Optimization of Weld Bead Geometry in GMAW Process Using RSM

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Abstract – Now a day's using of automatic & robotic system of welding leads a vital role for the fabrication industries in terms of maintaining their quality and productivity. And also helps them to come out from the problems such as lack of skilled welders, health & safety needs. To make more use of these type of system. This is very essential to choose the correct method and parameters which would satisfy the required nature of the weld bead. To get a high quality of welding all the various variables should be balanced in a corrective way, so in this paper we have focused on the high quality of welding all the various variables should be balanced in a corrective way.

Index Terms – Robotic, Welding leads, Fabrication.

INTRODUCTION

Modern industrial products which have donated to the prosperity of mankind, owe their extension and efficient performance to welding, which is now the universally accepted method of permanently joining metals and creating monolithic structures efficiently and economically.

Weld emerging is progressively working to improve the life & to lessen the cost of engineering component. Gas metals are welding (GMAW) covering is lengthily employed in its reflex mode to obtain the winner quality stainless steel cladding. Steels by distant are the most

extensively used and welded resources, primarily, due to the trueness that they can be mass-produced relatively economically in huge amounts to very exact requirement and have a surrounding range of motorized properties.

Surfacing or Coating-

Metal surfacing denotes to process of putting a metal on the external of base metal either to encounter the dimensional necessities (regaining of worn out parts) apparatuses or to inform convinced surface properties such as protection to wear, influence, or corrosion. The chief goal behindhand both these states is to save money and substantial by wounding costs and dropping the ingesting of exclusive metals. Primarily, this process was ongoing as the process of creation spare repairs until a fresh part could be found, but today it is becoming pretty satisfactory and inexpensive tool for surfacing. . Primarily, this process was ongoing as the process of producing spare repairs until a novel part could be found, but today it is becoming fairly satisfactory and inexpensive tool for surfacing.

MIG WELDING

MIG welding is mostly used for welding Aluminum and Stainless Steels thru inert gas welding. In $_2$this procedure, the arc is being formed amongst an electrode and the job. Where electrode deeds a simple wire of minor diameter, which offers the plaster metal and hence no extra field, is essential. Shielding g argon, helium, carbon dioxide and oxygen are being castoff for nearby the arc in order to defend the melted metal pond from atmospheric pollutants like dirt, dust, metal oxides, etc. These gases can be castoff both as a solitary gas and in mixture with other gases. When CO_2 only is castoff as the defensive gas, the procedure is called CO_2 welding. Formerly, argon and helium were used as shielding gases**.** Presently CO_2 is used Panoptic, and oxygen and CO_2 are oft assorted with inert gases.

Welding gun and wire feed unit

The distinctive MIG welding gun contains a diversity of no. key Portions such as control switch, a contact tip, an electrode conduit, power cable, a gas nozzle liner and a gas hose. When the operator press the control switch or the trigger, of the gun and when he regulate the wire feed rate, electric power and the shielding gas flow, then an electric arc is being hit. The contact tip is fundamentally linked with the power source with power cable and it is made up of copper, then the electrical energy changed into the electrode while it is being linked to the welding area. The gas nozzle is being used for upholding the flow of shielding gas as per ferment of call for.

Electrode

The assortment of electrode used should depend upon the kind of metal we used to be welded well as it is a kind of joint enterprise to be welded and the situations of the metal surface. The optimal of an electrode which is being to be used depends upon the mechanical possessions of the zone which is going to be welded and it theatres a vigorous role in defining the weld quality. At MIG chiefly the electrodes being used having

diameter fluctuating from 0.8 to 2.4 mm, but it may be as long as 4 mm. The electrode of extent at least 1.6 mm is being used in pulsed spray sort of welding.

Shielding gases

Shielding gases played a vigorous role for welding to create its welding shells cover protected from the surroundings; gases like nitrogen, oxygen due to which probabilities of receiving fusion faults, absorbency and which also harm the weld metal set up even they arises closer to the electrode. Hence, in MIG the wire of electrode has been covered with flux, therefore a distinct shielding gas is given to protect the weld. Which Splits slag, the hard residuals from the flux which set up after welding and must be clipped off to reveal the finished weld.

MIG Variables

After fruitful choice of the wire, gas which should be used for the welding drive and the circumstance proper for welding essential is selected as per our work order of request. These being is used because these constraints having an excessive effect on the weld oddity to a good amount. Due to this motive these issues will be supported out over a large range, these constraints should be deliberated as the preliminary modification in any of the welding operation. So the ethics is taken out under these circumstances. After fruitful choice of the wire, gas which must be used for the welding drive and the situation suitable for welding essential be selected as per our work order of request. These being used because these constraints having a abundant effect on the weld character to a decent extent.

Welding voltage

It should be plainly distinguished that the arc length is directly controlled by the voltage setting as well as it will a sure range is wanted to retain the arc stability at any specified current level of welding.

NPD

NPD mains are a vigorous part in continuing the bead shape and quality. When the NPD is being too smaller than it will critically harm the gas nozzle because it gets extremely heating but when the NPD is too long, the competence of the shielding gas is affected including with the chances of extinguishing for arc increases. Typically NPD of inner diameter approx. 1 to 1.5 of nozzle is being used.

