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Implementation of Automated Gas Tungsten Arc Welding (AGTAW) for Stainless Steel 309L Applications

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Abstract- Technology advancement is necessary for every industrial environment to over live in competition. The main determinants for getting better over live of an industry are throughput, and quality. In this work, Automated Gas Tungsten Arc Welding (AGTAW) was used for stainless steel 309L application and compared with Manual Gas Tungsten Arc Welding (MGTAW) with respect to the weld quality. The optimized welding parameters was generated using SIMUFACT welding simulation software. The optimized parameters are incorporated in AGTAW, increased the weld quality, time, production and cost compared with MGTAW. The results conclude that AGTAW is the viable alternative for welding of stainless steel applications.

Keywords: Automated Gas Tungsten Arc Welding, Simufact, Welding Parameters optimization, Welding quality

1. INTRODUCTION

Automation in the manufacturing industry is the process of integrating industrial machinery to automatically perform tasks such as welding, machining, material handling, palletizing, dispensing, cutting, packing etc. Utilizing hardware and software automation increases productivity, safety and profitability [1]. Automation in welding leads to higher productivity, better weld quality, reduces the cost of welding.[2] The use of automated welding has become a common means of industrial automation for manufacturers of steel products. Automated welding process has higher efficiency than manual welding operations. The increase comes from more control and consistency in the wire feed rate, constant travel speed, pulse waveform, and arc stability combined with slide movement within a single tightly integrated system. Other parameters of the arc process include peak current, base current, arc voltage, pulse mode, and pulse frequency are set within the welding equipment while others are dependent on the welder's skill and repeatability. In this paper an attempt was made to implement the AGTAW for stainless steel applications.

2. MANUAL GAS TUNGSTEN ARC WELDING

Tungsten Inert Gas (TIG) welding is a difficult welding process. The welder has to use his both hands for holding TIG torch and the filler wire metal to weld this joint. As both hands

compulsory to the TIG welding process, and it is a hardest process to learn. The welder must have a great control in this welding process compared to Shielded metal arc welding (SMAW) and Gas metal arc welding (GMAW).
Fig. 1 show the process of manual gas tungsten arc welding. Usually TIG Welding is a slow process but it produces good quality of weld and can do complicated welding joints in thin section of Stainless steel, Aluminium, Copper alloys.

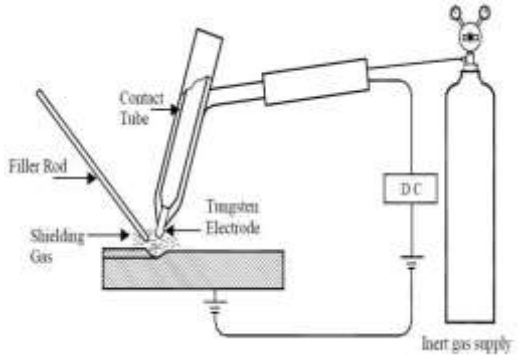

Fig. 1 Manual Gas Tungsten Arc Welding

The three main requirements of TIG welding are heat energy, shielding gas environment, filler material for weld. The heat is generated by passing the electricity to the tungsten electrode for creating an arc. The shielding inert gas drawn from the cylinder and it is spreads over the weld area to protect it from moisture, air or other contaminants. The filler wire is manually handled and get in touch with the arc to melt it. Gas flow rate is manually adjusted by the welder in order to prevent from contamination and oxidation. The torch is hold by the welder at a proper distance in order to maintain the arc. When the arc is in progress, the welder with his other hand starts to fill the joint manually dipping the welding wire into arc to fill the joint. By doing this process finally, material joining takes place [3-4].

3. AUTOMATED GAS TUNGSTEN ARC WELDING

In AGTAW drive mechanisms consist of slides and lathe chuck, which is coupled with servomotor. The TIG torch is mounted on the square block with bellows.

The filler wire is fed in front side of the torch. As servomotor is used, the TIG torch is adjustable as per requirement. A separate servomotor is used for feeding the filler wire. The HMI is used for entering the parameters for welding. The entered data in HMI is directly saved in PLC. PLC is the heart of AGTAW. PLC send the control signal to all the actuator in order to perform the welding. In this Automated TIG welding machine, six servomotors are used for drive mechanisms. Fronius magic wave 4000 power source is used for this TIG welding. The direct current electrode negative and work piece positive terminal (DCEN) is employed. Arc Voltage Control (AVC) is used to maintain the arc gap in welding.
In Automatic TIG welding, weld current, voltage, weld dimensions, weld speed, wire feed, arc length gap and other parameters has to be entered through HMI before welding the component. The entered input goes to Program Logic Control (PLC) and implement the sequence accordingly. Gas manifold send the inert gas towards the component in order to avoid oxidization. Then the electrode produces the arc and ready to meld the filler material.

