OPTIMIZATION OF MIG WELDING PARAMETERS FOR IMPROVING STRENGTH OF WELDED JOINTS

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Abstract— The problem that has faced the manufacturer is the control of the process input parameters to obtain a good welded joint with the required weld quality. Traditionally, it has been necessary to study the weld input parameters for welded product to obtain a welded joint with the required quality. To do so, requires a time-consuming trial and error development method. Then welds are examined whether they meet the requirement or not. Finally, the weld parameters can be chosen to produce a welded joint that closely meets the joint qualities. Also, what is not achieved or often considered is an optimized welding parameters combination, since welds can often be formed with very different parameters. In other words, there is often a more ideal welding input parameters combination, which can be used. In this thesis, the influence of welding parameters like welding current, welding voltage, welding speed on ultimate tensile strength (UTS) of AISI 1050 mild steel material during welding. A plan of experiments based on Taguchi technique has been used. An Orthogonal array, signal to noise (S/N) ratio and analysis of variance (ANOVA) are employed to study the welding characteristics of material & optimize the welding parameters. The result computed is in form of contribution from each parameter, through which optimal parameters are identified for maximum tensile strength. From this study, it is observed that welding current and welding speed are major parameters which influence on the tensile strength of welded joint.

Key words: MIG Welding; Speed; Taguchi Method; Mini Tab; Tensile Test;

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I. INTRODUCTION

Welding is, at its core, simply a way of bonding two pieces of metal. While there are other ways to join metal (riveting, brazing and soldering, for instance), welding has become the method of choice for its strength, efficiency and versatility.

There are tons of different welding methods, and more are being invented all the time. Some methods use heat to essentially melt two pieces of metal together, often adding a "filler metal" into the joint to act as a binding agent. Other methods rely on pressure to bind metal together, and still others use a combination of both heat and pressure. Unlike soldering and brazing, where the metal pieces being joined remain unaltered, the process of welding always changes the work pieces.

WELDING TOOLS OF THE TRADE

The most basic welding rigs, for occasional use in a home workshop, can be had for under $100. Typically, these rigs are set up for shielded metal arc welding(SMAW), or stick welding.

Many units only have an on/off switch in the way of controls, making them simple to operate. Torch welding rigs are small and easy to work with, which is part of why they're commonly used. These torches use oxyacetylene for the flame, along with a filler rod. But some rigs (like those used in laser-beam welding) are so expensive and complicated that they are only used in industrial applications. As for materials, some are much easier to weld than others. Steel can be a great choice because of its strength, affordability and weld ability. As a rule, the stronger the steel, the harder it is to weld. Accordingly, several steel alloys were developed with welding in mind. Of course, almost any metal can be welded, including cast iron, bronze, aluminium and even titanium, although the latter requires a highly protected atmosphere because the metal is so reactive.

Whatever you're welding, remember: safety first. If you've ever seen welding in person, you can testify to the blinding brightness the process creates. Looking directly at a weld site without protection can produce what's known as arc eye, a painful inflammation of the cornea that feels like getting sand in your eye. No wonder that a good welder's mask is a prerequisite for any welding outfit.

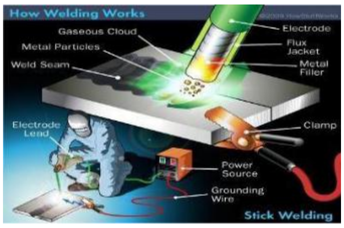

Fig1. welding process

THE PROCESS OF WELDING

Most welding done today falls into one of two categories: arc welding and torch welding.

Arc welding uses an electrical arc to melt the work materials as well as filler material (sometimes called the welding rod) for welding joints. Arc welding involves attaching a grounding wire to the welding material or other metal surface. Another wire known as an electrode lead is placed on the material to be welded. Once that lead is pulled away from the material, an electric arc is generated. It's a little like the sparks you see when pulling jumper cables off a car battery. The arc then melts the work pieces along with the filler material that helps to join the pieces.

Feeding the filler into the welding joint takes steady hands and an eye for detail. As the rod melts, the welder must continuously feed the filler into the joint using small, steady, back-and-forth motions. These motions are what gives welds their distinctive appearance. Going too fast or slow, or holding the arc too close or far away from the material can create poor welds.

