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Investigational Study and Enhancement of MIG Welding Process with Applying Activated Flux by Utilizing Taguchi Method

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***Abstract:** In the accompanying work is an endeavor to look at and enhance the cycle by concluding boundaries are as gas stream rate, current, and utilization of actuated motion in MIG welding which causes to changes of the weld globule quality. It is done on the hardened steel ss316 plate of 5mm thickness improvement of weld quality and profundity of entrance is impacted by enacted transition SiO2, Al2O3, CaO, Taguchi strategy exceptionally convenient to show the genuinely expected outcome by endeavoring a few emphases for this trial is assessed by applying L9 symmetrical exhibit in Mini-tab 18 programming and technique for experimentation had applied for getting ideal estimations of cycle boundary ; acquired outcome shows the upgrading of infiltration in weld and finished by utilizing motions are SiO2, Al2O3, CaO On the wellspring of existing outcome, by acquiring Marangoni convection impact is considered as a system in which expanding of entrance of initiated MIG welding.*
***Keywords:** Metal joining; MIG welding; Filler metal; Activated Flux; Penetration*

I. INTRODUCTION

MIG welding is a circular segment delivering welding measure in which bend is created between the base metal surface and welding firearm tip with passing a DC current in invert extremity. MIG is likewise called as GMAW (Gas metal curve welding) since it is gas protected cycle generally it is utilized in all position the different protecting gases is given over the weld to shield it from oxidation and defilement in the weld dab. the gases utilized which are artificially responsive This protecting gases utilized in MIG are dormant gas, for example, argon, helium, xenon and so on this are not receptive with air gases like oxygen which cause to frame consumption and makes imperfection in welding. It can utilized on practically all metals with, hardened steel, carbon steel, compound steel and Aluminum. In any case, aluminum tends to respond with oxygen there-for a protecting furnished with profoundly not receptive gas.

The examination is worried about the actuated motion utilizing MIG. Not many of transitions have affirmed that high impact on certain materials. Actuated motions having some measure of oxide comprises of, chromium, nickel, iron, calcium, cobalt, silicon, manganese, titanium, molybdenum are affirmed that having capacity to improve the weld quality, its hardness and entrance so welding velocity can be increment and accomplish the quicker cycle the. Her Yueh Huang examined the rakish twisting, weld globule maths and mechanical properties of the weld joint of material AISI 1020 carbon steel of 100 × 60 × 5 mm. The transition is taken for the experimentation were Fe2O3, SiO2 and MgCO3 with argon as the protecting gas of 15 L/min stream rate. It is closed from the examination that the motions expanded the weld territory as well as builds weld entrance and rigidity of the weld joint.[1] Sandip Shelar et al. anticipated a definitive elasticity and hardness of gentle steel Fe 410.

The welding current and gas stream rate are taken as the variable boundaries. the examination is finished by the Taguchi method and Regression analysis.[3] Pavan G. Chaudhari has done research on 'Assessment of MIG welding Process Parameter utilizing Activated motion on ss316 by AHP MOORA strategy' and had tested utilizing Minitab programming rendition 16. He set nine boundaries utilized with two motions Cr2O3 and SiO2. with two Flux SiO2 and Cr2O3. The outcome he got shows the improved entrance in weld got by utilizing Sio2, Cr2O3 Fluxes. an initiated motion is mix of dormant material in instable medium (CH3)2CO, ethanol and so forth) [12] In enacted MIG welding, most slender layer of blended Flux in with CH3)2CO is applied over the outside of base metal by utilizing a brush.

In this welding, all aspect of the motions over the base metal was applied dissolved and disintegrated. There are various sorts of oxide blended motions utilized in welding, for example, Fe2O3, SiO2, MgCO3, Al2O3, CaO and so on gives an outcome, profundity of infiltration, hardness and quality of weld increases.

