Investigation of Metal inert Gas welding process through different parameter for Chromium Nickel Stainless Steel and Hot Rolled Medium and High Tensile Structural Steel

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ABSTRACT

Dissimilar metal welded joints are integral parts of modern-day power and process plant equipment. Among the various types of material combinations, welded joints of austenitic stainless steels and mild steel are very common in nuclear and chemical industries. The dissimilar metal joints have been emerged as a structural material for various industrial applications which provides good combination of mechanical properties like strength, corrosion resistance with lower cost. Selections of joining process for such materials are difficult because of their physical and chemical properties. Dissimilar material joints of stainless steel and mild steel are commonly uses as 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 which affects the quality of joint leads deteriorates strength. Shielding gases are necessary in GMAW process to protect the welding area from atmospheric gases such as nitrogen and oxygen, which can cause fusion defects, porosity and weld metal embitterment.

In the present study, stainless steel plate of AISI-304 has been welded with mild steel plate of IS: 2062 by Metal Inert Gas (MIG) welding processes. The tensile strength and hardness of dissimilar metal joints have investigated. The results were compared for different joints made by MIG welding processes and finally optimize the best combination of input parameters. The optimum joint also test in Ansys -16 a package which determines the von misses stress and temperature stresses in combined joint. The Process of micro hardness gives the hardness of crystal structure of welded joint.

Keywords*: Dissimilar material, MIG Welding, Ansys, Taguchi*

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1. INTRODUCTION

The selection of the welding process for a particular job depends upon many factors. There is no one specific rule governing the type of welding process to be selected for a certain job. A few of the factors that must be considered when choosing a welding process are:

- Availability of equipment
- Repetitiveness of the operation
- Quality requirements (base metal penetration, consistency, etc.)
- Location of work
- Materials to be joined
- Appearance of the finished product
- Size of the parts to be joined
- Time available for work

1.1 LITERATURE REVIEW

It is observed that process of welding depends on the process parameters used during the welding process. Various characteristics of the welded material such as Strength, mechanical properties, microstructure depends largely on the proper selection of process parameters.

V. Subravel et al. [1] studied the effect of welding speed on tensile and microstructural characteristics of pulsed current gas tungsten arc welded AZ31B magnesium alloy joints. **Vineeta Kanwal and R.S.Jadoun et al [2]** have studied Optimization of MIG Welding Parameters for Hardness of Aluminium Alloys Using Taguchi Method; parametric optimization of MIG welding for Hardness has been performed by using Taguchi method. **B.Mishra, R.R. Panda and D.K Mohanta et al [3]** studied Metal Inert Gas (Mig) Welding Parameters Optimization; Metal Inert Gas welding (MIG) process is an important welding operation for joining ferrous and non-ferrous metals. The MIG input welding parameters are the most important factors affecting the quality of the welding and weld quality is strongly characterized by weld bead geometry. In This paper gives the effect of welding parameters like welding current, welding voltage, welding speed on penetration depth of AISI 1020 steel during welding. A plan of experiments based on Taguchi technique has been used to plan the experiment, acquire the data and to optimize the welding parameters as well as the process. **Subodh Kumar et al. [4]** have studied the influence of heat input on the microstructure and mechanical properties of gas tungsten arc welded 304 stainless steel (SS) plates. The size of plates used was 200x100x6mm. The welded joint was created using two numbers of passes with 308 SS solid electrode of 3.15mm diameter. Argon gas was used as a shielding gas with constant flow rate of 15 lpm. Three different heat input combinations corresponding to three different welding currents i.e. 120 A (low heat input 2.563 kJ/ mm), 150 A (medium heat input 2.784 kJ/mm) and 180 A (high heat input 3.017 kJ/mm) were selected.
Based upon their study it was recommended that welding speed of 3.5 mm/s should be preferred when welding AISI 201 stainless steel using GTAW process to achieve good mechanical properties and high corrosion resistance.

2. Methodology

For the current study, weld plates of AISI304 and IS2062 as shown in fig. 3.1 are used as it has a very large scale application in the process industry. The specimen size selected is 150 x 50 mm and of uniform thickness of 12 mm with a single groove of 30° as per ASTM standards. All the test specimens were cleaned thoroughly before welding them.