Shielded metal arc welding (SMAW or stick welding), gas metal arc welding (more commonly known as metal inert gas, or MIG, welding) and gas tungsten arc welding (frequently called tungsten inert gas, or TIG, welding) all exemplify arc welding.

These three common methods each offer unique advantages and drawbacks. Stick welding, for instance, is inexpensive and easy to learn. It's also slower and less versatile than some other methods. Oppositely, TIG welding is difficult to learn and requires an elaborate welding rig. TIG welding produces high-quality welds, however, and can weld materials that other methods can't.

Torch welding represents another popular welding method. This process typically uses an oxyacetylene torch to melt the working material and welding rod. The welder controls the torch and rod simultaneously, giving him or her a lot of control over the weld. While torch welding has become less common industrially, it's still frequently used for maintenance and repair work, as well as in sculptures (more on that later).

II. LITERATURE REVIEW

Gas Metal Arc Welding (GMAW), sometimes referred to by its subtypes Metal Inert Gas (MIG) welding or Metal Active Gas (MAG) welding, is a semi-automatic or automatic 0020 Arc welding process in which a continuous and consumable wire electrode and a shielding gas are fed through a welding gun. A constant voltage, direct current power source is most commonly used with GMAW, but constant current systems, as well as alternating current, can be used. In this research work an attempt was made to develop a response surface model to predict tensile strength of inert gas metal arc welded AISI 1040 medium carbon steel joints. The process parameters such as welding voltage, current, wire speed and gas flow rate were studied. The experiments were conducted based on a four-factor, three-level, face centred composite design matrix. The empirical relationship can be used to predict the yield strength of inert gas metal arc welded AISI 1040 medium carbon steel. Response Surface Methodology (RSM) was applied to optimizing the MIG welding process parameters to attain the maximum yield strength of the joint.

III. PROBLEM DESCRIPTION

Objective of the work In this thesis, materials AISI 1050 Mild Steel are welded by varying process parameters welding speed, welding current and welding voltage. Effect of process current on the tensile strength of weld joint will be analysed.

EXPERIMENTAL PROCEDURE

In this thesis, experiments are made to understand the effect of MIG welding parameters welding speed, welding current and welding voltage on output parameters such as hardness of welding, tensile strength of welding.

MIG welding experimental images

MIG welding machine

Work pieces (AISI 1050 STEEL)

Dumbbell shape work pieces for tensile test

Work pieces' setup

Welding process

For the experiment, welding parameters selected are shown in table.

The welding current and electrodes considered are

PROCESS PARAMETERS	LE VEL1	LEVEL 2	LEVEL 3
WELDING CURRENT (AMP)	180	230	280
WELDING SPEED (m. m/s)	200	300	400
WELDING VOLTAGE (V)	22	24	26
PROCESS	LE	LEVEL	LEVEL
PARAMETERS	VEL1	2	3
WELDING	180	230	280
CURRENT			
(AMP)			
WELDING	200	300	400
SPEED (m. m/s)			
WELDING	22	24	26
VOLTAGE (V)			

PROCESS PARAMETERS	LE VEL1	LEVEL 2	LEVEL 3

WELDING CURRENT (AMP)	180	230	280
WELDING SPEED (m. m/s)	200	300	400
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IV. TENSILE TEST REPORTS


Hyderabad Engineering Labs
TENSILE TEST REPORT


Hyderabad Engineering Labs
TENSILE TEST REPORT

INTRODUCTION TO TAGUCHI TECHNIQUE

• Taguchi defines Quality Level of a product as the Total Loss incurred by society due to failure of a product to perform as desired when it deviates from the delivered target performance levels.

• This includes costs associated with poor performance, operating costs (which changes as a product ages) and any added expenses due to harmful side effects of the product in use.

Taguchi Methods

- Help companies to perform the Quality Fix!

