder form of FeF_2, FeO, and FeS were used in as flux. Penetration depth and weld aspect ratio were increased and angular distortion and hot crack susceptibility were reduced while using FeS and FeO fluxes. It was also found that maximum penetration depth was got while using FeO flux

Chandrasekhar et al. [12] studied of low activation Ferritic/Martensitic steel in A-TIG welding. LAFM steel was used as base metal in A-TIG welding process. Fluxes were mixed with acetone and applied on the surface of base metal using paint brush. It was also indicated that coarse and harder Martensitic was observed in fusion zone and HAZ of the weld joints. Joint properties were improved by Post Weld Heat Treatment process. It was observed that the grain size of base metal was smaller than weld metal. A-TIG weld joint was stronger than base metal.

Tsai et al. [13] reported the effects of activated fluxes on duplex stainless steel in tungsten inert gas welding process. 2205 stainless steel plate was used as base metal. MnO_2, SiO_2, MoO_3, TiO_2 and Cr_2O_3 were used as activated flux. Ferritscope was used to measure ferrite content of base metal. Tensile test was also carried out for the metallurgical properties of weld metal. Scanning Electron Microscope (SEM) was used to observe tensile fracture mode of weld metal.

Marya et al. [14] investigated the effect of coating geometry and thickness on weld penetration. AISI304L stainless steel was used as base metal. Silica powder was used as activated flux.It was concluded that penetration depth was increased up to 200 µm thickness of coating in FB-TIG welding process but it was increased up to 70 µm thickness of coating in A-TIG process. It was also found that tensile strength was reduced than TIG welding process.

Badheka et al. [15] studied the effect of activating fluxes on mechanical and metallurgical properties of dissimilar activated flux-TIG welding process. Gr70 Carbon steel and 304 stainless steel was used as base metal. It was concluded that penetration was got maximum while using TiO_2, ZaO fluxes. It was also found that depth and width ratio was increased while using same. Lowest angular distortion was found while using TiO_2 fluxes

2.1 Summary

Following is summary of literature review:

- A-TIG welding process is used to weld thickness of 6 to 10 mm stainless steel.
- Penetration depth is increased up to 200% than conventional TIG welding with using different kind of fluxes in A-TIG welding process.
- There are various process parameters affecting in A-TIG welding like welding current, speed, rate of shielding gas, voltage, and tip angle. Table 2.1 shows research work done on these A-TIG welding process parameter.
- The microstructure in various regions of the welded plates is observed by Optical Microscope and Tool maker microscope.
- The creep rapture life is improved by using activated fluxes in A-TIG welding process.
- For the measurement of arc length during welding process the high speed camera is at various positions and then captured the images of arc length.
- The distortion angle and width of weld bead is decreased with using different kind of fluxes in.

Conclusion

From the literature survey, it concluded that the depth of penetration can improve by using activated flux, creep rupture life can be improved by it. Good impact on mechanical properties and productivity also improved.

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