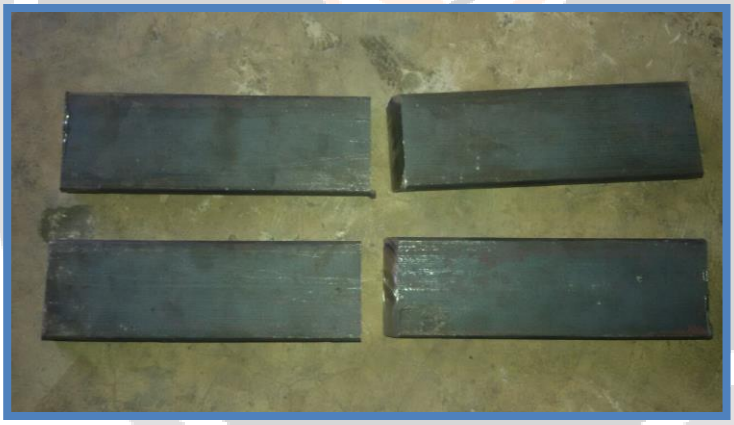

Fig- 1: Workpiece Specimen

2.1 Filler Metal

There are many types of materials used when making welds, which are generally categorized under the term filler metals. Filler metals are defined as, the metal to be added in making a welded joint. The filler metals used are consumed and become a part of the finished weld. Filler metals are classified into four categories:

a) Covered electrodes
b) Solid electrode wire or rod
c) Fabricated electrode wire
d) Fluxes for welding

For the present study, 1.2 mm diameter electrode having specifications as IS: 6419 AWS SFA: 5.18 ER70s-6 electrode using 100% Carbon dioxide gas is used as a filler material. ER 70s-6 represents the following:

- ER– An electrode or filler rod that is used in either a MIG wire feed or TIG welding.
- 70– A minimum of 70,000 pounds of tensile strength per square inch of weld.
- s -Solid wire.
- 6– The amount of deoxidizing agent and cleansing agent on the electrode.

Table 1: depicts the chemical composition of the filler material

Table 1: Chemical Composition of Filler Material

Ca	Si	Manganese	Su	Phosphor	Cu
0.	0.	1.45	0.	0.025	0.5

2.2 Mig Welding Machine

In the present study, MIG welding machine as shown in Fig.2 that we were going to use for joining the mild steel work pieces. The technical details of the welding machine are given below:

Make :	SAI ARC CV 300
Input supply voltage 3PH :	450
Output :	DC
Welding current range :	0 – 500A
Voltage :	0 – 60 V
Type of cooling :	Forced air cooled
Approximate dimensions (L x M x H) mm :	750 x 515 x 585
Approximate weight (Kg) :	220

Welding machine was provided with gas regulating attachment which is used for controlling the shielding gas flow manually during the experimentation. Welding current and voltage were manually regulated with the help of current indicator and voltage indicator respectively.

