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A Review on Activated Gas Tungsten ARC Welding Process

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***Abstract*:- This paper presents a review on Activated Flux Welding Process. In this paper different types of organizations are striving hard to control costs, maintain high levels of productivity, meet changing expectations of the customers and attain quality of weld. Gas tungsten arc welding has wide variety of application in industries due to advantages like high reliability, low cost, higher production rate. Activating flux is a concept, which is used in different welding process like GTAW, EBW and PAW. The flux ingredient which is inorganic compound (which can be used to produce deep penetration and are constriction). The use of activated flux in conventional GTAW process is one of the most significant advancements for overcoming the shortcomings of TIG welding, which helps in increasing the depth of penetration and depth to width ratio of the weld pool, thereby increasing the productivity of the process and also it helps in achieving better mechanical properties.**

Keywords: GTAW, A-TIG, Activated Flux, Penetration, Arc Constriction Effect.

INTRODUCTION:

Tungsten Inert Gas (TIG) welding is also called as Gas Tungsten Arc Welding (GTAW). It is an arc welding process where coalescence is produced by heating the work piece with an electric arc struck between tungsten electrode and work piece. To avoid atmospheric contamination of the molten weld pool, a shielding gas (argon or helium) is used. Argon is more widely used than helium because it is heavier gas, producing better shielding at lower flow rate. The shielding gas displaces the air surrounding the arc and weld pool. This prevents the contamination of the weld metal by the oxygen and nitrogen in the air. 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. Then the welding torch (holding electrode) is brought near to the work piece. When electrode tip reaches within a distance of 2 to 3 mm from the work piece, a spark jumps across the air gap between the electrode and the work piece. Then the air path gets ionized and arc is established [1].

A-GTAW PROCESS DESCRIPTION:

The study was concerned with the activating flux gas metal arc welding. The flux ingredient, which is inorganic compound (which can be used to produce deep penetration and arc constriction) are available in variety of range and compositions. Some of fluxes have been reported effective for particular materials. Activating fluxes contain oxides and halides (chlorides and fluorides). Oxide coating consists of iron, chromium, silicon, titanium, manganese, nickel, cobalt, molybdenum and calcium are reported to improve weld ability and increase the welding speed. The halogens, calcium fluoride and AlF_2, have claim to constrict the arc and increase weld depth of penetration Activated flux is a mixture of inorganic material suspended in volatile medium (acetone, ethanol etc.). Inactivated flux GMAW process, a thin layer of the fine flux is applied on the surface of the base metal with brush before welding. Flux mixed with acetone to make it in a paste form as shown in the Fig 1. During activated flux, welding a part or all the fluxes is molten and vaporized. There is different types of fluxes (oxides) used in welding like Fe_2O_3, SiO_2, $MgCO_3$, Al_2O_3 etc. As a result, the penetration of the weld bead is significantly increased [2].

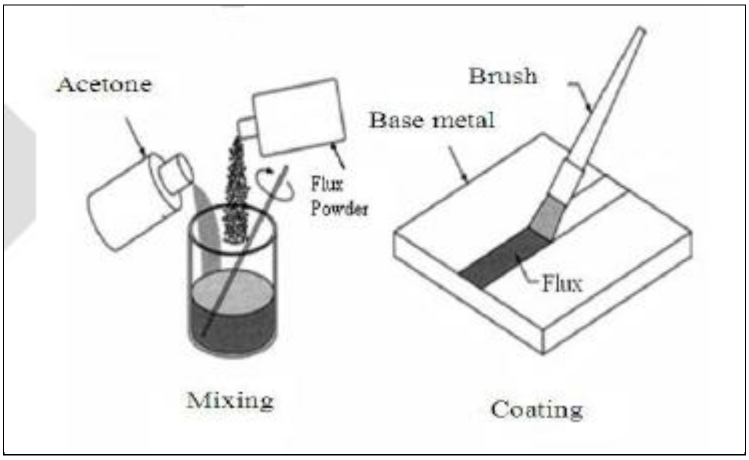

Fig 1. Method of Applying Flux

LITERATURE REVIEW:

Heiple et al. (1982) revealed that surface active elements in the molten pool change the temperature coefficient of surface tension from negative to positive, thereby reversing the marangoni convection direction from outward to inward. As the direction of the fluid flow in the molten pool becomes inward, the joint penetration increases dramatically [3].

