Review for Effects of Different Parameters on the Throat Thickness of the MIG Welded Joints

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***Abstract*- Energy storage device is a very critical electrical component used at converter of the many locomotives. The energy storage devices are made up of AISI 1040 steel cases or boxes. Bulging effects in these boxes exerts tensile load on welded joint and breaks them. AISI 1040 is having good weld ability. The boxes of these materials are joined with MIG welding with the filler metal of ER 70S-6. In order to improve its properties the effects of various parameters such as weld current, arc voltage, and electrode feed rate, torch travel speed, torch to work piece distance is need to be studied. In this paper the effects of all above parameters on two main parameters VIZ tensile strength and throat thickness are discussed. As throat thickness increases, tensile strength will also increase. Increase in voltage and current decreases strength initially but increases after some value. Electrode feed rate is varying with current. Torch to work piece distance varies with the arc voltage. Throat thickness increases with decrease in torch travel speed. In all the reviews optimization of the parameters are done and validation of the same is carried out.**

Index terms- AISI 1040, Taguchi, Throat thickness, weld current, arc voltage

1. INTRODUCTION

MIG welding which is also called as GMAW. i.e. Gas metal arc welding is used to join the case of capacitor. In this type of welding a wire from reel is fed through a torch which is in contact with base metal & which supplies a current. The wire melts & converts into pool by arc. The welding arc is protected by shield gas. It is necessary to avoid oxidation of weld pool. Coating is given on electrode wire in order to produce a smoke which is also acts like a shield. Depending on the shielding gas process is divided into two types: i) MIG (Metal Inert gas) ii) MAG (Metal Active Gas). In Metal active gas welding a reactive gas like carbon dioxide (CO2) is used to protect the weld while MIG welding used an inert gas like argon. Generally MIG welding is applied for aluminum, copper, stainless steel and high alloyed steel, metal transfer in the MIG welding is done by two methods: spray arc & short circuiting arc. In spray arc process an arc is introduced in between welding wire & work piece. The transfer of metal pool is in the form of continuous spray. The arc avoids spatters and it provides deep penetration in base material. In order to obtain spray arc, it is necessary to keep welding current above certain minimum value. The current level is depends on shielding gas, alloy, size of welding wire. So generally for wire having diameter greater than or equals to 0.8mm uses the current limit above 150 amperes. In short arc process no metal is transferred through an arc. It creates short circuits between wire and work piece, wire is fed again into arc. The arc produced in this method is having low heat input. To obtain a better weld the arc voltage & arc length must be kept at constant value. This can be done by two ways: i) by adjusting the filler material feed speed to exactly the same as its melting. ii) by adjusting the ampere to exactly at the value required to melt the material. The basic elements of MIG welding equipment are

1. Power source
2. Welding current switch
3. Power supply to wire feeder
4. Gas cylinder, Gas valve
5. Gas regulator with flow adjustment
6. Wire feed motor with drive rolls.
7. Cable package including welding current cable, gas hose, control circuit cables and wire feed tube Torch with contact tip for supplying current to the nozzle and control switch.

In this case of energy storage device base material of steel AISI 1040 & filler metal of ER 70S-6 is used. Following are the properties of both the materials.

Base Material- AISI 1040	
Ultimate Tensile Strength	620 MPa
Yield Strength (60 % of UTS)	372 MPa
Young's Modulus	210000 MPa
Poisson's Ratio	0.3
% Elongation	25 %
Filler Material- ER 70S-6	
Ultimate Tensile Strength	583 MPa
Yield Strength (60 % of UTS)	350 MPa
Young's Modulus	190000 MPa
Poisson's Ratio	0.29
% Elongation	26 %

Table 1 Properties of materials

2. LITERATURE REVIEW

Ajit Hooda, Ashwani Dhingra and Satpal Sharma [1] investigated the maximum yield strength both transverse and longitudinal, at the optimum values of process variables-welding voltage, welding current, wire speed and gas flow rate was experimented. The longitudinal yield strength is greater than the transverse yield strength.

Diganta Kalita, Parimal Bakul Barua [2] investigate the effect of the three process parameters of Metal Inert Gas Welding (MIG), welding current, voltage and shielding gas flow rate on tensile strength of welded joints having Grade C20 Carbon Steel as parent metal and ER70S-4 electrode. An experiment has been designed using Taguchi's Orthogonal Array L9.

