EXPERIMENTAL INVESTIGATION FOR EFFECT OF VIBRATION ON MECHANICAL PROPERTIES OF DSS 2205 DURING TIG WELDING

Tailor Krunal J[1], Gourav Purohit[2], Vivek Mishra[3]

[1]M.Tech Student, Aravali Institute of Technical Studies, Udaipur, Rajasthan, India
[2]Assistant Professor, Mechanical Engineering Dept., Aravali Institute of Technical Studies, Udaipur, Rajasthan
[3]Assistant Professor, Mechanical Engineering Dept., Laxmi Institute of Technology, Gujarat, India

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Abstract - *This research provides the information about the problem of tensile strength reduction of DSS due to welding. To overcome this problem different vibratory stress relief techniques are used. We have used mechanical vibration technique that uses low frequency vibrations to relieve residual stresses in weldment. The optimization of TIG of DSS 2205 using taguchi method has been done. Nine experimental runs (L9) based on orthogonal array taguchi method was performed. The welding parameters to be varied are Welding current, Torch tilt angle and Motor speed. As a response Tensile strength & Hardness are being investigated. As a result, this research provided the best combination of welding parameters to produce mechanically defect free and sounds welds.*

Key Words: TIG welding, DSS 2205, Taguchi Method, UTS, Hardness, Vibration, ANOVA.

1. INTRODUCTION

Welding is a process for joining two similar or dissimilar metals by fusion, with or without the application of pressure and with or without the use of filler metal. The process, in which an electric arc between an electrode and a work piece or between two electrodes is utilized to weld base metals, is called an arc welding process.

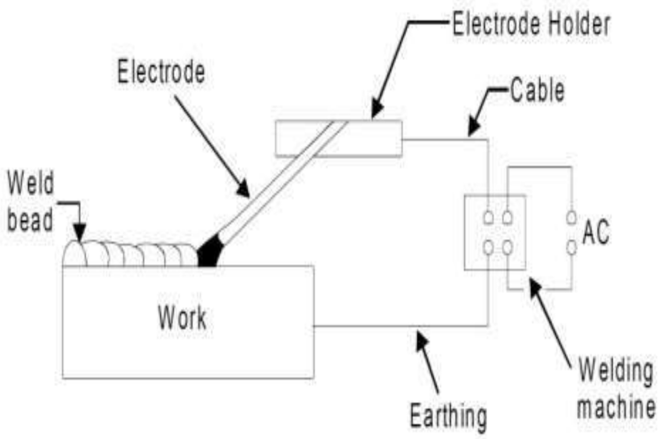

Fig -1: Principle of Arc Welding

Any arc welding method is based on an electric circuit consisting of the following parts:

I. Power supply (AC or DC);

II. Welding electrode;

III. Work piece;

IV.Welding leads (electric cables) connecting the electrode and work piece to the power supply.

1.1 Weldment properties

1.1.1 Ferritic stainless steels

Weldment properties are strongly affected by welding parameters. It is recommended that ferritic grades be welded using minimum heat input to prevent excess grain growth in the heat-affected zone (HAZ). Moist electrodes and shielding gases that contain hydrogen or nitrogen should be avoided. Due to their lower thermal expansion and higher thermal conductivity, distortion and buckling during welding is lower for ferritic stainless steels compared to austenitic or duplex grades.

1.1.2 Duplex stainless steels

The weld ability and welding characteristics of duplex stainless steels are better than those of ferritic stainless steels, but generally not as good as those of austenitic steels. Modern duplex steels with significant nitrogen content are readily weld able. Weldment properties are strongly affected by welding parameters such as the heat input range, so appropriate procedures should be followed to obtain a correct weldment structure.

Duplex stainless steels commonly solidify with a fully ferritic structure, with austenite nucleation and growth during cooling. Filler metals are specially designed with higher nickel content to produce a phase balance similar to that of the base material.

1.2 Objectives of Present Work

1. To understand the phenomenon of vibration in TIG welding.
2. To select an appropriate parent material, electrode and filler wire.
3. To evaluate the effect of different welding parameters on weld quality and strength.