Welding speed

The welding speed can be defined as the linear rate that which the arc moves along with the work piece. These parameters are being basically expressed in inches or meters per minute. Three statements are being made regarding the welding speed.

1. If there is any increase in the thickness of the material, the welding speed must be lowered down.
2. Higher arc travel speed is being achieved by using the forehand method of welding.

Electrode Stick Out

The distance from lower tip of the contact tube to the tip of the electrode wire is known as electrode stick out. It is an important parameter for controlling the decomposition rate and bead geometry. They stick out is basically kept between 5 to 15 mm for the short circuiting transformer and 16 to 25 mm for another type of metal transfer.

MR. Jesus E .Pinto Lopera (2012) used RSM to obtain an empherical model for describe the droplets size and transfer rate behavior in projected spray metal transfer for(GMAW)with constant voltage. P. Chavda (2013) RSM technique has been used by him on MIG welding process by applying design of experiments & finite element analysis by ANSYS software within his experiment consumable electrode is also used.

Kannan and Murugun (2006) investigated the effect of flux arc welding process parameters on duplex stainless steel clad quality using RSM. Shahi and Pandey (2006) studied the welding current prediction in GMAW and UGMAW processes using response surface methodology. Correia et al. (2005) compared the results obtain using RSM and genetic algorithm (GA) in GMAW welding. Gunaraj and Murugan (2005) effectively used RSM to develop mathematical models of heat input and area of HAZ for the bead on plate and bead on joint in the SAW of pipes.

Methodology

To accomplish the following objectives RSM has been designated (a conventional response surface method) method that it demand smaller amount of experimentations to be showed and also it can tackle uncompromising factors encompassed in the design of experimentations. Basic steps for completing the desire objectives are:

- **Data Collection:** Rendering to design matrix founded on RSM design matrix. The experimentations will be directed on mild steel plate consuming 304 stainless steel electrodes.
- **Empirical Modeling:** Design of the new empirical model (relationship among GMAW responses and the GMAW parameters) using regression analysis.
- **Test for adequacy of develop model**: Inspection of prototypical significance, model terms implication using ANOVA analysis. This empirical model will accommodate in optimal assortment of GMAW parameters.

Optimization of GMAW Parameters

Design of experiments approach, by using of RSM technique was found to the best appropriate optimization technique for contemporary work as contented by the literature survey. I have

taken four numeric factors such as nozzle plate distance, open circuit voltage, welding speed and wire feed rate being identified for my present work. This is being further accordance with the design matrix applying central rotatable design. Statistical software design expert 9.3.0 is being used for handling the numerical decisive of the value coefficients, checking the terms related to the models using ANOVA, numerical optimization and generating the graphs/ responses for output variables. Design of experiments approach, by using of RSM technique was found to the best suitable optimization technique for present work as satisfied by the literature survey.

Based upon the problem expressed or discussed above the following objectives were framed

Define the Parametric optimization of bead geometry parameters, bead Height

Bead Penetration of bead geometry.

EXPERIMENTATION

We are using the Mild steel plates of 8 mm thickness of size 300x 100x 10 mm which were expurgated from the flats using influence Hacksaw after that all blocks were used as the substrate physical for cladding.

Filler wire

The austenitic stainless steel solid wire of the kind 304 of diameter 1.2 mm is being used in the contemporaneous work. The physical and chemical possessions of the ASS type 304 are as follows:

Table 4.1 chemical composition of the solid wire 304

Mtrl	C	Mn	S	P	Si	CU	Ni
%	0.0195	1.7153	0.00086	0.0282	0.2884	0.1731	9.1355

Ti	Cr	Mb	V	Tu	Al	Fe
0.004	19.2703	0.0776	0.1189	0.036	0.006	68.923

Table 4.2 Composition of base metal plate M.S being used(wt%)

Material	C	Si	Mn	P	S	Ni	Cr	Al	Fe
M.S	0. 13	0.16	0.58	0. 024 0	0.021	0.020	0. 043	0.027	Balance

Shielding gas

The shielding gas used in this examination was technologically pure Argon. The shielding gas pressure was kept constant and preserved at 22Lt/min for each experimental run.

The selection of selection, Identification & establishment of ranges of parameters

The whole set up contains identification of the significant variables that having a heavy inspiration on this weld quality. variables THIS is the subsequent table , which was is being originates out of the experimental runs, shows the variety of the process parameters at two level higher and lower levels as per the request of prerequisite of enterprise matrix.

Countless preliminary trial runs being carried out in instruction to find the functioning range of this development The variables such as ocv, wire feed rate, outlet plate distance and repairing speed which will affect the weld bead proportions being acknowledged & selected.

Countless initial trial runs being carried out in order to find the operating range of this process variables THIS is the following table, which was is being comes out of the trial runs, shows the range of the process parameters at two level higher and lower levels as per the demand of requirement of design matrix.