P. Srinivasa Rao, O. P. Gupta, S. S. N. Murty, A. B. Koteswara Rao [3] have investigated the weld bead plays an important role in determining the mechanical properties of the weld. Its geometric parameters, viz., width, reinforcement height, and penetration, are decided according to the welding process parameters, such as wire feed rate, welding speed, pulse current magnitude, frequency (cycle time), etc. Therefore, to produce good weld bead geometry, it is important to set the proper welding process parameters.

Ravi Bharadwaj, M.K. Gaur, Saurabh Agrawal, Vedansh Chaturvedi [4] suggested the effect of MIG welding parameters specifically Welding current, Voltage, Gas flow rate and Plate thickness during welding of AISI-304 stainless steel Material on MIG welding machine at different level presents in this work. All the welding parameters are modeled using Taguchi-based Principle Component Analysis (PCA).

Nabendu Ghosh, Pradip Kumar and Goutam Nandi [5] suggested welding input process parameters play a very significant role in determining the quality of the welded joint. Only by properly controlling every element of the process can product quality be controlled. The quality of the weld has been evaluated in terms of yield strength, ultimate tensile strength and percentage of elongation of the welded specimens.

They also investigated [6] To study and analyze the effects of welding parameters: welding current, gas flow rate and nozzle to plate distance, on ultimate tensile strength (UTS) and Yield Strength (YS) in MIG welding of AISI409 ferritic stainless steel to AISI 316L Austenitic Stainless Steel materials. Experiments have been conducted as per L9 orthogonal array of Taguchi method.

P.Pavani, Mr. P. Sivasankar, Mr. P. Lokanadham, Mr. P. Uma Mhahesh [7] studied Manual Metal Arc Welding of carbon steel plates were studied. The finite element analysis of residual stresses in butt welding of two similar plates is performed with the ANSYS software. This analysis includes a finite element model for the thermal and mechanical welding simulation.

Dragi Stamenković and Ivana Vasović [8] studied Manual Metal Arc Welding of carbon steel plates were studied. The finite element analysis of residual stresses in butt welding of two similar plates is performed with the ANSYS software. This analysis includes a finite element model for the thermal and mechanical welding simulation.

M. D. Faseeulla Khan, D. K. Dwivedi, Satpa Sharma [9] investigated the development of a response surface model to study the influence of process parameters of weld-bonding on tensile shear strength of the weld-bond of 2 mm thick aluminum alloy 6061 T651 sheets. Welding current, welding time and welding pressure were identified as significant and controllable parameters.

Amit Kohli and Hari Singh [10] studied an effective procedure of response surface methodology (RSM) has been utilized for finding the optimal values of process parameters while induction hardening of AISI 1040 under two different conditions of the material i.e., rolled and normalized. Various process parameters, such as feed rate (speed at which the induction coil moves, which is measured in mm/sec), current, dwell time (time after which heat intensity starts to heat work piece in seconds) and gap between the work piece and induction coil have been explored by experiments.

G Haragopal, P V R Ravindra Reddy, G Chandra Mohan Reddy and J V Subrahmanyam [11] presents Taguchi method to design process parameters that optimize mechanical properties of weld specimen for aluminum alloy (Al-65032), used for construction of aerospace wings. Process parameters of MIG welding setup considered are gas pressure, current, groove angle and pre-heat. Assigning process parameters to L-9 orthogonal array, experiments were conducted and optimization condition was obtained along with the identification of most influencing parameters using S/N analysis, mean response analysis and ANOVA.

Satyaduttsinh P. Chavda, Jayesh V. Desai, Tushar M. Patel [12] studied the MIG welding parameters are the most important factors affecting the quality, productivity and cost of welding. This paper presents the influence of welding parameters like welding current, welding voltage, Gas flow rate, wire feed rate, etc. on weld strength, weld pool geometry of Medium Carbon Steel material during welding. By using DOE method, the parameters can be optimize and having the best parameters combination for target quality.