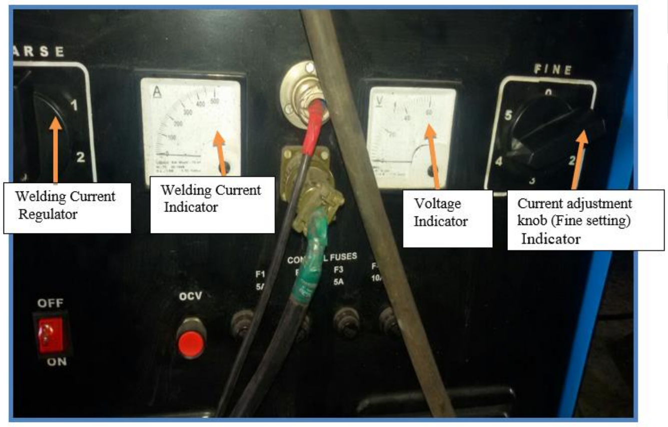

Fig 2: MIG Welding Machine

3. RESULT AND DISCUSSION

In Taguchi designs, a measure of robustness used to identify control factors that reduce variability in a product or process by minimizing the effects of uncontrollable factors (noise factors). Control factors are those design and process parameters that can be controlled. Noise factors cannot be controlled during production or product use, but can be controlled during experimentation. In a Taguchi designed experiment, you manipulate noise factors to force variability to occur and from the results, identify optimal control factor settings that make the process or product robust, or resistant to variation from the noise factors. Higher values of the signal-to-noise ratio (S/N) identify control factor settings that minimize the effects of the noise factors. Taguchi experiments often use a 2-step optimization process. In step 1 use the signal-to- noise ratio to identify those control factors that reduce variability. In step 2, identify control factors that move the mean to target and have a small or no effect on the signal- to-noise ratio. The signal-to-noise ratio measures how the response varies relative to the nominal or target value under different noise conditions. we can choose from different signal-to-noise ratios, depending on the goal of your experiment. For static designs, Minitab offers four signal-to-noise ratios out of these larger is better is consider for maximum the response.

Table-2: Criteria for Singal to Noise ratio

Signal-to-noise ratio	**Goal of the experiment**	**Data characteristics**	**Signal-to-noise ratio formulas**
Larger is better	Maximize the response	Positive	S/N = -10 *log(Σ(1/Y^2)/n)

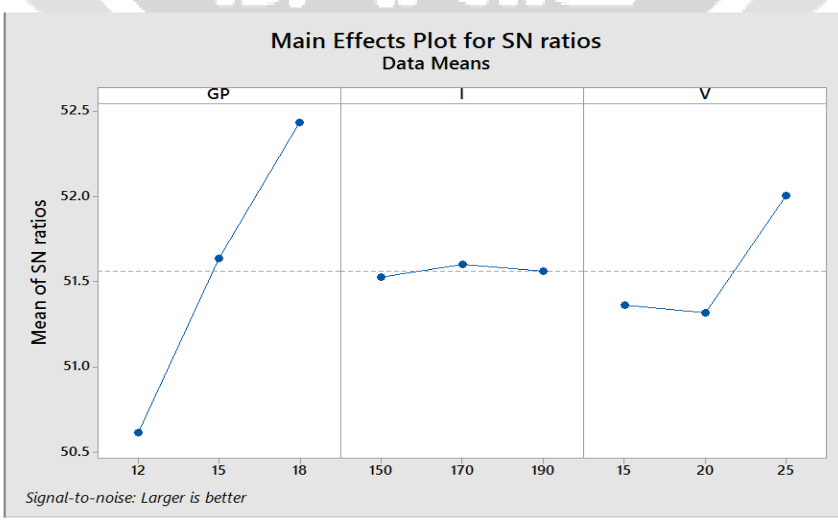

Fig 3: Main effects plot of S/N ratio

4.5 Taguchi design output

Taguchi Design

Taguchi Orthogonal Array Design

L9(3^3)

Factors: 3
Runs: 9

Columns of L9(3^4) Array

1 2 3

Taguchi Analysis: UTS versus GP, I, V

Response Table for Signal to Noise Ratios
Larger is better

Level	GP	I	V
1	50.93	51.84	51.67
2	51.63	51.60	51.32
3	52.44	51.56	52.01
Delta	1.51	0.28	0.69
Rank	1	3	2

Response Table for Means

Level	GP	I	V
1	351.9	393.7	384.3
2	381.8	381.0	368.3
3	419.8	378.8	400.9
Delta	67.8	14.9	32.6
Rank	1	3	2

Fig- 4: Taguchi design output

Fig no 4 shows the taguchi design output of the analysis and process parameter rank which affect the ultimate tensile strength. from this fig on rank, one is gas pressure that means the gas pressure is having highest effect on the ultimate tensile strength.

4. CONCLUSION

In this present work, experiments are carried out for ultimate tensile strength with respect to variation of gas pressure, current and voltage. There are 9 experimental readings taken for all variation of input parameter and they are used for conduct the parametric study for optimization of welding process parameter during welding of dissimilar material. The study found that the control factors had varying effects on the Tensile strength. The optimum welding condition obtained for highest tensile strength by Taguchi Method is at gas flow rate 18Psi, Welding current 150 Amp, welding voltage 25 volt.

The affect of parameter on the ultimate tensile strength can be ranked in decreasing order as 1) gas pressure 2) Welding Current 3) welding voltage, For validation purpose PTC Creo.4.0. used successfully for maximum tensile stress.

5. REFERENCES

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