2. RESEARCH METHODOLOGY

In our experimental procedure Thoriated Tungsten (TIG) Electrode has been selected as an electrode as its best suits its physical properties and ER2209 has been selected as an electrode wire as it is beneficial in overcome ferritic

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content. This wire is lower in ferrite compared to that of base metal in order to obtain improved weld ability.

2.1 Experimental Set-up

A vibration table (0.5m × 0.5m × 0.75m) capable of producing amplitude less than 1 mm with 50 Hz frequency will be used with the help of vibration motor attached below it. The base plate thickness is 5 mm.

The vibrating table shall be capable of being operated either through an eccentric rotor driven by a prime mover, such as electric motor, internal combustion engine, pneumatic power, or directly by electromagnetic pulsators.

Fig -2: Experimental Setup

A Vibration table has a vibratory motor attached below it is joined with Variac which is helpful in changing input Voltage of the motor. A multimeter is coupled with variac so that exact voltage input to the motor can be seen digitally and accurately. With the help of variac, Motor voltage is adjusted and RPM has been measured by tachometer. Different experiment has been performed by changing motor RPM, Torch tilt angle and Welding current.

2.2 Experimental Work

A set of 9 test-pieces as per TAGUCHI L9 orthogonal array has been welded.

Fig -3: Welded Specimen

Welding of all the base plate using different tools tensile test specimens where made using ASME section IX. Preparation of tensile test specimen and testing of the same was conducted.

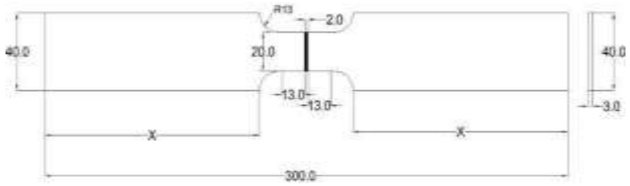

Fig -4: Tensile Test Specimen

2.3 Experimental Parameter

In this project, mainly three parameters are taken into three different levels to study. The three parameters are as follows:

1. Welding Current
2. Torch Tilt Angle
3. Vibration Motor Speed

The above process parameters and their levels are as per the following table:

Table -1: Process Parameter and Levels

FACTOR DES.	FACTORS	LEVEL 1	LEVEL 2	LEVEL 3
A	Weld Current (A)	80	90	100
B	Torch tilt angle (°)	60	75	90
C	Motor speed(RPM)	1400	1450	1500

2.3 Experimental Responses

The following responses will be studied after the welding is performed:

1) Ultimate Tensile Strength (UTS)

2) Hardness

3. RESULT AND DISCUSSION

Based on the values of various input variables, the responses have been recorded. Tensile test and Hardness test has been carried out and results are plotted in MINITAB.

Based on the Taguchi L-9 Orthogonal Array, for 3 different factors and 3 levels, 9 experimental runs were carried out and the responses i.e. ultimate tensile strength and hardness has been tested. The result from tensile testing and Vickers hardness test has been shown in table 2.

Also a single run without vibration has been carried out to compare the Tensile strength and hardness with and without vibration condition.

Table -2: Experimental runs and their Responses

	INPUT PARAMETERS			RESPONSES	
Sr. no	Welding current (A)	Torch Tilt Angle (°)	Motor speed (RPM)	UTS (MPa)	Hardness (HV)
1	80	60	1400	804	237
2	80	75	1450	843	238
3	80	90	1500	855	240
4	90	60	1450	646	241
5	90	75	1500	780	243
6	90	90	1400	570	244
7	100	60	1500	783	242
8	100	75	1400	655	244
9	100	90	1450	670	247

Table -3: Experimental run without Vibration

10	90	90	0	704	238

3.1 Tensile Test and UTS Measurement

Tensile testing, also known as tension testing, is a fundamental materials science test in which a specimen is subjected to a controlled tension load until Failure. The results from the tensile test are commonly Used to select a material for a various application, for better Quality control, and to predict how a material will react under various types of forces. Joint Properties that are directly measured via a tensile test are Ultimate tensile strength, maximum elongation of joint and reduction in area. From these testing measurements the following properties can also be determined: Young's modulus, Poisson's ratio, yield strength, and strain-hardening characteristics of welding material.