H.R. Ghazvinloo, A. Honarbakhsh Raouf and N. Shadfar [13] investigated aluminum alloys forming to AA6061 have a wide range of desirable properties which are used in different industries such as aircraft industry and other aerospace structures. The effect of processing variables on fatigue life, impact energy and bead penetration of AA6061 joints produced by MIG robotic welding process was analyzed in the present study.

C. LABESH KUMAR, T. VANAJA & M. MAHENDER REDDY [14] discovers that it is necessary to study the input parameters of welded product, to gain a 'welded joint' with good quality. The influence of welding parameters such as welding current, welding voltage and welding speed will show a significance effect on a welded joint. By using design of experiment method, the parameters can be optimized and made to have the best parameter combination for target quality.

Ramakrishna Koganti, Armando Joaquin, Matthew Zaluzec, Chris Karas [15] studied effects of weld travel speed and wire feed rate in metal inert gas (MIG) welding on the aluminum materials joint strength. Initial experiments indicated a noticeable positive effect of travel speed on weld strength with an over 95% statistical significance. Nonetheless further experimentation at a significantly lower wire feed rate proved the opposite with similar statistical significance. A negative effect of welding travel speed on joint strength was measured at lower wire feed rates.

Tao Yang, Jun Xiong & Hui Chen [16] investigated 2219 aluminum alloy is one of the most extensively used materials for the fabrication of rocket fuel storage box. This paper aims at revealing effect of process parameters on tensile strength in 2219 aluminum alloy welded by means of the plasma-MIG hybrid welding method. Process parameters such as MIG voltage, plasma gas, plasma current, welding speed, wire feed speed, etc. play a major role in deciding the joint tensile strength.

Radha Raman Mishra, Vishnu Kumar Tiwari and Rajesha S [17] investigated Selections of joining process for such materials are difficult because of their physical and chemical properties. The stainless steel and mild steel dissimilar material joints are very common structural applications joining of stainless steel and mild steel is very critical because of carbon precipitation and loss of chromium leads to increase in porosity affects the quality of joint leads deteriorate strength. In the present study, stainless steel of grades 202, 304, 310 and 316 were welded with mild steel by Tungsten Inert Gas (TIG) and Metal Inert Gas (MIG) welding processes.

K. Sivasakthivel, K. Janarthanan, R. Rajkumar [18] the purpose of this study is to propose a method to decide optimal settings of the welding process parameters in MIG welding. Properties include Tensile strength, Impact strength; Hardness, etc also influenced process parameters. In this study which parameter is most effectively effect the weld strength, Weld strength varies under various conditions is

studied. By using Taguchi and ANOVA technique an optimal solution is find out, which provides us an optimal results of the varying condition.

Satyaduttsinh P. Chavda, Jayesh V.Desai, Tushar M.Patel [19] The MIG welding parameters are the most important factors affecting the quality, productivity and cost of welding. This paper presents the influence of welding parameters like welding current, welding voltage, Gas flow rate, wire feed rate, etc. on weld strength, weld pool geometry of Medium Carbon Steel material during welding. By using DOE method, the parameters can be optimize and having the best parameters combination for target quality.

Darshan A. Bhatt, Hardik R. Mehta [20] this Research Paper is based on how to increase the strength of Welding joints by applying the MIG Welding process. To achieve the best possible solution we have conducted series of experiments using Mild Steel (IS 2062) by applying varying welding parameters like voltage, current, welding speed etc.

P.K. Palani, N. Murugan [21] a detailed study is essential to arrive at a method of predicting the conditions that will give a good weld and this paper reviews various aspects of the pulsed GMA welding, the effects of pulse parameters and different methodologies adopted for selecting these parameters to obtain better quality welds.

BY M. SEN, M. MUKHERJEE, AND T. K. PAL [22] The Taguchi method was applied to plan the design of experiments (DOE). Contour and surface plots were made using response surface methodology (RSM) to understand the effect of different parameters on the bead geometry. It was found that at a particular range of arc voltage higher mean current, higher pulse frequency along with lower thermal pulse frequency produced optimum conditions for high depth of penetration with low or moderate bead width and height.

