Weld Joint Performance of Two Dissimilar Metals by GMAW

Mohammad Nadeem Khalid, Apurv Yadav

Abstract**: *In present experiment stainless steel and mild steel were joined together by the process of Gas Metal Arc Welding. To check effects of the process chosen we had set parameters like wire feed rate, welding speed, gas flow rate, distance of nozzle and the inclination of the plate. Taguchi's robust design was used for the experiment and the parameters used were changed at each stage. After obtaining a satisfactory weld we decided to check the Tensile strength of the material using an ultimate tensile machine (UTM) and to determine which parameters are the best to obtain satisfactory quality of weld.***

Keywords**: *Gas metal arc welding, flow rate of gas, microstructure, speed of flame travel, welding current***

I. INTRODUCTION

Gas Metal Arc Welding (GMAW) is a welding technique in which an arc is shaped between the consumable wire anode at the tip of the welding gun and the work piece which produces heat making them heat up and soften therefore going along with them. Alongside the wire terminal there is a protecting gas that is sustained through the welding weapon which shields the welding procedure from residue or dust particles in the air. The application of the GMAW process generally uses DC voltage in reverse polarity to the electrode. The GMAW is otherwise called MIG (Metal Inert Gas) welding and one more variety of the procedure is MAG (Metal Active Gas) welding. The GMAW can be semi-automatic or completely automatic. A constant voltage is passed using a DC power supply that is generally used in these processes with constant current system but alternating current can also be used. There are four primary strategies for metal transfer in GMAW processes namely (a) Globular, (b) Short Circuiting, (c) Spray and (d) Pulse Spray. Each of these has special properties and their respective advantages and disadvantages and limitations.The GMAW process was originally devised for welding of aluminium and other non-ferrous metals. Later it was applied to steels because of the faster welding that it provided. The cost of inert gas also played a role in using of GMAW method and its use in the industry was limited. After the utilization of carbon dioxide as an inert gas ended up prevalent there were further improvement in the welding forms which gave greater adaptability which further expanded the notoriety of the GMAW in enterprises. In today's date the GMAW is one of the most preferred form of welding because of its speed, ease of process, versatility and general simplicity.

Mild steel and stainless steel are the two most common and widely used materials in every industry and hence joining them is a need in the industry. The problem with this is that the different chemical and mechanical properties of the material make it hard for them to be welded.

Our objective is to weld these two different metals with less leftover weight, less twisting and maximum tensile strength. Both the materials are cut into the desired dimensions i.e. 4'x2' inches with a thickness of 5 mm. Both the cut pieces of the material are Butt jointed and even though there are multiple methods of welding dissimilar metals we chose GMAW because of its unique weld qualities. Varying the parameters in the GMAW welding process, the quality of the weld can be drastically changed. There are different methods to get the rational design of the experiment, however we have picked Taguchi technique for experiment due to its vigorous nature and structure and furthermore on the grounds that it is generally utilized over the world.

The effects of different parameters on welding infiltration, micro structural and hardness estimations in mild steel by using the mechanical gas metal curve welding are studied by Karadeniz et al. [1]. Ibrahim et al. studied the effect of parameters such as bend voltage, welding current and welding speed. The use of dim based Taguchi procedures for the enhancement of the submerged circular segment welding process parameters is also represented [2]. Tarng et al. used diminish social audit gained from the diminish social examination as the execution trademark in the Taguchi procedure. By then, perfect process parameters are directed by using the parameter setup proposed by the Taguchi system [3]. George et al., found that beat current, hole-voltage and heartbeat on-time are the basic parameters for anode wear rate and material expulsion rate [4]. Benardos and Vosniakos implemented this procedure for the prediction of surface harshness in CNC milling utilizing neural systems and found that feed rate per tooth, profundity of cut, instrument wear, the cutting velocity, utilization of cutting liquid and the three segments of the cutting power are crucial variables for surface hardness [5].

II. METHODOLOGY

A. Selection Parameters of GMAW Process

The parameters to be considered for the above mentioned experiments are rate of wire feed (current dependent), rate of flow of gas, welding speed, and distance of nozzle from plate and inclination angle of the plate.

Revised Manuscript Received on January 15, 2020

***** Correspondence Author

Mohammad Nadeem Khalid, Department of Engineering, Amity University, Dubai, United Arab Emirates.

Apurv Yadav*, Amity School of Engineering and Technology, Amity University, Noida, India.