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II. EXPERIMENTAL WORK

A. Work Material

Base metal utilized for the test is hardened steel 316 plate of 100mm ×60mm×5mm measurement. SS316 material is chromium-nickel based tempered steel including estimated measure of molybdenum which having property of consumption obstruction and furthermore it improves contradicting protection from chloride particle blend. Therefore, SS316 is likewise called as "Mo-Added" variant of SS304. Compound creation in SS316 as 0.047%C, 1.58%Mn, 0.027%P, 0.016%S, 0.428%Si, 16.425%Cr, 11.90%Ni, 2.27%Mo as should be obvious that chromium has max sum in ss316 which protection from consumption.

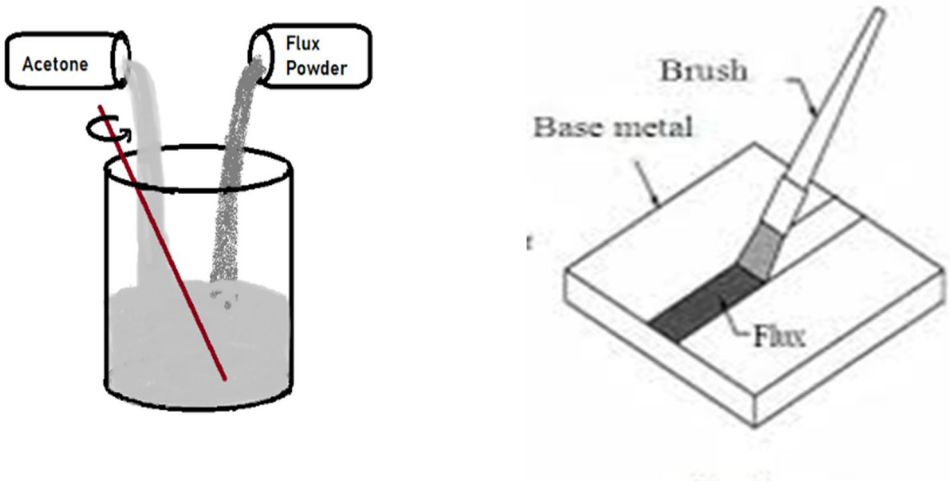
B. Fluxes

Three different fluxes SiO_2, Al_2O_3, CaO were used to bead on plate welding. fluxes are in the powder form before mixed with acetone as shown in below (a), (b), (c).

(a) Sio_2 (b) CaO (c) Al_2O_3

C. Application Of Flux

flux is in the form of powder it is difficult to apply evenly on weld surface, therefore is converted in the form of paste by mixing with acetone as shown in fig.1(a, b).



a) Mixing of Flux b) Coating of Flux

Fig.1. Method of applying Flux

After mixing with acetone apply fine paste flux over the weld surface by using brush properly applying of flux is necessary due to the weld get affected and the portion without flux eroded.

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D. Welding Parameter Setup

The welding is done with MIG having the capacity of Power 300A and 30V arc length is maintaining automated by robot producing and continuously feed wire. Chemical properties of activated flux as shown in following table.

Sr. No	Activated Flux Powder	Density (g/cm3)	Molecular mass (g/mol)	Melting Point (°C)	Boiling Point (°C)
1	Cr_2O_3	5.22	151.99	2435	4000
2	TiO_2	4.23	79.86	1843	2972
3	Al_2O_3	3.95	101.96	2072	2977
4	SiO_2	2.65	60.08	1600	2230
5	CaO	3.34	56.07	2613	2850
6	$MgCO_3$	2.96	84.313	650	1107

Table I. Activated flux powder

Parameters	Level 1	Level 2	Level 3
Current	140 A	180 A	200 A
Arc voltage	20-24 V	20-24V	20-24V
Welding Speed	140 mm/min	160 mm/min	180 mm/min
Shielding Gas	Ar+Co2	Ar+Co2	Ar+Co2
Gas flow rate	11 Lit/min	14 Lit/min	16 Lit/min
Flux used	SiO_2	Al_2O_3	CaO

