A-TIG Welding Process- A Review Paper

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Abstract: In today's world, of heavy competition companies are striving hard to increase their production. This paper represents a review on A-TIG Welding Process. Gas tungsten arc welding is fundamental in those industries where it is important to control the weld bead shape and its metallurgical characteristics. However, compared to the other arc welding process, the shallow penetration of the TIG welding restricts its ability to weld thick structures in a single pass thus its productivity is relativity low and skill welders are required. The use of activated flux in conventional GTAW (i.e A-TIG) process is one of the most significant advancements for overcoming the shortcomings of TIG welding, which helps in increasing the depth of penetration in single pass and to also increase 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, Reverse of Marangoni Effect*

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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.Activated flux is used in the A-TIG welding, which is the only difference from the conventional TIG welding. Activated flux can be prepared by using different kind of component oxides packed in the powdered form with about 30-60 µm particle size. These powders mixed with acetone, methanol, ethanol etc to produce a paint-like consistency. Before welding, a thin layer of the flux, brushed on to the surface of the joint to be welded. The coating density of the flux should be about 5-6 mg/cm²., Specific activated flux has been developed for enhancing the penetration performance of the TIG welding process for welding of type 304 LN and type 316LN stainless steels. A significant increase in penetration of over 300% has been observed in single pass TIG welding. The significant improvement in penetration was attributed to constriction of the arc and the reversal of Marangoni flow. The use of flux has been found to overcome the variable weld penetration observed during autogenous TIG welding of austenitic stainless steel with less than 50 ppm silver. There is no degradation in the microstructure and mechanical properties of welds produced by A-TIG welding compared to that of conventional TIG welding process.

The activated flux which gets vaporized during welding will constrict the arc by capturing electrons in the outer regions of the arc. Electron attachment can take place in the cooler peripheral regions where the electrons have low energy in a weak electric field. Towards the centre of the arc where there is a strong electric field, high temperatures and very high energy electrons and ionization will dominate. Thus restricting current flow to the central region of the arc will increase the current density in the plasma and at the anode resulting in a narrower arc and a deeper weld pool. A reversal in the Marangoni flow caused by the change in the coefficient of surface tension from negative to a positive value due to an increase in the dissolved oxygen content creates a narrow and deep weld pool. Combined operation of the above two mechanisms only lead to increased penetration by 300% in A-TIG welding.

To improve the penetration of TIG welding, thorough analysis has been done A-TIG welding (Active flux TIG welding) because the weld shape is sensitive to the free oxygen content in the weld pool. A-GTAW 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. The weldment aesthetics are observed to be unaffected**.** Although the A-TIG welding is still under consideration, the effects of the oxide flux quantity on the weld penetration showed that the arc constriction and the reversed Marangoni convection on the top surface of the weld pool were the main mechanism for changing the weld shape according to the experimental investigation. Comparison has been made between mechanical and metallurgical properties of welds with flux and without flux. The A-GTAW process has been exploited to improve production efficiencies in a wide range of industries, including power generation, chemical, aerospace and marine manufacturing and in nuclear plant.

2. Determinant factors.

2.1Joint gap

The joint gap (which can be only butt-weld) has great importance from the point of view of the faultlessness of the joint. If the gap is wider than a certain joint gap then inclusions will occur in the welded joint. Realizing this property it was thought that the ATIG welding is applicable only with about zero joint gap. However this condition would query the industrial.

2.2 Method of applying of activating flux

The quantities of the applied activating fluxes (0,1… 0,25 g/m and 0,1… 0,15 mm) found in the international literature of ATIG Welding.

2.3 Sensitivity for the measure of the activating flux

It is obvious that the human factor always contains the possibility of faults (not suitable measure of applied flux, overcovering, etc.). This is why the effects of applying of not suitable quantity of activating fluxes had to be determined.

2.4 Choosing of tungsten electrode

The ATIG welding needed 25% lower amperage (84 Amperes) than the TIG welding (110 Amperes) when we welded 3 millimetres thick, 1.4301 type stainless steel plates with 13,5 cm/min welding speed by one root. Notwithstanding that the ATIG welding gave full penetration with 25% lower current nevertheless the tungsten electrode got visibly higher heat load. This would lead to faster electrode amortization. To prevent this other tungsten electrode choosing method had to be developed than is usable for TIG welding.

2.5 Motorization of ATIG welding

It should be realised that the ATIG welding is very sensible for the changing of the arc length so the first impression was that this procedure should be used by motorised. What may be done when great thickness plates wanted to be welded manually without joint preparation. And finally very important question regarding the comparison of TIG and A-TIG welding's results.

• What are the mechanical properties of the joints of TIG and A-TIG welding?

• What nature of the microstructure of the welded joint and the heat affected zone (HAZ) has?

• What effects do the activating fluxes left on the joint's surface have on the degradation of corrosion resistance?