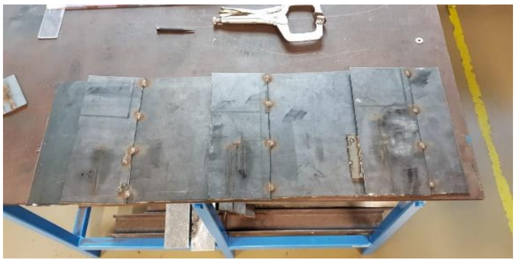


Fig. 1. Fixture for inclination

Fig. 2. Work bench for performing welding

B. Selection of Experimental Ranges

After the parameters are selected, the trial and error method is used to get the range of the parameters to obtain good weld quality as per our requirement. The range is selected by a well experienced engineer and after the trial and error method the range of the parameters is decided. The selected range of parameters is capable of providing a satisfactory weld quality in any combination with other parameters. This procedure is tedious and ought to be finished with up most consideration on the grounds that the parameters choose a definitive nature of the weld.

Table- I: Parameters of process and their ranges

Symbols	Parameters of the process	Unit	Range
A	Wire Feed Rate	Cm/min	Step 1 – Step 4
B	Flow Rate of Gas	l/min	10 - 15
C	Speed of Travel	Cm/min	12 - 25
D	Distance between nozzle and plate	mm	2 – 17
E	Inclination	degrees	0 – 16

After we obtain the range of the parameters to be used, we can divide the parameters in three level. These are the levels on which welding should be performed in different combinations. These combinations will decide the design of the experiment of Taguchi method, and in this experiment we choose three levels of five parameters for the L27 orthogonal array that has been used to perform the experiment.

Table- II: Parameters of process and their levels

Symbol	Parameter of the process	Unit of parameters	I	II	III
A	Rate of Wire Feed	Cm/min	28 0	330	400
B	Flow Rate of Gas	l/min	11	16	21
C	Speed of Travel	Cm/min	15	18	21
D	Distance between nozzle and plate	Mm	4	8	12
E	Inclination	Degree	4	8	12

The above Table 2 represents the parameters and their levels and the following Table 3 showcases their combination and the later Table 4 represents their actual values.

Table III: Experimental Layout Using L27 Orthogonal Array

S.NO	Rate of wire feed (cm/min)	Flow rate of gas (l/min)	Speed of travel (cm/min)	Distance between nozzle and plate (mm)	Inclination of fixture (degree)
1	1	1	1	1	1
2	1	2	1	2	2
3	1	3	1	3	3
4	2	1	1	2	3
5	2	2	1	3	1
6	2	3	1	1	2
7	3	1	1	3	2
8	3	2	1	1	3
9	3	3	1	2	1
10	1	1	2	1	1
11	1	2	2	2	2
12	1	3	2	3	3
13	2	1	2	2	3
14	2	2	2	3	1
15	2	3	2	1	2
16	3	1	2	3	2
17	3	2	2	1	3
18	3	3	2	2	1
19	1	1	3	1	1
20	1	2	3	2	2
21	1	3	3	3	3
22	2	1	3	2	3
23	2	2	3	3	1
24	2	3	3	1	2
25	3	1	3	3	2
26	3	2	3	1	3
27	3	3	3	2	1

Table IV: L27 Orthogonal Array with real Values

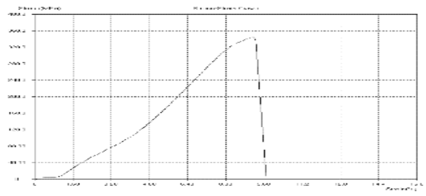
S.NO	Rate of wire feed (cm/min)	Flow rate of gas (l/min)	Speed of travel (cm/min)	Distance between nozzle and plate (mm)	Inclination of fixture (degree)
1	280	11	15	4	4
2	320	16	18	8	8
3	400	21	21	12	12
4	280	11	15	4	4
5	320	16	18	8	8
6	400	21	21	12	12
7	280	11	15	4	4
8	320	16	18	8	8
9	400	21	21	12	12
10	280	11	15	4	4
11	320	16	18	8	8
12	400	21	21	12	12
13	280	11	15	4	4
14	320	16	18	8	8
15	400	21	21	12	12
16	280	11	15	4	4
17	320	16	18	8	8
18	400	21	21	12	12
19	280	11	15	4	4
20	320	16	18	8	8
21	400	21	21	12	12
22	280	11	15	4	4
23	320	16	18	8	8
24	400	21	21	12	12
25	280	11	15	4	4
26	320	16	18	8	8
27	400	21	21	12	12