Howse et al. (2000) associated the greater penetration of activated TIG welding to a constriction of the arc. Information on these processes is necessary to determine the TIG penetration capability improvement function of the activated flux. Because austenitic stainless steels have a higher coefficient of thermal expansion and lower thermal conductivity than carbon and alloy steel, it can induce a large amount of shrinkage and distortion after welding fabrication. Determining the effect of the activated flux on weld distortion is essential to improving the performance of the stainless steel activated TIG technique. This study used five different kinds of oxide fluxes to investigate the effect of single component flux on the morphology and distortion of Type 316L stainless steel TIG welds. Aside from studying the microstructure and hardness of activated TIG weld metal, this study investigated the theoretical and experimental mechanisms for increasing the A-TIG penetration capability [4].

Paulo et al. (2000) concluded that without activating flux weld depth achieved is very less and bead width is unnecessarily high. Best result is achieved in case of silicon dioxide, and highest penetration. CaO and Al oxide is not advisable to use because they are giving same or near result as conventional TIG welding [5].

Tseng et al. (2001) reported that an austenitic stainless steel exhibits considerably higher thermal expansion than other stainless steels, and the thermal conductivity is generally lower than that of carbon steel. Such characteristics cause a serious thermal stress in applications with temperature fluctuations, heat treatment of complete structures, and on welding. During welding, the arc heats a joint plate is locally and the temperature distributions in the weldment are not uniform. Heating and cooling cycles induce non uniform thermal strains in both the weld metal and the adjacent base metal. The thermal strains produced during heating then produce plastic upsetting. These non-uniform thermal stresses combine and react to produce internal forces that cause shrinkage and distortion [6].

Hidetoshi Fujii (2008) investigated on Development of an advanced A-TIG (AA-TIG) welding method by control of Marangoni convection. A new type of tungsten inert gas (TIG) welding has been developed, in which an ultra-deep penetration is obtained. In order to control the marangoni convection induced by the surface tension gradient on the molten pool, He gas containing a small amount of oxidizing gas was used. The effect of the concentration of O_2 and CO_2 in the shielding gas on the weld shape was studied for the bead-on-plate TIG welding of SUS304 stainless under He–O_2 and He–CO_2 mixed shielding gases. Because oxygen is a surface active element for stainless steel, the addition of oxygen to the molten pool can control the marangoni convection from the outward to inward direction on the liquid pool surface. Also, for He-based shielding gas, a high welding current will strengthen both the inward Marangoni convection on the pool surface and the inward electromagnetic convection in the liquid pool. Accordingly, at a welding speed of 0.75 mm/s, the welding current of 160A and the electrode gap of 1mm under the He–0.4% O_2 shielding, the depth/width ratio reaches 1.8, which is much larger for Ar–O_2 shielding gas (0.7). The effects of the welding parameters, such as welding speed and welding current were also systematically investigated [7].

Huang (2009) investigated that one of the most notable techniques is to use an activated flux in TIG welding process. This novel variant of the TIG process is called A-TIG welding, which uses a thin layer of activated flux on the surface of the joint. The primary benefit of using flux is to reduce the heat energy required for TIG penetration [8].

Kuang Hung Tseng (2011) expressed that MoO3 flux assisted TIG welding technique can produce a significant improvement in power density of heat source and weld aspect ratio, resulting in low angular distortion and residual stress levels. The MoO3 flux assisted TIG welding associated with a rapid cooling rate of the welds, therefore exhibiting higher ferrite content in austenitic stainless steel 316L weld metals during the solidification after welding [9].

Kuang-Hung (2012) revealed that Cr2O3 flux assisted TIG welding can create a high depth-to width ratio weld. Since the A-TIG welding can reduce the heat input per unit length in welds and
the residual stress of the weldment can be reduced. TIG welding with Cr2O3 flux can increase the
retained ferrite content of stainless steel 316L weld metal and in consequence, the hot cracking susceptibility is reduced [10].

Kuang-Hung Tseng (2013) found that in A-TIG welding the flux is mixed with the solvent. 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. It was also found that there was reduction of the angular distortion using weld parameters [11].