Table II. Welding parameters

III. EXPERIMENTAL PLAN

A. Taguchi Technique

Taguchi is a named after the Japanese researcher who concocted a trial strategy which is executed in numerous regions of designing enterprises. it gives the factual investigation and exploratory efficient approach to streamlining of execution in plan arrangement, and furthermore cost and its quality. this strategy is relying upon Orthogonal

Fig.2. Weld Specimen 9 sample for L9 orthogonal Array (100mm ×60mm×5mm)

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Exhibit which gives the made Design for a tests and least number control measure boundary which can be differs according to plan of trials. it is inferring sign to commotion (S/N) proportions which are utilized for advancement. In the examination by utilizing L9 symmetrical exhibit boundaries are organized by test set. The cost, time And quantities of trial is decreased due to Taguchi technique; it is a logical. In the accompanying test, three Factors, three Levels relies upon L9 symmetrical cluster. Table 3 shows nine Alternative with current, GFR and Flux for the welding tests.

Alternative	Current	Gas flow rate	Flux
A_1	140 A	11	SiO_2
A_2	140 A	14	Al_2O_3
A_3	140 A	16	CaO
A_4	180 A	11	Al_2O_3
A_5	180 A	14	CaO
A_6	180 A	16	SiO_2
A_7	200 A	11	CaO
A_8	200 A	14	SiO_2
A_9	200 A	16	Al_2O_3

Table III. L9 Orthogonal Array

IV. EXPERIMENTAL RESULT

Alternative	WS	WC	Gas flow rate	Without Flux		With Sio2		With Al_2O_3		With CaO	
	mm/min	A	Lit/min	Hardness	Penetration	Hardness	Penetration	Hardness	Penetration	Hardness	Penetration
A_1	140	140	11	205.22	2.56	204.22	2.89	203.5	2.90	200.01	3.1
A_2	140	180	14	203.12	2.02	198.33	2.55	199.03	2.66	194.95	2.89
A_3	140	200	16	198.03	1.7	200.01	2.6	200	2.70	201.36	2.5
A_4	160	140	11	186.41	1.92	185.31	2.87	189.30	2.95	191.02	2.44
A_5	160	180	14	185.40	1.88	201.65	2.40	204.7	3.1	200.44	3.22
A_6	160	200	16	190.67	2.08	189.66	3.1	190.35	3.22	195.52	3.45
A_7	180	140	11	192.3	2.13	191.22	3.41	195.3	2.98	196.05	3.54
A_8	180	180	14	188.33	2.67	198.47	3.56	194.14	3.66	200.01	3.69
A_9	180	200	16	196.00	3.1	194.67	4.57	201.66	4.1	199.95	4.66

Table IV. Result with Taking Different Parameters and Flux

Units:, Welding Current= ampere, Welding Speed = mm/min Arc Voltage = voltage , Hardness= HV, Penetration = mm.

A. Minitab Graph

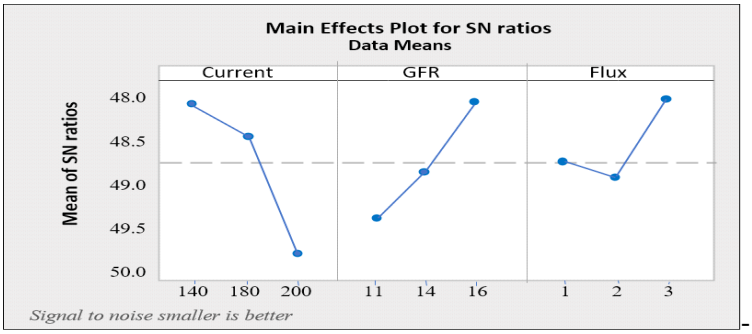

Chart 1: SN Ratios for strength and hardness plotted

Above chart shows the optimum value by taking variable inputs parameters and the SN ratios for optimum parameter are 140A , CaO, Al_2O_3, SiO_2 fluxes and GFR 16 Lit/min.