III. EXPERIMENT AS PER ORTHOGONAL ARRAY

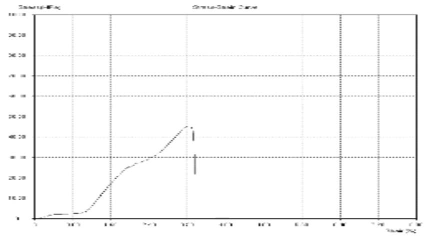
After the parameters and the dimensions to be utilized in the test are fixed and the examination is done according to the L27 Orthogonal Array, 27 steel plates of mild steel and stainless steel are butt welded together utilizing the GMAW strategy. The welded joint is put through tensile strength testing on the UTM machine so that the best parameters for the weld can be selected and worked upon, and also so that we can decide which parameters are to be used for further tests and processes.

IV. RESULTS AND DISCUSSION

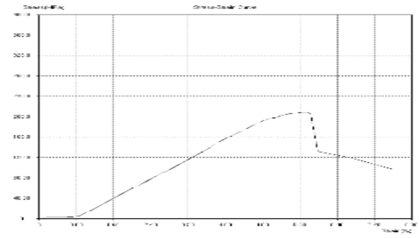
As per the accompanying diagrams of the Tensile test done on the UTM machine we find that the most productive and the best nature of weld is formed from the parameters used in the first iteration.



