ISSN 2395-1621

A comparative investigation of TIG and Electric arc welding for strength analysis

#1Shinde Rajendra, #2Prof. Rahane S.P

1rajendrashinde16@gmail.com
2raj.rahane21@gmail.com

#12 Department of mechanical engineering, Savitribai Phule University of Pune

ABSTRACT

Now a day in shipping and in process industry different types of steels are commonly used because of their valuable properties such as high strength, ductility and weld ability. The current study aim to compare TIG and electric arc welding for different groove angle and bevel heights keeping root opening constant. The specimens are prepared by using V groove butt weld joints. In this work gas tungsten arc welding and electric arc welding process has been selected because TIG welding is the process of joining different materials with high quality in the presence of inert gas and electric arc welding process is more economical. Alternating current power source has been selected because of better cleaning action and due to alternating current the high heat concentration on the material can be avoided. Mechanical tests such as tensile test, impact test, hardness test have been conducted to find out the mechanical properties such as tensile strength, impact strength, toughness of HAZ. Also longitudinal and transverse distortions are measured after welding of plates.

Keywords— **TIG welding, Electric arc welding, Groove angle, Bevel height, HAZ, Distortion**

ARTICLE INFO

Article History

Received :18th November 2015

Received in revised form :

19th November 2015

Accepted : 21st November , 2015

Published online :

22nd November 2015

I. INTRODUCTION

Welding technology has obtained access virtually to every branch of manufacturing; to name a few, ships, rail road equipments, building construction, boilers, launch vehicles, pipelines, nuclear power plants, aircrafts, automobiles, pipelines. Welding technology needs constant upgrading and with the widespread applications of welding. Welding is a fabrication or sculptural process that joins materials, usually metals, or thermoplastics, by causing coalescence. This is often done by melting the workpieces and adding a filler material to form a pool of molten material that cools to become a strong joint, with pressure sometimes used in conjunction with heat, or by itself, to produce the weld.

Welding is one of the essential and inescapable processes in manufacturing industries. Various types of welding processes like Shielded Metal Arc Welding (SMAW), Gas Tungsten Arc Welding (GTAW), Gas Metal Arc Welding (GMAW), and Flux Cored Arc Welding (FCAW) are being practiced in industrial environment. Welding technology has obtained access virtually to every branch of manufacturing; To consistently produce high quality of welds, arc welding requires experienced welding personnel. One reason for this is the need to properly select welding parameters for a given task to provide a good weld quality which is identified by its micro-structure and the amount of spatter and relied on the correct bead geometry size. Therefore, the use of the control system in arc welding can eliminate much of the “guess work” often employed by welders to specify welding parameters for a given task.

II. LITERATURE REVIEW

R.P. Singh et.al studied the effects of various welding parameters on penetration in mild steel having 5 mm thickness welded by shielded metal arc welding were investigated. The welding current, arc voltage and welding speed were chosen as variable parameters. The depths of penetration were measured for each specimen after the welding operations and the effects of these parameters on penetration were researched. Welding currents were chosen as 90, 95,100, 105 and 110 Ampere (A), arc voltages were chosen as 20, 21, 22, 23 and 24Volt (V), the welding speeds were chosen as 40, 60 and 80 mm/min and external magnetic field strengths were used as 0, 20, 40, 60 and 80 Gauss for all experiments. As a result of this study, it was observed that on increasing welding current, the depth of penetration increased. In addition, arc voltage is another important parameter for penetration. However, its effect is not as much as current's. The highest penetration was observed for 100 A current, 22 V voltage, 40 Gauss magnetic field and 40mm/min welding speed. In this paper, the effect of a longitudinal magnetic field generated by bar magnets on the weld was experimentally investigated. The welding speed was kept constant with the help of a lathe machine. Using the experimental data a multi-layer feed forward artificial neural network with back propagation algorithm was modeled to predict the effects of welding input process parameters on weld bead geometry. D. Akbari et.al studied finite element techniques to analyze the thermo-mechanical behaviour and residual stresses in dissimilar butt-welded pipes. The residual stresses at the surface of some weld specimens were measured experimentally by using the hole-drilling method. The results of the finite element analysis were compared with experimentally measured data to evaluate the accuracy of the finite element modelling. Based on this study, a modelling procedure with reasonable accuracy was developed. The developed finite element modelling was used to study the effects of welding heat input on magnitude and distribution of welding residual stresses in butt-welded pipes made of ferritic and austenitic steels. The hoop and axial residual stresses in dissimilar pipe joints of 8 mm thick for V-groove shape were studied. It is shown that the welding heat input has a significant effect on magnitude and distribution of residual stresses in the stainless steel side of the studied joints.