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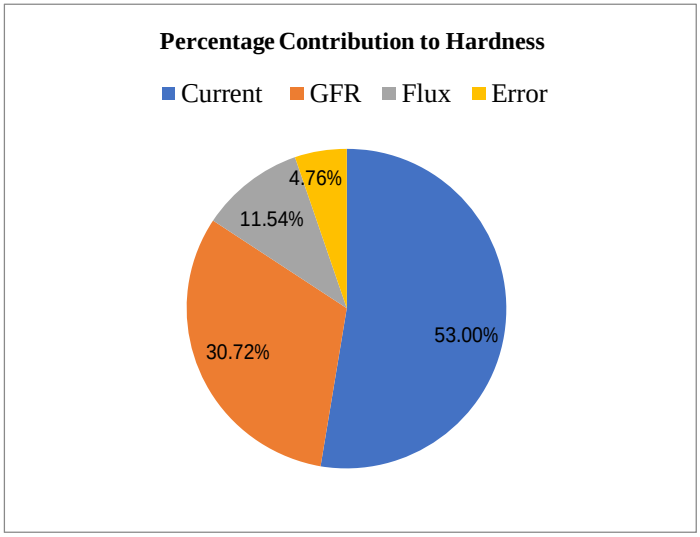
B. Anova Data

Parameter	DF	Seq SS	Adj SS	Adj MS	F Value	P value	Contribution
Current	2	4780.1	4780.1	2390.05	11.00	0.091	53.00%
GFR	2	2933.5	2933.5	1466.75	5.99	0.143	30.70%
Flux	2	975.6	975.6	487.8	2.01	0.333	11.54%
Error	2	485.3	485.3	242.65			4.76%
Total	8	9174.5					100 %
S = 15.6710			R-sq= 95.02%			R-sq (Adj)=79.20%	

Table V. Results of anova data

ANOVA data is a statistical method to find the Contribution of given Parameter for analysis. ANOVA is referred as analysis of variance and its calculations for degree of penetration and test of hardness has completed using Minitab 18 software in excel sheet. Above table 5 represent the contribution of current is 53.00% there for it is the most important factor and Gas flow rate gives 30.70% and Activated flux gives 4.76%.



Graph 4.4: % Contribution to hardness by Input Parameters

V. RESULT

The results values obtained for evaluation of MIG welding Process by Taguchi method using L9 orthogonal array is shown in above Table 3, Table 4 and Table 5.

Without Flux MIG gives the performance which satisfy the industrial work of welding but with flux (Al_2O_3, SiO_2, CaO) it gives the best features performance and increase the strength and penetration of weld bead.

VI. CONCLUSION

The present work gives way when by operation on ss316 material of MIG welding it is necessary to select an alternative parameter for good performance of Welding. The completed work shows that to achieve a best suited MIG welding operation with an effective performance using SS316 material; it is very important to select possible alternative of parameters and attributes. TAGUCHI method and Minitab ANOVA DATA gives an chance to select the best alternative for MIG welding, following point is to be noted.

1. For deep Penetration and optimum hardness current affect the most among other parameter and followed by GFR (gas flow rate) and Flux has significant role as shown the improvement in weld bead.
2. The result shows that optimum condition for getting required hardness and penetration after obtaining such values; as current 140A, GFR (gas flow rate) 16 Lit/min, with SiO_2 CaO, Al_2O_3 Flux
3. the hardness and penetration are increasing gradually.

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VII. FUTURE SCOPE

Metal Inert Gas welding is one of the regular techniques to join two materials. Wide scope of materials might be joined by Metal Inert Gas welding comparative metals, unique metals and amalgams, different sorts of transitions. Thus, for future further work in MIG Welding. Study should be possible on more boundary like for various gas type and blends, speed, light point, spout to plate separation, wire feed rate, sorts of joints and welds, joint hole and so forth In this examination entrance and UTS was chosen yield boundary. Notwithstanding as infiltration and rigidity, weld hardness, weld globule calculation, hole size, welding smoulder age rate, micro-structure, yield quality, rate lengthening, surface and sub-surface deformities, precise distortion(bending) and so on can likewise be chosen as a major aspect of study.