- Quality problems are due to Noises in the product or process system

- Noise is any undesirable effect that increases variability

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- Conduct extensive Problem Analyses

- Employ Inter-Disciplinary Teams

- Perform Designed Experimental Analyses

- Evaluate Experiments using ANOVA and Signal-to noise techniques

TAGUCHI PARAMETER DESIGN FOR TURNING PROCESS

In order to identify the process parameters affecting the selected machine quality characteristics of turning, the following process parameters are selected for the present work: cutting speed (A), feed rate (B) and depth of cut (C). the selection of parameters of interest and their ranges is based on literature review and some preliminary experiments conducted.

Selection of Orthogonal Array

The process parameters and their values are given in table. It was also decided to study the two – factor interaction effects of process parameters on the selected characteristics while turning. These interactions were considered between cutting speed and feed rate (AXB), feed rate and depth of cut (BXC), cutting speed and depth of cut (AXC).

PROCESS PARAMETERS	LE VEL1	LEVEL 2	LEVEL 3
WELDING CURRENT (AMP)	180	230	280
WELDING SPEED (m. m/s)	200	300	400
WELDING VOLTAGE (V)	22	24	26

Using randomization technique, specimen was turned and cutting forces were measured with the three – dimensional dynamometer. The experimental data for the cutting forces have been reported in Tables. Feed and radial forces being 'lower the better' type of machining quality characteristics, the S/N ratio for this type of response was and is given below:

$$\text{S/N ratio} = -10 \log \left[\frac{1}{n} (y_1^2 + y_2^2 + \dots + y_n^2) \right] \qquad \dots (1)$$

Where y1,y2,…..,yn are the responses of the machining characteristics for each parameter at different levels.

TAGUCHI ORTHOGONAL ARRAY

WELDING CURRENT (AMP)	WELDING SPEED (m. m/s)	WELDING VOLTAGE (V)
180	200	22
180	300	24
180	400	26
WELDING CURRENT (AMP)	WELDING SPEED (m. m/s)	WELDING VOLTAGE (V)
180	200	22
180	300	24
180	400	26

OBSERVATION

The following are the observations made by running the experiments. The ultimate tensile strength observed.

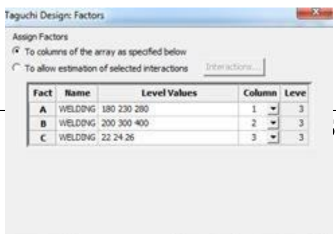
UTS (MPa)
375
410
451.917
403
440.581
372
375.287
369
378

OPTIMIZATION OF ULTIMATE TENSILE STRENGTH USING MINITAB SOFTWARE

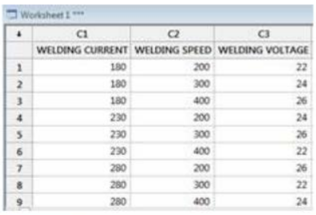
Design of Orthogonal Array

First Taguchi Orthogonal Array is designed in Minitab17 to calculate S/N ratio and Means which steps is given below:

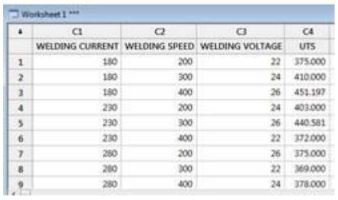
FACTORS



OPTIMIZATION OF PARAMETERS

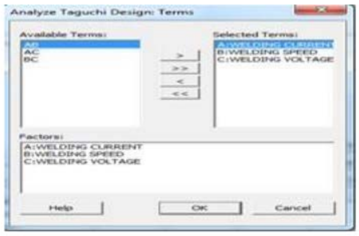


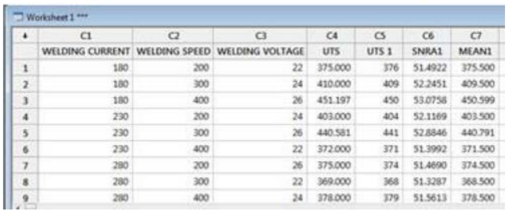
	C1 WELDING CURRENT	C2 WELDING SPEED	C3 WELDING VOLTAGE
1	180	200	22
2	180	300	24
3	180	400	26
4	230	200	24
5	230	300	26
6	230	400	22
7	280	200	26
8	280	300	22
9	280	400	24



