© 2018 IJSRST | Volume 4 | Issue 5 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
Themed Section: Science and Technology

A Review Paper on "Optimization of Shielded Metal Arc Welding Parameters for Welding of (Ms) Sa-516 Gr.70 Plate by Using Taguchi Approach

Afnan Dadi*[1], Proff. Bhupesh Goyal[2], Mr. Hardik Patel[3]

*[1]PG Fellow, Mechanical Engineering Department, Parul Institute of Technology, Vadodara, Gujarat, India

[2]Faculty of Engg. and Tech., Mechanical Engineering Department, Parul Institute of technology, Vadodara, Gujarat, India

[3]Quality Assurance/ Quality control Department, Ishan Equipments Pvt Ltd, Vadodara, Gujarat, India

ABSTRACT

Shielded Metal Arc Welding (SMAW) is the most used welding process in the small scale industries and for repair work, because of low cost, flexibility, portability and versatility. Shielded metal arc welding uses consumable electrode metal filler rod and is covered by flux coating that gives slag through burning of electrode which will give shield gases to protect from atmospheric oxides. SMAW has various welding parameters that affect the quality, productivity and cost of welding. Proper selection of process will give better weld strength. The present work is to optimize the parameter of SMAW process of mild steel by using Taguchi method and ANNOVA analysis. To fulfill this objective, selecting important welding parameters like welding current, root gap and thickness of plate as per field experts suggestions and available literature. On the selected parameters, trails have been conducted as per Taguchi method.

Keywords: Shielded metal are welding (SMAW), Optimization, Welding parameter, (MS) SA-516 Gr.70, , Tensile test, Hardness test Taguchi technique, Orthogonal array, ANNOVA analysis.

I. INTRODUCTION

Low carbn steel is most common form of steel because of its low cost and provides material properties that are used for different applications. Mild steel contain 0.005 to 0.25% of carbon which give ductile and malleable. Mild steel has low tensile strength because of its low carbon content. Thick sections may require preheating to reduce the cooling rate. Pressure vessel steel plate has a multiple range of steel grades that are designed for pressure vessel, boilers, heat exchangers and any other vessel that contains a gas or liquid at high pressures. Familiar examples include gas cylinders for cooking and for welding, oxygen cylinders for diving and many of the large metallic tanks that you see in an oil refinery or chemical plant. There is a huge range of different chemicals and liquid that stored and processed under pressure. ASTM A516 Grade 70 is an excellent choice for service in lower than ambient temperature application, has excellent notch toughness and is used in both pressure vessels and industrial boilers. It offers a greater Yield and Tensile strength when compared to ASTM A516 Grade 65 and can operate in lower temperatures. It's ideally suited for high standard set by the oil, gas and petrochemical industry.

This shielded metal arc welding process commonly used in construction/fabrication process. It has different names like, MMA or MMAW or stick welding. Consumable electrode used for this welding process. The flux burns and produces fumes to prevent from atmospheric conditions. The current can be AC or DC. Because of versatility and simplicity it is widely used around the world, it is mostly used for repair and maintenance in the heavy steel industry. The advantage is that, it is simple arc welding process compare to other arc welding processes. The equipment is portable in size and can be shift from one place to the other. Equipment is less costly. The heat required is obtain from touching a tip of electrode to workpiece and lift it back to maintain the arc. The heat generated melts electrode and its coating and the base metal in that weld region. Slag obtain to protect the weld from oxides, nitrides, and inclusions. Welding can be performed in all positions, can be used in shop and at site. Welded joints of sound quality and adequate mechanical properties can be obtained by selecting proper electrodes and welding procedures.