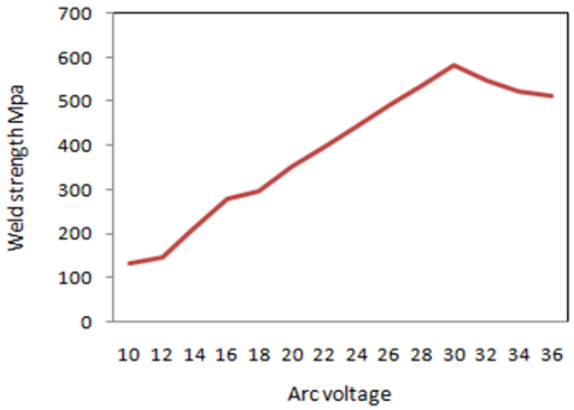
BY R. A. RIBEIRO, E. B. F. SANTOS, P. D. C. ASSUNÇÃO, R. R. MACIEL, AND E. M. BRAGA [23] predicting the geometrical features of a new welding process is of fundamental importance. Statistical methods are the most commonly used for predicting such geometries, and they provide particular confidence regarding the accuracy of the obtained regression. In this study, the geometries of weld beads produced using cold wire gas metal arc welding (CWGMAW) were predicted using regressive and sensitivity analyses.

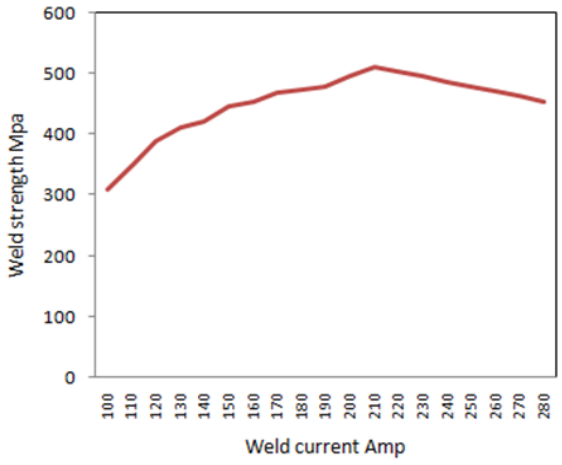
Prakash et al. [24] the present work deals with optimization of welding process variables by using MIG welding. In this process input variables are arc voltage (V), current (A) and welding speed(S) with tensile properties, hardness &penetration as responses of low carbon steel (ASTM A29). Design of experiments based on taguchi orthogonal array [L9]; and analysis of variance (ANOVA) is used to determine the impact of parameters with the optimal condition.

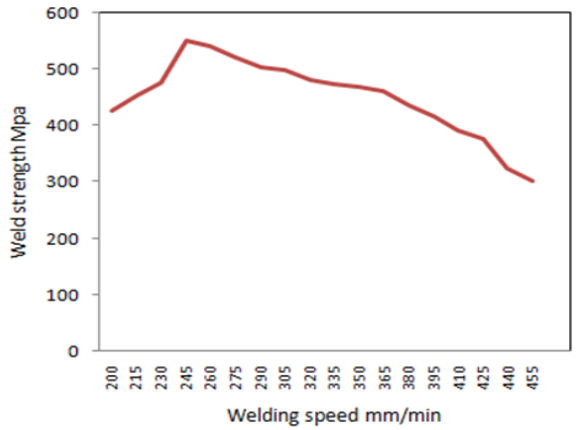
Singhmar et al. [25] reviewed that the various combination of parameters were obtained by conducting the experiment as per the orthogonal array. Arc current has the highest influence on the tensile strength with contribution of 41%followed by Arc voltage with contribution of 20% and gas flow rate with contribution of 16%.

3. OBSERVATIONS

Weld strength Vs Voltage, Current & welding speed







4. CONCLUSION

From above literature it can be observed that for AISI 1040, increase in arc voltage up to 27 to 30 volts will increase the tensile strength but above this value will increase heat input, induce some defects and reduces tensile strength. Weld current above 250 amp will also overheat the material. As current increases weld strength decreases. Wire feed rate is also varies equally as current with strength. The strength of the weld joint increases with reduction in welding speed. In fact by keeping the welding speed constant and increase in the voltage will improve its tensile strength. Throat thickness or reinforcement height of the welding will also increase with decrease in the welding speed. A constant welding speed between 240 mm/min to 360 mm/min gives higher value of welding strength. These parameters are optimized by using the Design of experiment by Taguchi with L9 orthogonal array.

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