3. Advantages of A-TIG Welding

- Existing welding machine, similar welding procedures, but greatly improved productivity
- Usage of this flux results in 1.5 – 3 times increase in weld penetration compared to single pass regular TIG welding.
- Overall heat input to the joint significantly reduces, giving extra security against sensitization of low carbon austenitic stainless steels.
- Higher penetration welds obtained using this flux satisfactorily meets the non destructive tests –DPI, RT & UT.
- Mechanical properties of the weld meet the requirements.
- Application of thin layer of this flux (< 100 microns) on the area to be welded is enough to get the above benefits.
- Reduction in bevel preparation requirements
- Decrease in number of weld passes.
- Shortening of welding times.
- Reduced consumption of welding filler wire.
- Elimination of back gouging and grinding.
- Reduced distortion.

4. Disadvantages of A-TIG Welding Process

- The use of the flux is seen as an additional cost and its application an additional operation.
- The commercial fluxes tend to produce an inferior surface finish compared to conventional TIG welding in mechanized welding operations but in manual welding operations, the surface roughness is similar.

5. Applications

- Pipes and tubes in nuclear industry.
- Fabrication of pressure vessels and tube to tube sheets in heat exchangers .
- Power and chemical industries.
- Hydraulic cylinders and undercarriage legs in aerospace industry.

REFERENCES

[1] Priya Chauhan, Hemant Panchal -May2016 IJSDR Vol 1, Issue 5 – A Review on Activated Gas Tungsten Arc Welding (A-GTAW).

[2] T. Sandor, Janos Dobranszky- Materials Science Forum Vols. 537-538 (2007) pp 63-70-The experiences od activated tungsten inert gas (A-TIG) welding applied on 1.4301 type stainless steel plates.

[3] Prof A.B Sambherao- International Journal of Emerging Technology and Advanced Engineering-Vol 3 Issue-12 Dec 2013-Use of Activated Flux for Increasing Penetration in Austenitic stainless Steel while performing GTAW.

[4] Rui-Hua ZHANG, Ji-Gan PAN, Seiji KATAYAMA – Front Mater Sci 2011-104-118 – The Mechanism of penetration increase in A-TIG Welding.

[5] Akash. B Patel, Prof Satyam P.Patel International Journal of Computational Engineering Research Vol-04 Issue 1 - The Effect of Activated Flux in TIG Welding.

[6] Siddharaj Prajapati, Ketan Shah- IJARIIE – Vol 2 Issue 3 2016 Experimental study on Activated tungsten inert gas welding- A Review Paper.
[7] Kuang-Hung, Tseng chih-Yu Hsu- Journal of Materials Processing 211(2011) 503-512- Performance of activated flux process in austenitic stainless steel welds.
[8] Er. Bhawandeep Singh, Er. Avtar Singh- IOSR Journal of Mechanical and Civil Engineering Vol 12 Issue 2 – Performance of activated TIG process in mild steel welds.
[9] Magudeeswarang G, Sreehari R. Nair, L. Sundar, N. Harikannan- Define technology (2014)1-10 Optimization of process parameters of the activated tungsten inert gas welding for aspect ratio of UNS S32205 duplex SS welds..
[10] A. Berthier, P. Paillard, M. Carin, F. Valensi and S. Pellerin-, Science and technology of welding and joining 17 (8) (2012) 609-615 - TIG and A-TIG welding experimental investigations and comparison to simulation Part 1: Identification of Marangoni effect.
[11] T. Sakthivel , M. Vasudevan, K. Laha, P. Parameswaran, K.S. Chandravathi, M.D. Mathew, A.K. Bhaduri- Journal of nuclear materials 413 (2011) 36-40 - Creep rupture strength of activated-TIG welded 316L(N) stainless steel.
[12] E. Ahmadi, A. R. Ebrahimi, R. Azari Khosroshahi- International journal 10 (1) (2013) 27-33- Welding of 304L Stainless Steel with Activated Tungsten Inert Gas process (A-TIG).
[13] Paulo J. Modenesi, Eustaquio R. Apolinario, Iaci M. Pereira- Journal of Materials Processing Technology 99 (2000) 260-265- TIG welding with single component fluxes
[14] Shanping Lu, Hidetoshi Fujii, Hiroyuki Sugiyama, Manabu Tanaka, Kiyoshi Nogi- Material Transactions 43 (11) (2002) 2926-2931- Weld Penetration and Marangoni convection with Oxide Fluxes in GTA Welding.
[15] Y.L.Xu, Z.B Dong, Y.H. Wei, C.L.Yang- Theoretical and Applied Fracture Mechanics 48 (2007) 178–186 - Marangoni convection and weld shape variation in A-TIG welding process.
[16] B. Arivazhagan, M. Vasudevan- Journal of Manufacturing Processes- A comparative study on the effect of GTAW processes on the microstructure and mechanical properties of P91 steel weld joints.