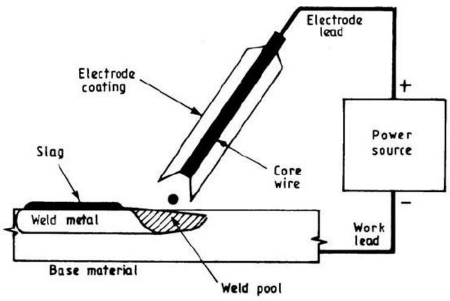

Figure 1. Schematic diagram of SMAW

II. LITERATURE SURVEY

Prof. Rohit Jha et al[1] Investigate the characteristics of weldment with respect to different types of weld design and welding current. Mild steel plates of 6mm were welded using different joint designs. Single V, Double V and Flat surfaces were joined by Shielded Metal Arc Welding process. Welding current was varied in all the cases. Mechanical properties such as ultimate tensile strength, yield strength and percentage elongation were evaluated. Results indicated that the single V joint design depict maximum UTS in comparison to other welding joints. At the welding current of 110amp the tensile strength was maximum for single V joint design in comparison with weld carried out of 90amp, 100amp and 120amp. And also in comparison to other types of joint design, i.e. double V (UTS 387.74MPa, YS 297.81MPa) and square butt joint (UTS 394.16MPa, YS 284.93MPa) the ultimate tensile strength of single V joint design was maximum. With the increase in welding current which was taken as a variable parameter the ultimate tensile strength 435.59MPa, yield strength 340.23MPa and percentage elongation of 20.39 was recorded. Maximum/optimum value of tensile strength of single V joint design was obtained when welding speed was 157.80mm/min. The maximum UTS was obtained when the heat input rate was 919.63 J/mm. Hence it can be concluded that the ultimate tensile strength in case of the single V joint. was maximum as a result of correct fusion between weld metal and base metal, right joint design and edge preparation for this type of material thickness. Also, it may be concluded that with the increase in welding current the UTS will increase until an optimum value. Increasing the current beyond this optimum value will result in decreasing UTS.

B S Praveen Kumar et al [2] explained on parametric design of Shielded Metal Arc Welding to ensure no leak to occur during the process. To achieve the objective an attempt has been made to select important welding parameters like welding current, welding speed, root gap and position of electrode. The results have indicated that leak proof joints can be produced in few specific operating conditions. Each parameter towards the leak is also estimated by ANOVA. For pipe diameter 60mm and 3mm thickness, 9 trail runs are conducted as per OA. Out of 9 trails 2 trails, run 2 and run 7 have given welding joints with no leak. This attributed to the fact that trail run 7 will run at higher current with relatively less welding speed 3.5rpm (11mm per sec.). As contribution of current is 54.64% and the contribution of welding speed is 22.96%. For pipe diameter 60mm and 4mm thickness, 9 trail runs are conducted as per OA. Out of 9 trails 2 trails, run 7 and run 8 have given welding joints with no leak. These trial runs are conducted at 150 Amps.

Om Prakash Satyam et al [3] studied on the change of hardness, impact strength, tensile strength and microstructure at various process parameters is investigated. There is increase in hardness and small decrement in impact strength and tensile strength as current increases. The microstructure also changes with increase in current. Originally mild steel contains ferrite and pearlite at grain boundaries. As current increases ferrite is converted in cementite and martensite. There is small increase in hardness and increment in impact strength and tensile strength with increase in welding speed. There is small increase in hardness and impact strength and tensile strength with increase in arc force. There is small increase in hardness and impact strength and tensile strength with increase in heat input. Parameters :- welding current, welding speed, arc force, heat input.

Munish Kainth et al [4] investigated the effect of mechanical vibrations on the mechanical properties of welded jointthey improved the mechanical properties of the weld metal through vibratory treatment. Finer grain structures can be produced during the welding of metals along with mechanical vibrations. During manual butt weld joints, uniform long dendrites are formed which shows that a uniform solidification process took place with uniform dendrites. Due to auxiliary mechanical vibrations, long dendrites break and form a new nucleation sites and a non-uniform solidification process took place. Tensile strength of the material AISI 1018 during vibration welding is 18.25 % more as compared to the tensile strength of same material during SMAW. Elongation of the specimen is 39.34 % more during vibration welding than SMAW.

Brijesh Sharma et al [5] explained the research work of Gas Metal Arc Welding (GMAW) that shows the current effect, voltage effect, arc length, welding speed and angle of welding on penetration and weld bead width on MS2062. An experiment runs by automatic welding are conduct using on L27 orthogonal array for optimization of welding parameters level of current, voltage, speed, angle and electrode gap. A strong joint of mild steel is produced by using the SMAW technique. If amperage is increased, weld bead width increases as well as penetration also increase. If voltage of the arc is increased, welding bead width generally increases. At one best possible voltage the WBW minimum and penetration is maximum. If travel speed is increased welding WBW generally decreases or penetration generally decrease but a value gives best penetration. And the travel speed increase the electrode deposition is decrease so electrode life is increase. The best Arc length is around equal to core diameter we use 3.15 mm electrode we find best values of arc length at 3mm arc distance. Optimum values:- welding current=100A,welding voltage=24V,angle=70 °& arc length=3mm.