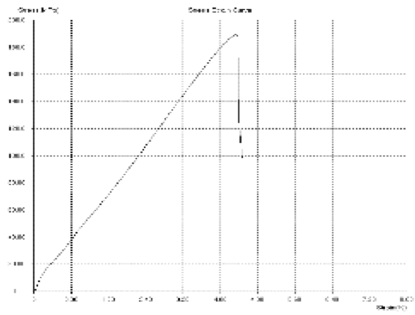
1



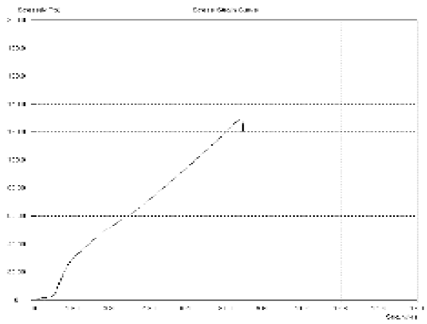
2



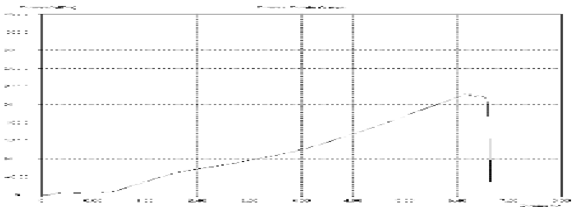
3



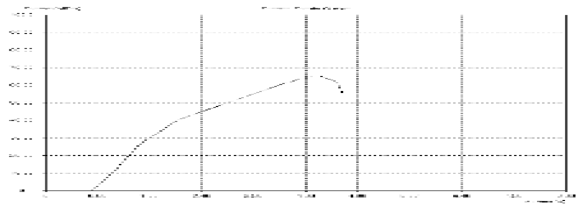
4



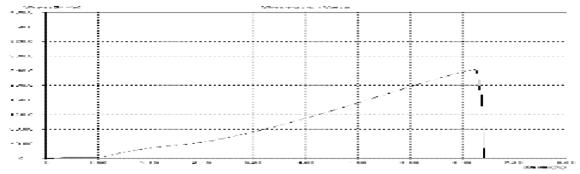
5



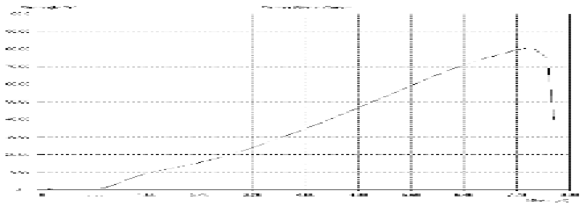
6



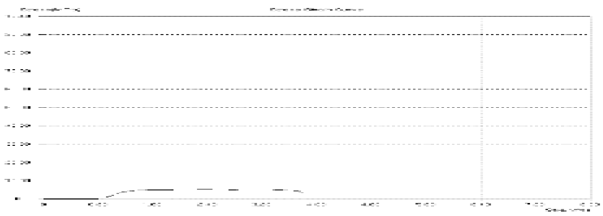
7



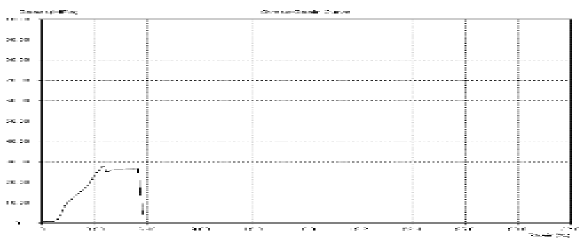
8



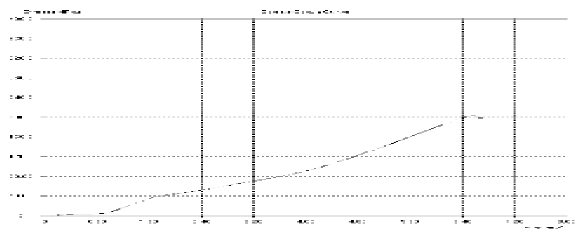
9



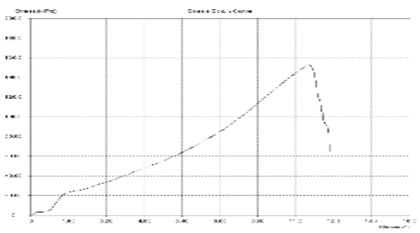
10



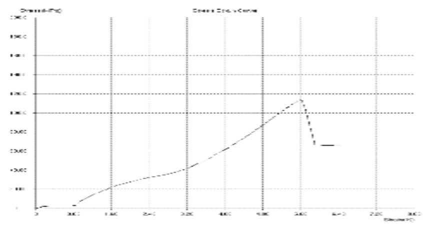
11



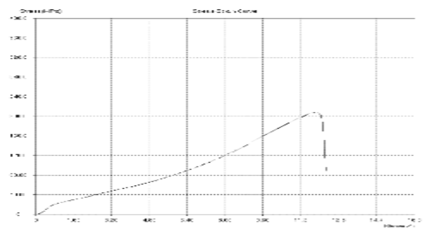
12



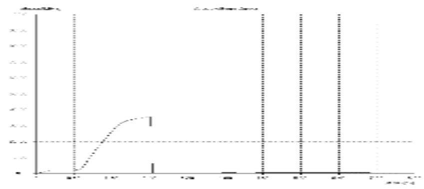
13



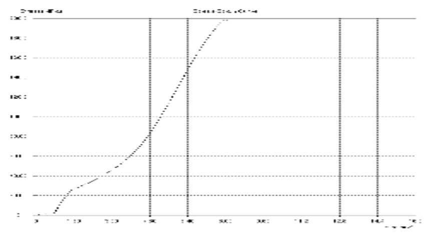
14



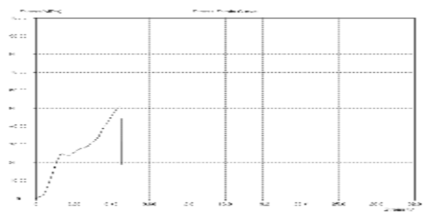
15



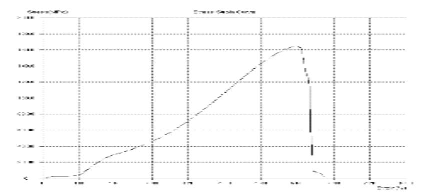
16



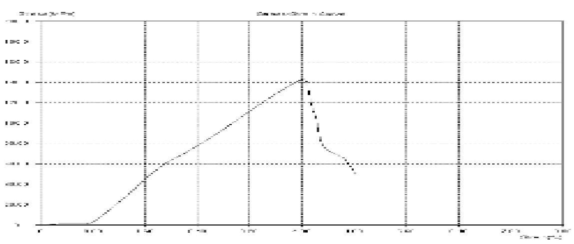
17



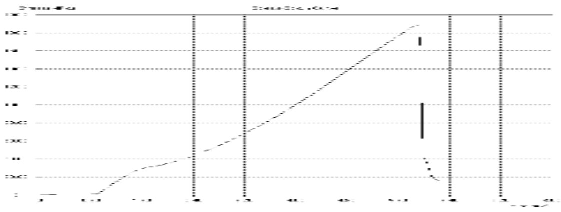
18



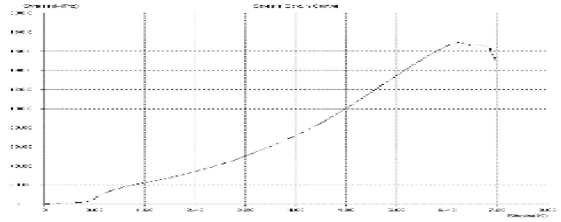
19



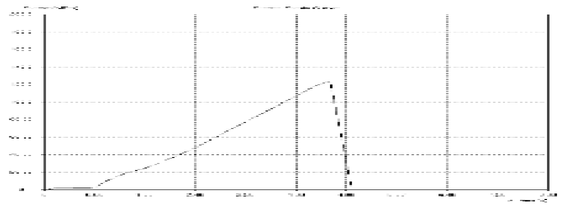
20



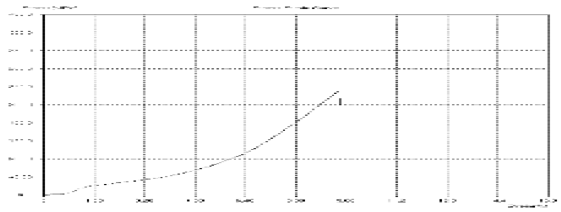
21



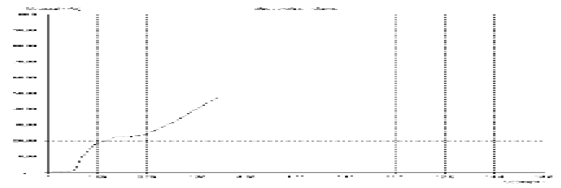
22



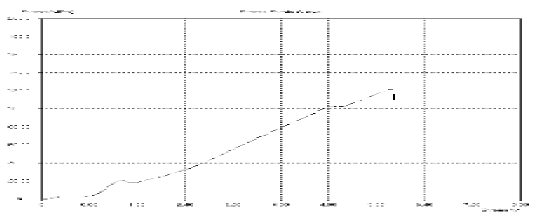
23



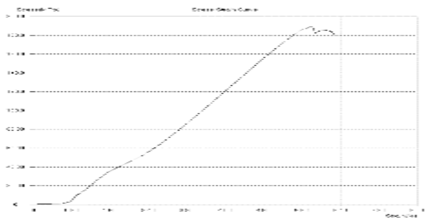
24



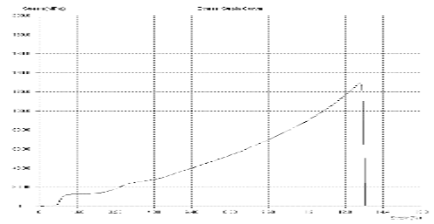
25



26



27



28

V. CONCLUSION

The conclusion to our experiment and research is that the parameters is to be chosen for the best quality of weld are the first set of parameters, since during the testing they had the most favorable results. In the future work scope the microstructure of the welds can be worked upon and tested.

REFERENCES

1. E. Karadeniz, U. Ozsarac and C. Yildiz, "The effect of process parameters on penetration in gas metal arc welding processes" in Materials & design, 28(2), 2007, pp. 649-656.