In the meantime longitudinal/cross slide movement also started. The same is for the rotary movement. Once the welding completed, the welding current progressively slows and before the current back to zero the filler wire stops. The gas flow for5 secs even after the movement of slide stops. In this way, the Automated TIG cycle is executed [5]. Fig. 2 shows the block diagram of AGTAW.

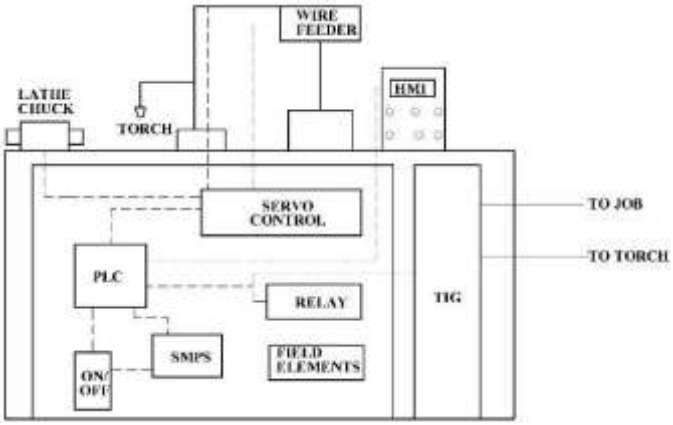

Fig. 2 Block diagram of AGTAW

4. PARAMETERS INVOLVED IN AUTOMATED GAS TUNGSTEN ARC WELDING

The main parameters of AGTAW are

1. Welding Current
2. Welding Voltage
3. Shielding gas
4. Wire feed
5. Welding speed
6. Arc length

1. Welding Current

Welding current has the main influence in shape of theweld bead and its quality. Most of gas tungsten arc welding employ DCEN, which gives high weld penetration depth. If we go with reverse polarity result on the result in the tungsten is damaged and rapid heating takes place mostly reverse polarity AC is used for Aluminium welding because it allows balancing of electrode heating and work piece cleaning effects.

2. Welding Voltage

Welding voltage controls the height and width of the weld deposit. This is regardless of the process. Constant Current/Amperage power source's main control, controls the amperage and voltage is adjusted with the arc length.

3. Shielding Gas

It is mainly used to prevent atmospheric contamination. This has a main influence on the stability of arc. Argon is the mostly used gas in TIG welding process. It is heavier than air, produces excellent shielding. In this Automated TIG, welding machine shielding gas is produced using homogeneous gas mixing unit.

4. Wire Feed

The wire feed is the speed at which the electrode moves alongthe base material while welding. Too fast of a wire feed results in a convex weld. Too slow of a wire feed results in a wide weld with excessive metal deposit.

5. Welding Speed

Welding speed influence the weld bead cross section in a great way. Weld bead penetration and the cross section gets reduced once the weld speed gets increased. Weld speed influences the volume of melted material.

6. Arc Length

Arc length for GTAW is to between 2-5 mm by increasing the arc length the heat input to work piece decrease due to radiation losses from column of arc also the depth of the penetration is decreased. In Automated GTAW machine AVC is used which maintains the arc length between electrode and work piece.

5. OPTIMIZATION OF WELDING PARAMETERS USING SIMUFACT SOFTWARE

In the area of welding still there is a practical trial and error methods are used to optimize the welding parameters.This takes more time, materials and man power. In order to overcome from this, an offline welding simulation technique has been implemented to optimize the welding parameters. In this work Simufact welding simulation software is used to optimize the welding parameters of stainless steel. Using this software, structural simulation can also be done to determine residual stress, distortion, Heat Affected Zone (HAZ), minimum and maximum temperature of welds can also be determined. Before taking practical experimental welding trails on the Automated TIG Welding Machine**,** the welding parameters of the various materials are optimized using this virtual welding simulation software. Fig.3 shows the Butt joint welding of stainless steel in Simufact software & Fig.4 shows the Depth of penetration measured in Simufact software the simulation result is almost similar to the practical work.