Pankaj Kumar et al [6] investigated to measure and analyze impact toughness value before and after post weld heat treatment (PWHT) with three different soaking temperatures. The specimens are welded by Submerged Arc Welding (SAW) process. Significant improvement in impact toughness at 620°C of soaking temperature is recorded against risk of decrease in tensile strength. They found that when toughness of material increases material become softer. From the results obtained, these conclude that the ductility of the metal is increased because of the mechanical property change in the microstructure. The phase for the metal is pearlite with ferrite and the metal is heated below lower critical temperature of material. The pearlite is known for tougher, extremely strong and highly deformed. After PWHT formation of acicular ferrite were observed in weld zone which results in increase in impact toughness. Parameters:-

welding current, welding voltage, welding speed, electrode stick out.

Vijayesh Rathi , Hunny et al [7] explained on effect of controllable process variables on the heat input and the micro hardness of weld metal and heat affected zone (HAZ) are calculated and analysed. It is found that the micro hardness of weld metal and heat affected zone increased when low heat input is used. In the multi pass welding process parameters directly affect the number of passes and total heat input. The individual effect of current, voltage, speed on hardness of weld and HAZ is higher. It is observed that the hardness is higher in the HAZ than the weld metal. With increasing cooling rate, hardness increases in the weld metal and HAZ at higher cooling rate. Based upon the present study it is recommended that for the multi pass welding of J7 201SS using SMAW process the low heat input should be preferred because of the reason that it gives good hardness, toughness and ductility to the material. Bend test also turns positive for low heat input.

M. A. Bodude1, I. Momohjimoh et al [8] investigated the effect of heat input on the mechanical properties of low-carbon steel was studied using two welding processes: Oxy-Acetylene Welding (OAW) and Shielded Metal Arc Welding (SMAW). Two different edge preparations on a specific size, 10-mm thick low-carbon steel, with the following welding parameters: dual welding voltage of 100 V and 220 V, various welding currents at 100, 120, and 150 Amperes and different mild steel electrode gauges of 10 and 12 were investigated. The tensile strength, hardness and impact strength of the welded joint were carried out and it was discovered that the tensile strength and hardness reduce with the increase in heat input into the weld. However, the impact strength of the weldment increases with the increase in heat input. Besides it was also discovered that V-grooved edge preparation has better mechanical properties as compared with straight edge preparation under the same conditions. Microstructural examinations conducted revealed that the cooling rate in different media has significant effect on the microstructure of the weldment. Pearlite and ferrite were observed in the microstructure, but the proportion of ferrite to pearlite varied under different conditions

R.A. Mohammed et al [9] investigated the mechanical and metallurgical properties of medium carbon steel using shielded metal arc welding process (SMAW) with weld metal, heat affected zone and parent metal. From the results, shielded metal arc welding (SMAW) of medium carbon steel increased the strength of the welded joint in particular the heat affected zone (HAZ), as revealed by lower impact strength, higher tensile strength and hardness values as compared with the parent and weld metal which is attributed to the fine ferrite matrix and fine pearlite distribution as compared to the weld and parent metal. However, there was a loss of ductility at the welded joint resulting to brittleness of the material. The parent metal (un-welded specimen) had the highest toughness and is the most ductile as compared to the heat affected zone and the weld metal. The weld metal possessed an appreciable amount of hardness and a deep in toughness showing less ductility than the parent metal, but more ductile than the heat affected zone. The heat affected zone possessed the highest hardness, tensile strength and least impact strength showing that it is the most brittle as compared to the weld metal and the parent metal. That shielded metal arc welding (SMAW) of medium carbon steel increased the strength of the welded joint in particular the heat affected zone, as revealed by lower impact strength, higher tensile strength and hardness values as compared to the parent and weld metal.

Alay Shah et al [10] explained the mechanical properties of single v-groove, single pass welded joints of ASTM A515 Grade 60 (group designation B) mild steel using submerged arc welding (SAW) and shielded metal arc welding (SMAW). A backing was provided by Metal Active Gas (MAG) welding process on the first two specimens followed by a single pass of SAW and SMAW (on the opposite side with a single v-groove) respectively. For the third specimen SMAW-Repair- was done over a 40% gouged SAW coupon and a similar MAG welding backing was initially provided.. These three specimens were then tested for – Charpy Impact test and Vickers Hardness test, and metallographic studies were conducted with a microscope in order to study the resulting microstructures. The results of Hardness and Impact test prove that the original toughness and hardness of SAW specimen (Sample-2) are regained by the repair SMAW performed on previously SAW specimen (Sample-3). This clearly legitimizes the viability of performing SMAW repair on damaged SAW welded joints in order to regain its lost mechanical properties. Significant grain growth was observed in Sample-3 HAZ. The toughness of Sample-3 is more than Sample-1 and Sample-2 because during weld repair further grain refinement takes place. VHN of Sample-3 is quite similar to that of Sample-2.