Susheel Kumar Sharma et.al studied the influence of the welding process parameters on the weldability of material, low carbon alloy steel (0.14% C) specification having the dimensions 75 mm X 50 mm X 6mm welded by metal arc welding were investigated. The welding current, arc voltage, welding speed, heat input rate are chosen as welding parameters. The depth of penetrations were measured for each specimen after the welding operation on closed butt joint and the effects of welding speed and heat input rate parameters on depth of penetration were investigated. Stefano Maggiolino et.al studied a comparison of the corrosion resistance of AA6060T5 and AA6082T6 jointed surfaces via Friction Stir Welding (FSW) and Metal Inert Gas (MIG), respectively, is reported. The test was conducted putting the welded and polished samples in an acid salt solution. The corrosion resistance was detected via morphological analysis of the surface. The attack was localized (pitting), an index referred to the pit density was used for the comparison. The result indicated that the joint welded via Friction Stir is more resistant than that welded via Metal Inert Gas technique. R Sudhakaran et. al studied the quality of a welded joint is directly influenced by the welding input parameters. Inadequate weld bead dimensions such as shallow depth of penetration may contribute to failure of a welded structure since penetration determines the stress carrying capacity of a welded joint. In this study, the regression model was used to establish a relationship between welding input parameters and depth of penetration for gas tungsten arc welding of 202 grade stainless steel plates. A five level four factor central composite rotatable design (CCRD) with 31 experimental Runs was used to conduct the experiments. The process control parameters chosen for the study are welding current (I), welding speed (V), welding gun angle and shielding gas flow rate (Q). A mathematical model was developed to correlate the process parameters to depth of penetration. The developed model was then compared with the experimental results; it was found that the deviation falls within the limit of a 95% confidence level. Additionally, the results obtained from the mathematical model were more accurate in predicting depth of penetration. The direct and interactive effects of the process parameters are also discussed.

III. MATERIALS AND METHODS

A. Materials

The material used to carry out experimental work to investigate and compare TIG and Electric arc welding for strength analysis using SAE 1005. The dimensions of weld materials are 8×300×300mm.

B. Welding Geometry

The two plates are welded by the single V-groove butt weld joint with different groove angles and bevel heights. The geometry of butt weld joint is as follow.

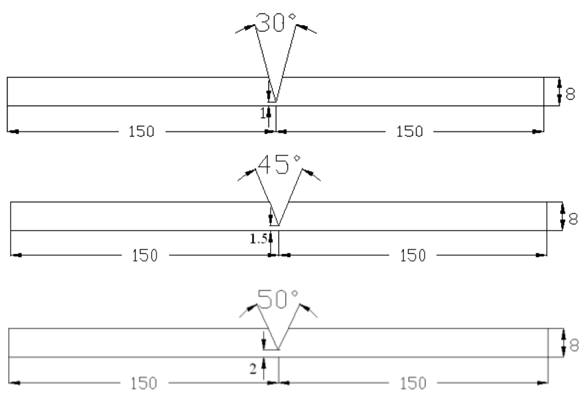

Fig.1 Welding geometry of V Groove butt weld joint with groove angle 30^0, 45^0, 50^0 respectively.

C. TIG Welding process

TIG welding is an electric arc welding process in which the fusion energy is produced by an electric arc burning between the workpiece and the non consumable tungsten electrode. The inert gases are used to provide the shielding over the electrodes and weld pools because inert gases are in active in nature so it avoids the contamination. Variety of tungsten electrodes are used within the process. The electrode is normally ground to a point or truncated cone configuration to minimize arc wandering.

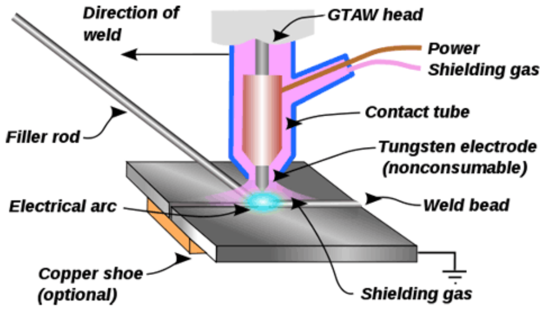

Fig.2 TIG Welding process

D. Electric Arc Welding Process

Arc welding, which is heat-type welding, is one of the most important manufacturing operations for the joining of structural elements for a wide range of applications, including guide way for trains, ships, bridges, building structures, automobiles, and nuclear reactors, to name a few. It is most versatile process which can be applied for thin and thick section and also useful for welding of complicated shapes.