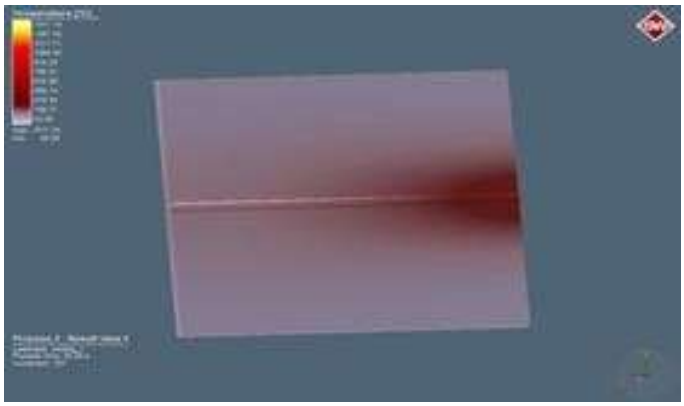

Fig.3 Butt Joint welding of stainless steel inSimufact software

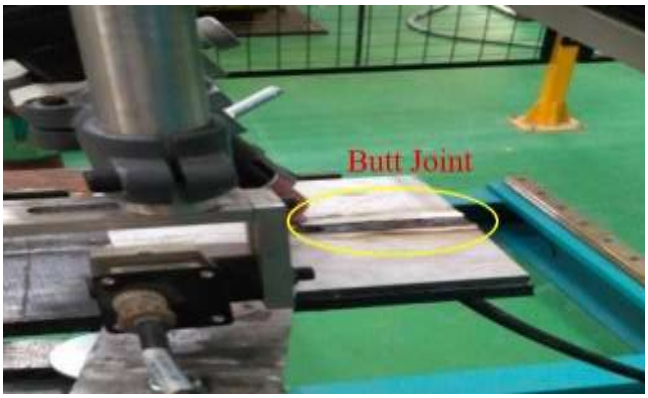

Fig.4 Depth of penetration measured in Simufact software

6. EXPERIMENTATION ON AUTOMATED GAS TUNGSTEN ARC WELDING

Experiments were conducted on SS 309 L. The optimized parameters from Simufact is incorporated in AGTAW. The dimension of plate is 100×50×4 mm. The main scope of experiment is to achieve good quality welding. Fig. 5 shows the welding of stainless steel in AGTAW. Utmost all welding machines uses constant current power source for welding. This makes current remains constant during the welding and the voltage continuously changes with respect to the arc length.

Fig.5 Butt Joint welding of stainless steel in AGTAW machine

In MGTAW, the arc length is constant and it is controlled by the hand of the welder. This process makes MGTAW as labour intensive work and it is very difficult to keep the constant arc length, but in the AGTAW, the arc length remains constant and makes unchanging quality of weld though out the weld seam. In this AGTAW Machine, arc length is controlled with Arc Voltage Control (AVC).

An automated welding system ensures weld integrity through controllers. Automated torch and part motions have good quality of weld compared with manual welding. Human has many chances of doing improper torch holding result in lack of penetration or a possibly flawed weld. In this AGTAW Machine Arc view camera is attached to monitor the welding. Fig 6 shows the arc view camera for monitoring the weld.

Fig.6 Arc view camera for monitoring the weld

7. PERFORMANCE RESULTS

Welding of Stainless steel is done on MGTAW and AGTAW. Figure 7 shows manual weld joint and Figure 8 shows weld joint obtained in AGTAW machine. Irregularities exist in manual welding joint and it can be seen in Figure 7. The weld joint obtained is uniform and elegant in AGTAW machine and it can be seen in Fig 8. Welding speed achieved was found to be 120 mm/min (in terms of filler wire consumption). Uniform welding coat was developed. Welding joints in different work pieces was found to be likely.

Fig.7 Manual Weld Joint

Fig.8 Automated Weld Joint

8. CONCLUSION

In this paper implementation of AGTAW for Stainless Steel application was presented. The optimized welding parameters from Simufact welding software is incorporated on MGTAW& AGTAW. Irregularities exist in MGTAW whereas weld joint obtained in AGTAW machine is uniform and elegant due to more control and consistency in the wire feed rate, constant travel speed, Arc Voltage Control etc. From this it is concluded that with AGTAW the quality of welding is much higher than MGTAW so that productivity, safety and profitability is increased.

9. ACKNOWLEDGEMENT

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