	C1 WELDING CURRENT	C2 WELDING SPEED	C3 WELDING VOLTAGE	C4 UTS
1	180	200	22	375.000
2	180	300	24	410.000
3	180	400	26	451.197
4	230	200	24	403.000
5	230	300	26	440.581
6	230	400	22	372.000
7	280	200	26	375.000
8	280	300	22	369.000
9	280	400	24	378.000

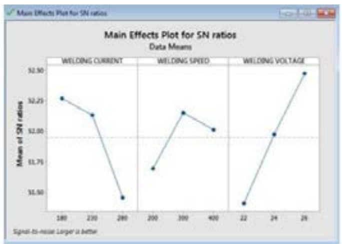
Terms

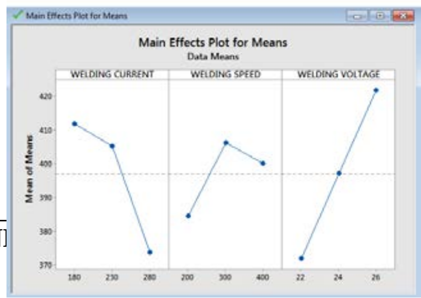




	C1 WELDING CURRENT	C2 WELDING SPEED	C3 WELDING VOLTAGE	C4 UTS	C5 UTS 1	C6 SNRA1	C7 MEAN1
1	180	200	22	375.000	376	51.4922	375.500
2	180	300	24	410.000	409	52.2451	409.500
3	180	400	26	451.197	450	53.0758	450.599
4	230	200	24	403.000	404	52.1169	403.500
5	230	300	26	440.581	441	52.8846	440.791
6	230	400	22	372.000	371	51.3992	371.500
7	280	200	26	375.000	374	51.4690	374.500
8	280	300	22	369.000	368	51.3287	368.500
9	280	400	24	378.000	379	51.5613	378.500

S/N ratio plot





V. RESULTS

Taguchi method stresses the importance of studying the response variation using the signal–to–noise (S/N) ratio, resulting in minimization of

quality characteristic variation due to uncontrollable parameter. The cutting force is considered as the quality characteristic with the concept of "the larger-the-better". The S/N ratio for the larger-the-better is:

S/N = -10 *log(Σ(Y2)/n))

Where n is the number of measurements in a trial/row, in this case, n=1 and y is the measured value in a run/row. The S/N ratio values are calculated by taking into consideration above Eqn. with the help of software Minitab 17.

The force values measured from the experiments and their corresponding S/N ratio values are listed in Table

Worksheet 1 ***

↓	C1	C2	C3	C4	C5	C6	C7
	WELDING CURRENT	WELDING SPEED	WELDING VOLTAGE	UTS	UTS 1	SNRA1	MEAN1
1	180	200	22	375.000	376	51.4922	375.500
2	180	300	24	410.000	409	52.2451	409.500
3	180	400	26	451.197	450	53.0758	450.599
4	230	200	24	403.000	404	52.1169	403.500
5	230	300	26	440.581	441	52.8846	440.791
6	230	400	22	372.000	371	51.3992	371.500
7	280	200	26	375.000	374	51.4690	374.500
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9	280	400	24	378.000	379	51.5613	378.500

VI. CONCLUSION

The experiment designed by Taguchi method fulfils the desired objective. Fuzzy interference system has been used to find out the ultimate tensile strength. The all possible values of have been calculated by using MINITAB 17.0 software. Analysis of variance (ANOVA) helps to find out the significance level of each parameter. The optimum value was predicted using MINITAB-17 software.

The welding parameters are Welding current, welding voltage and welding speed for MIG welding of work piece AISI1050 steel. In this work, the optimal parameters of welding speed are 200m.m/s, 300 m.m/s & 400 m.m/s, welding current are 180, 230 &280 amps, and welding voltage are 22, 24 &26 volts. Experimental work is conducted by considering the above parameters. Ultimate tensile strength validated experimentally.

The experimental results confirmed the validity of the used Taguchi method for enhancing the welding performance and optimizing the welding parameters in MIG welding at welding speed 400 m.m/s, welding voltage 26 volts and welding current 180 amps

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