Dhananjay Kumar et al [11] investigated the effect of welding process on the distortion with 304L stainless steel 12thk weld joints made by TIG (tungsten inert gas) and SMAW (Shielded metal arc welding) welding process involving different type joint configuration. 12mm thick 304L stainless steel weld joints made by different welding process with different angular distortion value. Double side TIG weld joints exhibited lower angular distortion value while double side SMAW weld joint exhibited maximum angular distortion value. The positive effect of angular distortion takes place when length of plates and diameter of electrode increases. The negative effect of angular distortion takes place when current and time gap between passes increases. The highest effect on angular distortion is observed on diameter of the electrode using within the design range of parameters.

R H. Zoalfakar et al [12] studied the effect of welding parameters on mechanical and microstructural properties of St.37/2, St.44/2 and St.52/3 joints produced by shielded metal arc welding (SMAW) was analyzed. Different heat inputs (H) were applied to butt- welding joints by controlling current. The specimens were machined with different groove angles 40°, 60°, 80° and 100°. In order to determine the effect of welding process on the local heat affected zone (HAZ) thermal cycle during welding, three different conditions were chosen, temperatures were recorded by using K-type thermocouples and a data acquisition system card of USB 6008, National Instrument type. The mechanical properties were evaluated by means of micro hardness and tensile tests at room temperature. Taguchi approach was applied to determine the most influential control factors which will yield better mechanical properties of the joints, where Taguchi's tools such as signal-to- noise ratio (S/N) have been used to observe the significant parameters and the optimal combination level of SMAW parameters. In this study, the effect of experimental parameters namely groove angle, C.E, heat input, and preheating on UTS, elongation and average hardness are investigated experimentally and statistically Taguchi technique and ANOVA. Specific findings of this research include the followings: The combined effect of both carbon equivalent and groove angle play an important role in improving tensile strength while keeping ductility at relatively high level. In this annealing is effect to reduce the hardening effect during and after welding via reducing crack susceptibility. The error between the experimental results at the optimum settings and the predicted values for UTS, elongation%, and average hardness (Hv) lie within 2.1, 3.1, and 4% respectively.

R.P. Singh et al [13] explained the effects of various welding parameters on penetration in mild steel having 5 mm thickness welded by shielded metal arc welding. 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. 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. 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. A strong joint of mild steel is found to be produced in this work by using the SMAW technique. If amperage is increased, depth of penetration generally increases. If voltage of the arc is increased, depth of penetration decreases. If travel speed is increased, depth of penetration of weld decreases. If magnetic field is increased, depth of penetration of weld decreases. Artificial neural networks based approaches can be used successfully for predicting the output parameters like weld width, reinforcement height and depth of penetration of weld.

Rajeev Ranjan et al [14] had studied to optimize various parameters for Shielded Metal Arc Welding process, including welding voltage, welding current and welding speed. Factorial design approach has been applied for finding the relationship between the various process parameters and weld deposit area. The study revealed that the weld deposit area varies directly with welding voltage and welding current and inverse relationship is found between welding speeds with weld deposit area. A strong joint of mild steel is found to be produced in this work by using the SMAW technique. If amperage is increased, welding deposition area generally increases. If voltage of the arc is increased, welding deposition area generally increases. Weld voltage was found to be most influencing variable to WDA. If travel speed is increased welding deposition area generally decreases. The two level fractional half area fractional designs is found to be very effective tool for quantifying to main and interaction effects of variable on weld bead area.

J. O. Olawale et al [15] studied on process variables of shielded metal-arc welding (SMAW) and post weld heat treatment on some mechanical properties of low carbon steel weld. Three hundred and sixty pieces of weld samples were prepared. The samples were welded together using AWS E6013 electrodes with DC arc welding process. Varying welding currents of 100 A, 120 A, 140 A were used with a terminal voltage of 80V. The weld samples were prepared for hardness, tensile and impact test. The prepared samples were then subjected to normalising heat treatment operation at temperatures of 590°C, 600°C, 620°C, 640°C, 660°C, 680°C, and 700°C. It was observed that increase in welding current led to an increase in hardness and ultimate tensile strength values of as-weld samples while impact strength de-creases. After post heat treatment operation the hardness and ultimate tensile strengths decreases while impact strength increases. From this outcome we conclude that there is correlation between the welding current and mechanical proper-ties of weld metal on one hand and normalising temperatures and mechanical properties on the other hand. As the cur-rent increases the hardness and strength increases but impact strength reduces, while hardness and strength continuously reduces but impact strength increases as normalising temperatures increases. There is correlation between the welding current and mechanical properties of weld metal. As the current increases the hardness and strength increases but impact strength reduces. Post welding normalising heat treatment operation reduces the weld metal hardness and strength but in-creases the impact strength.