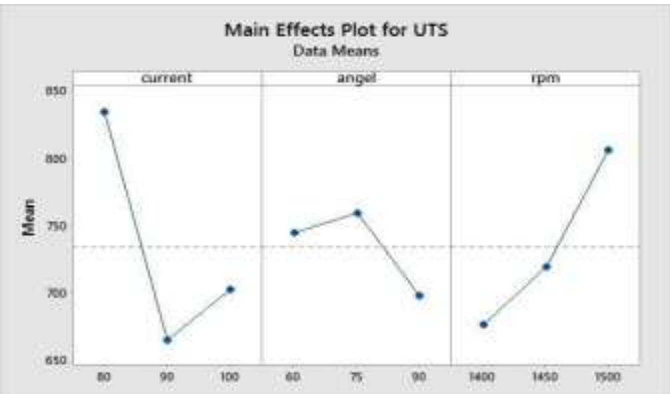

Fig -5: Mean Effects Plot for UTS

The values of UTS are in N/mm2 or MPa.

3.2 Hardness Test and Measurement

Vickers Hardness Test

The Vickers scale is a hardness scale based on indentation hardness of a material. The Vickers hardness test determines the hardness by measuring the depth of penetration of welding an indenter under a large load compared to the penetration Made by a preload. The Vickers hardness test method consists of indenting the test material with a diamond in denter, in the form of a right pyramid with a square base and an angle of 136 degrees between opposite faces subjected to a load of 1 to 100 kgf. The full load is normally applied for 10 to15 seconds.

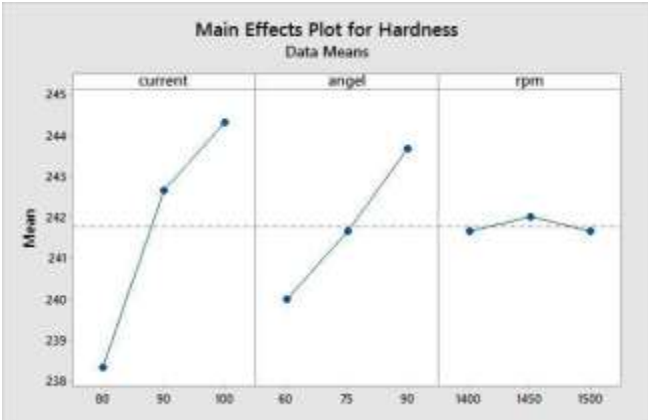

Fig -6: Mean Effects Plot for Hardness

The result is a dimensionless Number. Hardness value is measuring at welding area during experiment.

The results shows that the Hardness of the welded area increases slightly as the welding current increases, while other welding parameters has not much effect on it.

4. CONCLUSIONS

The following Conclusions are arrived at from the above investigations:

1. The auxiliary vibrations induced into the weld pool resulted in increased hardness and the yield the welded joint which indicates the orientation of the crystal and refinement of grains took place.

2. RPM of vibration motor is varied during the welding so that weld pool could be mechanically stirred in order to induce favorable micro structural effects.

3. The tensile strength of the weld with vibration was larger than that without vibration. Especially, the tensile strength was remarkably increased when the combination of certain parameters takes place.

4. Here largest value of tensile strength is 855 Mpa of tensile strength with lowest current (80 A) Maximum torch tilt angle (90°) and maximum RPM of vibration motor (1500 RPM).

5. FUTURE SCOPE OF WORK

1. Experiment can be carried out with purging so that the common defects found in steel can be reduced.

2. Different vibration setups can be designed to produce better effects on weldments. A change in vibration setup can be made in structure so that it can be used in steel structures in real conditions.

3. Experiment can be carried out with different base material thickness and different Filler metal. So that the best fit filler material can be determined.

4. Different welding methods like Arc, MIG, SAW can also be analysed with this principle.

5. Other emerging Duplex grade and Super Duplex grade steels can be used in experimentation.

6. Since this material used in pipes, welding of pipe joints can be analysed.

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BIOGRAPHIES

Krunal J. Tailor[1]
M.Tech Scholar
Mechanical Engineering Dept.
Aravali Institute of Technical Studies, Udaipur, Rajasthan

Gourav Purohit[2]
Assistant Professor,
Mechanical Engineering Dept.
Aravali Institute of Technical Studies, Udaipur, Rajasthan