VIKESH et al. (2013) found that in effect of A-TIG welding process parameters on penetration in mild steel plates. TIG welding is mostly used to weld thin sections for high surface finish. A major drawback in the processis having very small penetration as compare to other arc welding process. The problem can be avoided by using active flux in conventional TIG welding. In the present study investigate the optimization of A-TIG welding process on mild steel for an optimal parameter by using Taguchi technique. The effect of various process parameters (welding current (I), welding speed (V), active flux) .IN the present study efforts were made to increase the weld penetration by appling the active flux and to optimize the process parameters [12].

Nilesh Ghetiya et al. (2014) expressed that a mathematical model was developed to predict the
weld penetration and bead width in A-TIG welding of mild steel. The developed relationships can be used to predict the penetration and bead width in activated TIG welding of mild steel within the range of parameters. In A-TIG welding process, the temperature coefficient of surface tension on the molten pool is changed from negative to positive value. Therefore the surface tension at the center is higher than the edge of metal, which produce shallow and high depth of penetration in the weldment [13].

M. Zuber et al. (2014) have worked on effect of flux coated Gas Tungsten Arc Welding on 304L. Purpose of present work is to investigate the effect of oxide flux on welding of austenitic stainless steel 304L plates having thickness 8 mm its effect on welding distortion, ferrite number, hardness value and depth of penetration. SiO_2 is used as a flux in the form of powder mixed with the acetone and applied on bead plate without making a joint preparation and without addition of filler wire. The result showed that this technique can increase depth of penetration and weld aspect ratio resulting in lower angular distortion. Finite Element analysis of plate has been carried out using SYS WELD. Three dimensional double ellipsoidal heat source is used to model the heat flow during the welding finally transient thermal analysis of welded plate has been done for study the peak temperature reaching in flux coated GTA welding [14].

Guttikonda Raja Kumar et. al. (2016) have worked on effect of activated flux and nitrogen addition on the bead geometry of borated stainless-steel GTA welds. Borated stainless steels (304B) are used in nuclear power plants as control rods, shielding material, spent-fuel storage racks and transportation casks as they have a high capacity to absorb thermal neutrons. In this study, bead-on-plate welds were made on 10-mm-thick 304B plates using gas tungsten arc welding with Ar and Ar+2% nitrogen as the shielding gases, activated-flux GTA and electron-beam welding processes. The effects of the activated flux and nitrogen addition to the weld metal through the shielding gas, on the microstructure, bead geometry and mechanical properties were investigated. Activated-flux GTA welding and electron-beam welding substantially enhanced the depth of penetration and the aspect ratio compared to the other processes. GTA, nitrogen-added GTA and activated-flux GTA welds exhibited a partially melted zone adjacent to the fusion zone; with the activated-flux GTAW process resulting in a significantly thinner partially melted zone (PMZ). No PMZ was noticed in the EB welds. All the welds exhibited a high joint efficiency and impact toughness equal to those of the base material. It is concluded that the activated-flux GTA and EB welding processes are advantageous due to the use of a low heat input and failure location [15].

Memduh Kurtulmus et. al. (2017) have worked on Activated Flux TIG Welding of Austenitic Stainless Steels. The TIG welding with active flux (A-TIG welding) consists in depositing a thin layer of flux on the work piece surface just before the welding. It is found that with this process it is possible to increase the weld penetration and productivity up to three times higher or more compared to the TIG process in metals. In this review paper, A-TIG welding of austenitic stainless steels is examined. The welding flux, the shielding gas and the welding parameters affect the weld penetration in A-TIG welds. The effects of the activated flux welding mechanisms, the flux chemical composition, thickness of the flux, flux powder size welding current, the arc voltage, the arc length, the welding speed and composition of the shielding gas on weld geometry of austenitic stainless steel A-TIG welds are explained in detail [16].

CONCLUSION:

- 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.

- A-TIG welding can increase the joint penetration and weld depth-to-width ratio, by significantly reducing the angular distortion of the weldment.
- TIG welding with SiO2 and MoO3 fluxes achieves an increase in weld depth and a decrease in bead width respectively. The SiO2 flux can facilitate root pass joint penetration.
- Without activating flux weld depth achieved is very less and bead width is unnecessarily high.
- One of the aim of this research was to find out the Penetration of the weld joint, and also the find out which parameter is most effective on tensile strength of the weld joint using Activated flux.
- For He-based shielding gas, a high welding current will strengthen both the inward Marangoni convection on the pool surface and the inward electromagnetic convection in the liquid pool, which make the weld depth/width ratio continuously increase with the welding current.

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