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METAL INERT GAS WELDING (MIG)

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Abstract: - Metal Inert Gas welding (MIG) process is an important component in many industrial operations. The GMA welding parameters are the most important factors affecting the quality, productivity and cost of welding. We used the MIG process to find out the characteristics of the metal after it is welded. We use SS410 as our work material and take different values of current, voltage and wire speed and find it effects on Tensile strength and Hardness.

Keyword: - ARC, MIG, SS410, UTM

I. INTRODUCTION

Welding is a metal fabrication process which is used to join metals by the phenomenon of coalescence. The work-pieces are melted using heat derived from various energy sources such as a gas flame, an electric arc, friction, ultrasound, electron beam, laser energy, etc., to produce a pool of molten metal (weld pool), which on cooling solidifies to form very strong joints. Use of filler material and application of pressure is also done in order to achieve better and stronger joints.

II. MIG WELDING

MIG welding was developed in the 1940's and 60 years later the general principle is still very much the same. MIG welding uses an arc of electricity to create a short circuit between a continuously fed anode (+ the wire-fed welding gun) and a cathode (- the metal being welded). The heat produced by the short circuit, along with a non-reactive (hence inert) gas locally melts the metal and allows them to mix together. Once the heat is removed, the metal begins to cool and solidify, and forms a new piece of fused metal.

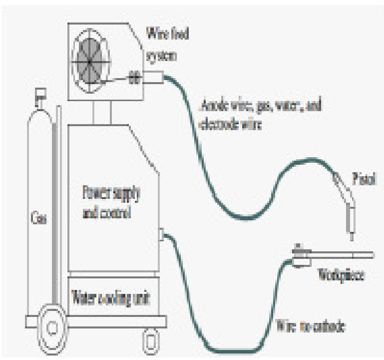


Figure 1

MIG welding is useful because you can use it to weld many different types of metals: carbon steel, stainless steel, aluminum, magnesium, copper, nickel, silicon bronze and other alloys.
Gas Metal Arc Welding (GMAW) is welding process in which a continuous and consumable wire electrode and a shielding gas are fed through a welding gun. GAS Metal Arc welding process is an important component in many industrial operations. The GMAW welding parameters are the most

important factors affecting the quality, productivity and cost of welding. This work presents effect of the welding parameters on the response penetration. In which input parameters for MIG welding are welding speed, welding current and wire diameter and the output parameter is penetration.

III. MATERIALS AND METHODS

Selection of Material

Material selection is the most important to this experiment because different materials have different working parameters based of their properties. The right selection of the welding material is the most important aspect to take into consideration in MIG welding process. SS410 is the basic martenstic stainless which will attain high mechanical properties after heat treatment. It has good impact strength, corrosion and scaling resistance up to 1200 F (649 C). The range of applications of SS410 is Cutlery, steam and gas turbine blades and buckets, bushings, valve components, fasteners, screens and kitchen utensils. Machinability is that material Tough, draggy chips with heavy build-up. While this alloy can be machined in the annealed condition, it tends to perform better in the cold drawn or heat treated condition.

Design of Experiment

Design of experiments, DOE, is used in many industrial sectors, for instance, in the development and optimization of manufacturing processes. Typical examples are the production of wafers in the electronics industry, the manufacturing of power generation industry, and the synthesis of compounds in the pharmaceutical industry. Another main type of DOE-application is the optimization of analytical instruments. Many applications are found in the scientific literature describing the optimization of spectrophotometers and chromatographic equipment. Usually, however, an experimenter does not jump directly into an optimization problem; rather initial screening experimental designs are used in order to locate the most fruitful part of the experimental region in question. Other main types of application where DOE is useful is robustness testing and mixture design. The key feature of the latter application type is that all factors sum to 100%. Areas where DOE is used in industrial research, development and production

Taguchi method

Taguchi’s philosophy is an efficient tool for the design of high quality manufacturing system. Dr. Genichi Taguchi, a Japanese quality management consultant, has developed a method based on orthogonal array experiments, which provides much-reduced variance for the experiment with optimum setting of process control parameters [4,19]. Thus the integration of design of experiments (DOE) with parametric optimization of process to obtain desired results is achieved in the Taguchi method. Orthogonal array (OA) provides a set of well balanced (minimum experimental runs) experiments and Taguchi’s signal-to-noise ratios (S/N), which is logarithmic functions of desired output serve as objective functions for optimization. This technique helps in data analysis and prediction of optimum results. In order to evaluate optimal parameter settings, Taguchi method uses a statistical measure of performance called signal-to-noise ratio. The S/N ratio takes both the mean and the variability into account. The S/N ratio is the ratio of the mean (signal) to the standard deviation (noise). The standard S/N ratios generally used are as follows: Nominal is best (NB), lower the better (LB) and higher the better (HB). The optimal setting is the parameter combination, which has the highest S/N ratio [4, 19]. Taguchi designs use orthogonal arrays, which estimate the effects of factors on the response mean and variation. An orthogonal array means the design is balanced so that factor levels are weighted equally. Because of this, each factor can be assessed independently of all the other factors, so the effect of one factor does not affect the estimation of a different factor. This can reduce the time and cost associated with the experiment when fractionated designs are used. Orthogonal array designs concentrate primarily on main effects. Some of the arrays offered in Minitab's catalog let a few selected interactions to be studied. You can also add a signal factor to the

Taguchi design in order to create a dynamic response experiment. A dynamic response experiment is used to improve the functional relationship between a signal and an output response.