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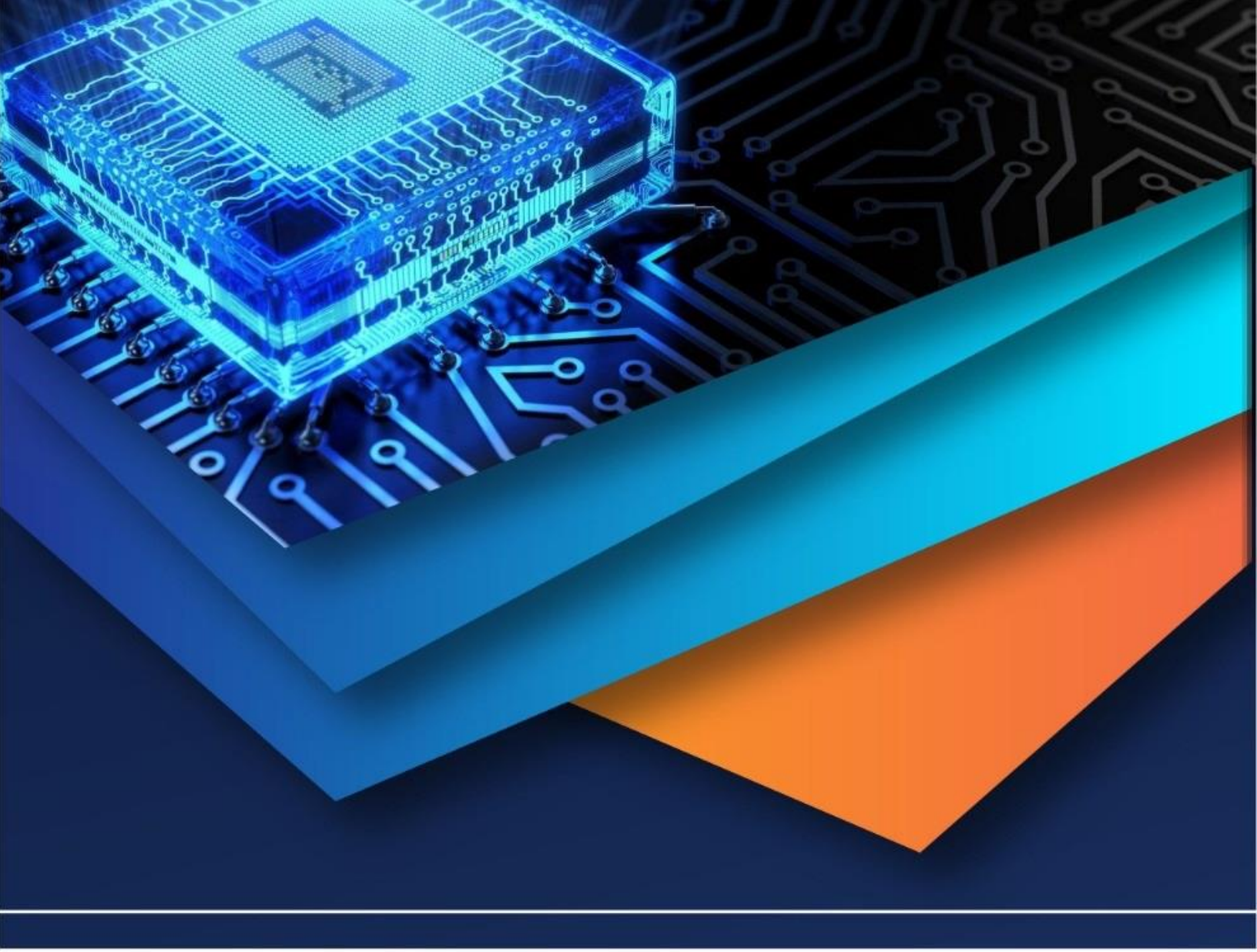

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