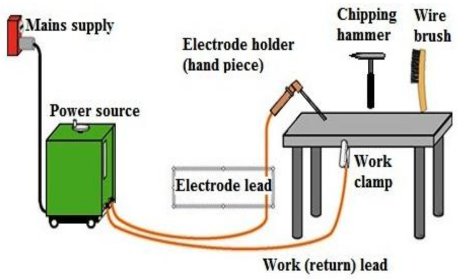

Fig.3 Electric arc welding process

Electric arc welding is a fusion welding process in which welding heat is obtained from an electric arc between an electrode and the workpiece. The electrode is first allowed to touch the workpiece to form an electric circuit and then separated continuously to flow through the gaseous medium. The temperature produced at the centre of arc is 6000^{0}C to 7000^{0}C. In this the base metal is melted by the temperature of the arc, forming a pool of molten metal which is forced out of the pool by blast from the arc. Electrode metal also get melted and deposited at the weld. Either AC or DC supply is used for arc welding process. The electrodes used in the process are of two type i.e. bare electrodes and coated electrodes. Bare electrodes are cheaper but welds produced through this are of poor quality whereas, coated electrodes are used in modern welding machines as they carry a core of bare metallic pipe produced with coating on the outer surface.

IV. EXPERIMENTATION

Steel plates with the dimensions of 8x300x300 are prepared with the bevel height of 1, 1.5, 2 millimeters, bevel angle of 30^0, 45^0,50^0.These specimens are then welded with a root opening distance 2 millimeter. After preparation, plates are placed on the workbench. In each placement, distance between the nozzle and work piece and the electrode extension were 20 and 10 millimeters respectively. The welding electrode is held perpendicular to the welding surface. Welding is started and the flow rate of shielding gas is adjusted to 10 lit/sec. The plates were welded at single pass. By changing the heat inputs to all the samples are welded by keeping the other parameters constant.

Table 1. Experimentation values for TIG welding

Specimen No	Root Opening (mm)	Groove Angle in Degree	Bevel Height (mm)	Type of Groove	Gas Flow Rate Lit/sec
1	2	30	1	V	10
2	2	45	1.5	V	10
3	2	50	2	V	10

Table 2. Experimentation values for electric arc welding

Specimen No	Root Opening (mm)	Groove Angle in Degree	Bevel Height (mm)	Groove	Welding Voltage (V)	Welding Current (A)
1	2	30	1	V	35	210
2	2	45	1.5	V	35	210
3	2	50	2	V	35	210

V. CONCLUSIONS

Following are the probable outcomes which are obtained at the end of experimentation and testing

1) Comparative Investigation in between TIG and electric arc welding for tensile strength. Using SAE 1005 at different groove angles and bevel heights.
2) Comparative Investigation of TIG and electric arc welding for impact strength. Using SAE 1005 at different groove angles and bevel heights.
3) To find out the effect of the different groove angles and bevel heights on toughness of HAZ for TIG and electric arc welding.
4) To suggest the best suitable welding process for maximum tensile, impact strength and minimum hardness of HAZ.
5) To suggest the best suitable groove angle and bevel height for maximum tensile, impact strength and for minimum hardness of HAZ and distortion for plate welding application.

ACKNOWLEDGMENT

First and foremost, I would like to express my deep sense of gratitude and indebtedness to my supervisor Mr. S.P Rahane Professor, Mechanical Engineering Department for his invaluable encouragement, suggestions and support from an early stage of this project stage one report and providing me extraordinary experiences throughout the work. Above all, his priceless and meticulous supervision at each and every phase of work inspired me in innumerable ways.

I specially acknowledge him for his advice, supervision, and the vital contribution as and when required during this project stage one. His involvement with originality has triggered and nourished my intellectual maturity that will help me for a long time to come. I am proud to record that I had the opportunity to work with an exceptionally experienced Professor like him.

I am highly grateful to Dr. C. L. Dhamejani, Principal, Prof. D. S. Galhe, Jaihind college of Engineering, Kuran for their kind support and permission to use the facilities available in the Institute.

REFERENCES

[1] R.P. Singh, R.C. Gupta and S.C. Sarkar, "The Effect of Process Parameters on Penetration in Shielded Metal Arc Welding under Magnetic Field using Artificial Neural Networks", International Journal of Application or Innovation in Engineering & Management (IJAIEM) Volume 1, Issue 4, December 2012, ISSN 2319 – 4847.

[2] D. Akbari, I. Sattari-Far, "Effect of the welding heat input on residual stresses in butt-welds of dissimilar pipe joints" International Journal of Pressure Vessels and Piping 86 (2009) 769–776.

[3] Susheel Kumar Sharma, Syed Hasan Mehdi, "Influences of the Welding Process Parameters on the Weldability of Material", International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-2, Issue-5, June 2013.

[4] Stefano Maggiolino, Chiara Schmid, "Corrosion resistance in FSW and in MIG welding techniques of AA6XXX", Journal of materials processing technology 197 (2008) 237–240.

[5] R Sudhakaran, V Vel-Murugan, PS Sivasakthivel, "Effect of Process Parameters on Depth of Penetration in Gas Tungsten Arc Welded (GTAW) 202 Grade Stainless Steel Plates Using Response Surface Methodology" TJER 2012, Vol. 9, No. 1, 64-79.