IV. EXPERIMENTAL WORK

Experiments were designed by the Taguchi method using an L-9 orthogonal array that was composed of three columns and 9 rows. This design was selected based on three welding parameters with for levels each. The selected welding parameters for this study were: welding current (amp), voltage (volts) and Wire speed (m/s.)

In this work, two plates of SS410 stainless steel have taken. The chemical compositions of these materials are presented in Table 1. A V joint was applied for joining the two plates together. In the course of this work, the plate's edges were cleaned and grinded along the weld line to ensure full contact. The experiments were carried out according to the design matrix given in Table 3 and the process parameters are used according to the given in Table 4.

Input parameters range :-

Table 1. Input parameters range

Factors	Range
current (amp)	100-150
voltage (volts)	20-28
Wire speed (m/s.)	30-50

Factors with Level Value:-

Table 2. Factors with level value

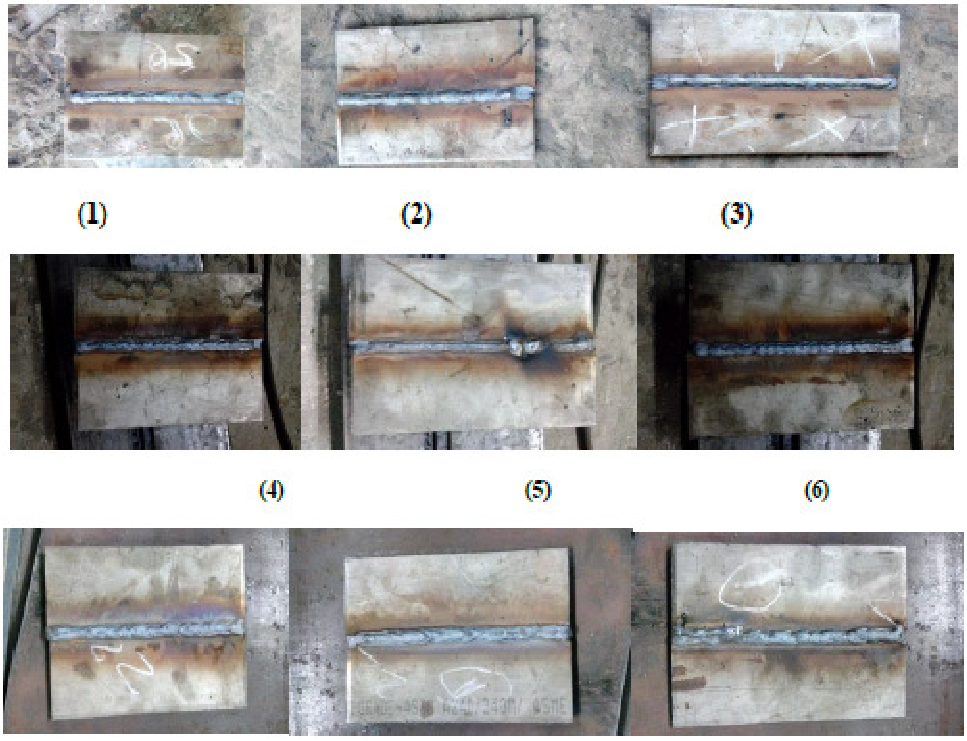
Factors	Level 1	Level 2	Level 3
current (amp)	121	130	139
voltage (volts)	22	24	27
Wire speed (m/s.)	35	40	45

Plan of Experiments

As stated previously three MIG Welding parameters viz. welding current (amp), voltage (volts) and Wire speed (m/s.) are considered as input variables for the MIG welding. From the range available for these parameters, numbers of levels are kept three. Each experiment for MIG welding takes 4min. Experiment table is shown in below.