2. I. A. Ibrahim, S. A. Mohamat, A. Amir and A. Ghalib, "The Effect of Gas Metal Arc Welding (GMAW) processes on different welding parameters" in Procedia Engineering, 41, 2012, pp. 1502-1506.
3. Y. S. Tarng, S. C. Juang and C. H. Chang, "The use of grey-based Taguchi methods to determine submerged arc welding process parameters in hardfacing" Journal of materials processing technology, 128(1-3), 2002, pp. 1-6.
4. P. M. George, B. K. Raghunath, L. M. Manocha and A. M. Warrier, "EDM machining of carbon–carbon composite—a Taguchi approach" in Journal of Materials Processing Technology, 145(1), 2004, pp. 66-71.
5. P. G. Benardos and G. C. Vosniakos, "Prediction of surface roughness in CNC face milling using neural networks and Taguchi's design of experiments" in Robotics and Computer-Integrated Manufacturing, 18(5-6), 2002, pp. 343-354.

AUTHORS PROFILE

Mohammad Nadeem Khalid is working as a faculty member in the Department of Mechanical Engineering in Amity University, Dubai since 2017. Prior to this he has worked as an assistant professor in Satya group of colleges in India as well as Assistant engineer in Climate engineering company which is located in Delhi. Khalid has authored many research papers in international journals and his research interest is in optimization of process parameters of different mechanical applications

Apurv Yadav received his degree of B.Tech. Mechanical Engineering from IPEC, Ghaziabad, India in 2009 and degree of M. Tech. in Solar & Alternate Energy from Amity University Uttar Pradesh, Noida, India in 2011. He is currently a Ph.D. scholar at Amity University, Noida, India.