III. OBJECTIVE

1. Optimizing the welding parameters like welding current, root gap, thickness of plate to get the higher tensile strength and Hardness.
2. Optimization is done with the help of Taguchi method and ANNOVA analysis

IV. REFERENCES

[1]. Prof. Rohit Jha, Dr. A.K. Jha. "Influence of Welding Current and Joint Design on the Tensile Properties of SMAW Welded Mild Steel Joints," Prof. Rohit Jha et al nt. Journal of Engineering Research and Applications ISSN: 2248-9622, Vol. 4, Issue 6(Version 4), June 2014, pp.106-111.

[2]. B S Praveen Kumar, Dr. Y. Vijayakumar. "Optimization of Shielded Metal Arc Welding Parameters for Welding of Pipes by using Taguchi Approach," B S Praveen Kumar et al. /International Journal of Engineering Science and Technology (IJEST) ISSN: 0975-5462 Vol. 4 No.05 May 2012.

[3]. Om Prakash Satyam, Mr. Kajal Sarmah. "To Study the Effect of Process Parameters on Mechanical Properties of Mild Steel in SMAW," IJMEIT// Vol. 2 Issue 7 //July 2014 //Page No: 631-638//ISSN-2348-196x.

[4]. Munish Kainth, Deepak Gupta, Vivek Kumar Sharma. "Experimental investigation of the effect of vibration on mechanical properties of AISI 1018 mild/low carbon steel welded joint using smaw," ijme, Vol. 2, Issue 2 (July, 2015) e-ISSN: 1694-2302 | p- ISSN: 1694-2418.

[5]. Brijesh Sharma, Sanjeev Goyal. "Parametric Optimization of Shielded Metal Arc Welding of Mild Steel (MS) 2062 Using Taguchi Method," ADR Journals Sharma B et al. J. Adv. Res. Mech. Engi. Tech. 2016; 3(3).

[6]. Pankaj Kumar, H. K Arya, Sandeep Verma. "Effect of post weld heat treatment on impact toughness of SA 516 GR. 70 Low Carbon Steel Welded by Saw Process", International Journal for Research in Applied Science & Engineering Technology (IJRASET) ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887 Volume 5 Issue VII, July 2017.

[7]. Vijayesh Rathi,Hunny. "Analyzing the Effect of Parameters on SMAW Process", International Journal of Emerging Research in Management &Technology ISSN: 2278-9359 (Volume-4, Issue-6) June 2015.

[8]. M. A. Bodude1, I. Momohjimoh. "Studies on Effects of Welding Parameters on the Mechanical Properties of Welded Low-Carbon Steel", Journal of Minerals and Materials Characterization and Engineering, 2015, 3, 142-153 May 2015.

[9]. R. A. Mohammed, M. Abdulwahab, E. T. Dauda "Properties evaluation of shielded metal arc welded medium carbon steel material," International Journal of Innovative Research in Science, Engineering and Technology Vol. 2, Issue 8, August 2013.

[10]. Alay shah, Mohit rayjada, Shantam gupta "Investigating mechanical properties of saw and smaw welded joints & the effect of smaw-repair of saw welded specimen," International Journal of Mechanical And Production Engineering, ISSN: 2320-2092, Volume- 3, Issue-9, Sept.-2015.

[11]. Dhananjay Kumar, Dharamvir mangal "Study and analysis of the effect of welding process on distortion with 304l stainless steel weld joints," international journal of engineering sciences & research technology Kumar* et al., 6(2): February, 2017.

[12]. S. H. Zoalfakar,A. A. Hassan "Analysis and Optimization of Shielded Metal Arc Welding Parameters on Mechanical Properties of Carbon Steel Joints by Taguchi Method," International

Journal of Advanced Engineering and Global Technology IVol-05,Issue-01, January2017.

[13]. 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.

[14]. Rajeev Ranjan "Parametric optimization of shielded metal arc welding processes by using factorial design approach," International Journal of Scientific and Research Publications, Volume 4, Issue 9, September 2014.

[15]. J. O. Olawale, S. A. Ibitoye, K. M. Oluwasegun, M. D. Shittu, R. C. Ofoezie "Correlation between Process Variables in Shielded Metal-Arc Welding (SMAW) Process and Post Weld Heat Treatment (PWHT) on Some Mechanical Properties of Low Carbon Steel Welds," Journal of Minerals and Materials Characterization and Engineering, 2012, 11, 891-895 June29,2012.