Table 3. Input parameter of experiment

Trial No	Input Parameter		
	current (amp)	voltage (volts)	Wire speed (m/s.)
1	121	22	35
2	121	24	40
3	121	27	45
4	130	22	40
5	130	24	45
6	130	27	35
7	139	22	45
8	139	24	40
9	139	27	35



(1) (2) (3)

(4) (5) (6)

(7) (8) (9)

after welding

Figure 2. After welding

V. RESULTS AND DISCUSSION

Result:

Table 4. Experimental details with input and output parameter

Sample No.	Input Parameter			Output Parameter
	current (amp)	voltage (volts)	Wire speed (m/s.)	Hardness (BHN)
1	121	22	35	348.2
2	121	24	40	355.4
3	121	27	45	366.6
4	130	22	40	346.3
5	130	24	45	352.5
6	130	27	35	363.6
7	139	22	45	344.3
8	139	24	40	351.3
9	139	27	35	362.4

Figure 3

Main effects plot for hardness is shown in Fig. 3. The first plot displays effect of current on hardness using data means. The graph shows that the hardness decreases rapidly as current increases from 121 amp to 139 amp.

Second plot for hardness displays effect of voltage on hardness using data means. The graph shows that the hardness increases rapidly as voltage increases from 22 V to 27 V.

The third plot displays effect of wire speed on hardness using data means. The plot shows that as the wire speed increases from 35m/s. to 45 m/s. for hardness is static.

Result:

Table 5. Experimental details with input and output parameter

Sample No.	Input Parameter			Output Parameter
	current (amp)	voltage (volts)	Wire speed (m/s.)	UTS (N/mm2)
1	121	22	35	480.2
2	121	24	40	392.4
3	121	27	45	491.6
4	130	22	40	478.3
5	130	24	45	390.7
6	130	27	35	489.1
7	139	22	45	476.6
8	139	24	40	387.5
9	139	27	35	485.1

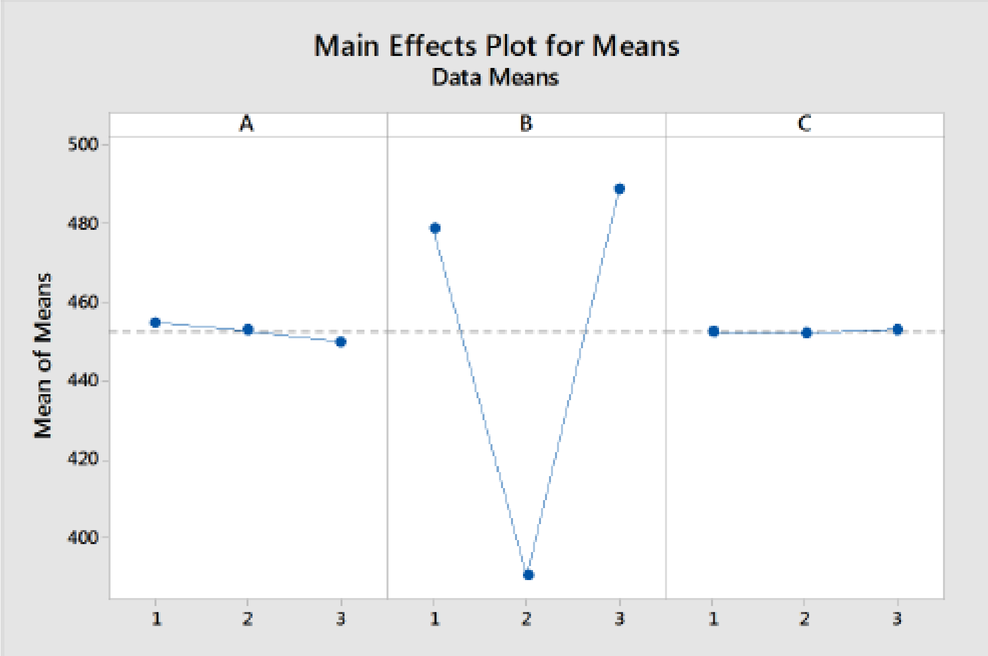


Figure 4

Main effects plot for UTS is shown in Fig. 4. The first plot displays effect of current on UTS using data means. The graph shows that the UTS decrease rapidly as current increases from 121 amp to 139 amp.
Second plot for UTS displays effect of voltage on UTS using data means. The graph shows that the UTS increases rapidly as voltage increases from 22 V to 27 V.
The third plot displays effect of Wire speed on UTS using data means. The plot shows that as the Wire speed increases from 35m/S. to 45 m/s. for an UTS is static.

VI. CONCLUSION

The effects of Current, Voltage and Wire speed used for MIG welding of stainless steel 410 specimens have been studied in this work. The L9 orthogonal has been used to assign the identified parameters.

- ❖ It is necessary that the edges of the plate were cleaned and grinded along the weld line to ensure full contact.
- ❖ Results show that among main input welding parameters the effect of the welding speed is significant.
- ❖ The hardness and UTS decreases rapidly as current increases from 121 amp to 139 amp.
- ❖ The hardness and UTS increases rapidly as voltage increases from 22 V to 27 V.
- ❖ The wire speed increases from 35m/s. to 45 m/s. for hardness and UTS are static.

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