Table 4.3 process parameters varied at two levels

Input parameters	**Units**	**low(-)**	**High(+)**
Nozzle to plate distance(N)	mm	6	14
Open circuit voltage(V)	Volts	15	27
Welding speed(s)	Cm/min	20	40
Wire feed rate(f)	m/min	4	12

Final runs

Experimentation of bead on plate technique was being used for showing off the result of final run. Totally 30 experimental runs was made by the use of stipulated conditions as shown in "Table"

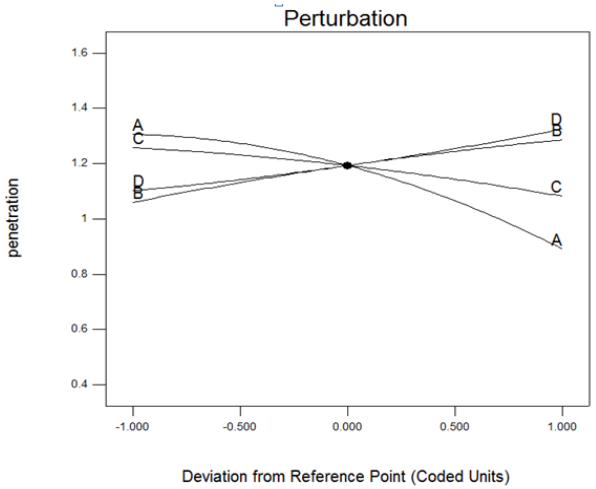
TABLE 4.4

Analysis of numerical optimization

For optimization of responses viz. Height of weld bead geometry, and weld bead penetration, the design expert 9.3.0 software is used. The optimization results are obtained in the form of ramps by setting the target values of the responses as desired which in turn gives up different solutions with different settings of the input parameters. A highlighted point will shows the factor setting of each variable for particular solution.

Design matrix for response (PENETRATION) Table						
		factor1	factor2	factor3	factor4	response1
std	Run	A:NPD (mm)	B:OCV volts	C:WELDING SPEED cm/min	FEED RATE m/min	Penetration
20	1	10	33	30	9	1.37
15	2	6	27	40	12	1.36
24	3	10	21	30	15	1.55
7	4	6	27	40	6	1.26
9	5	6	15	20	12	1.28
1	6	6	15	20	6	1.19
30	7	10	21	30	9	1.19
14	8	14	15	40	12	0.72
18	9	18	21	30	9	0.41
19	10	10	9	30	9	0.85
17	11	2	21	30	9	1.12
13	12	6	15	40	12	1.24
4	13	14	27	20	6	0.98
21	14	10	21	10	9	1.34
29	15	10	21	30	9	1.21
27	16	10	21	30	9	1.23
2	17	14	15	20	6	0.79
3	18	6	27	20	6	1.3
5	19	6	15	40	6	1.2
12	20	14	27	20	12	1.2
10	21	14	25	20	12	0.96
23	22	10	21	30	3	0.99
25	23	10	21	30	9	1.25
22	24	10	21	50	9	0.85
16	25	14	27	40	12	1.16
28	26	10	21	30	9	1.21
8	27	14	27	40	6	0.71
26	28	10	21	30	9	1.07
6	29	14	15	40	6	0.41
11	30	6	27	20	12	1.49

FIGURE:-5.1 PENETRATION VS REFRENCE POINT



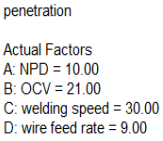
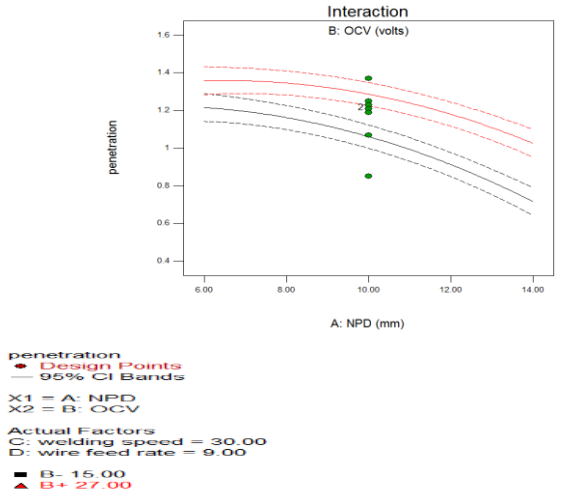


FIGURE:-5.2 PLOT OF INTRRACTION OF OCV V/S NPD



RESULT AND CONCLUSION

The following conclusions are as follows:

1. With increase in wire feed rate, depth of penetration will increase.
2. When wire feed rate increases, its weld bead rate also increases. In open circuit voltage and nozzle to plate distance but decreases in welding speed.
3. A five level four factor full factorial project matrix based on the central composite rotatable design method can be used for the development of mathematical model to predict.
4. Out of the four process variables considered wire feed rate was the most significant and influential factor having the positive effect.
5. The value of "prob.>F" for main effect NPD, Welding speed, OCV and Wire feed rate penetration were found to be less than 0.05, which indicate their significant effect on surface roughness.

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