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Optimization of Weld Quality of SS410 in TIG Welding

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Abstract:- **Research work deals with the identification of the best combination of the welding process for SS410 metal by using TIG welding. Welding voltage, gas flow rate and strike off distance were selected to ascertain with effect on the metal hardness of the welding bed. NDT technique is used to detect the defect of the welding bed. SS410 have gathered wide acceptance in the fabrication of the lightweight structures requiring a high strength to weight ratio and good corrosion resistance. Modern structures concepts demand reduction in the weight as well as the cost of the production and fabrication of the materials.410 SS joints are inevitable for certain applications due to unique performances such as corrosion resistance and mechanical properties. TIG welding is the most conventional method used due to material and energy saving. An attempt was made in this study to improve the hardness and tensile strength by tungsten inert gas welding of 410 SS. Optimum parameters were obtained using a statistical approach. Impact and hardness tests were applied to the joints. This present work deals with a novel approach for the optimization of welding parameters on SS410 welded joints with multiple responses based on the orthogonal array by grey relational analysis. Experiments are conducted by varying the welding parameters in Tungsten inert gas welding. In this study, welding parameters namely voltage, gas flow rate and strike off distances are optimized with the considerations of multi responses such as impact strength and hardness. A grey relational grade is obtained from the grey analysis. Based on the grey relational grade, optimum levels of parameters have been identified. The ultrasonic testing helped to detect the defects in the welded segment for further acceptance. Experimental results have shown that the responses in welding process can be improved effectively through this novel approach.**

1. INTRODUCTION

Welding is a permanent joining process used to join different materials like metals, alloys or plastics, together at their contacting surfaces by application of heat and or pressure. During welding, the work-pieces to be joined are melted at the interface and after solidification a permanent joint can be achieved. Sometimes a filler material is added to form a weld pool of molten material which after solidification gives a strong bond between the materials. Weld ability of a material depends on different factors like the metallurgical changes that occur during welding, changes in hardness in weld zone due to rapid solidification, extent of oxidation due to reaction of materials with atmospheric oxygen and tendency of crack formation in the joint position. TIG welding is an arc welding process that uses a non-consumable tungsten electrode to produce the weld. The weld area is protected from atmosphere by an inert shielding gas (argon or helium), and a filler metal is normally used. The power is supplied from the power source (rectifier), through a hand-piece or welding torch and is delivered to a tungsten electrode which is fitted into the hand piece. An electric arc is then created between the tungsten electrode and the work piece using a constant-current welding power supply that produces energy and conducted across the arc through a column of highly ionized gas and metal vapour. The tungsten electrode and the welding zone are protected from the surrounding air by inert gas. The electric arc can produce temperatures of up to 20,000oC and this heat can be focused to melt and join two different part of material. The weld pool can be used to join the base metal with or without filler material. The power source required to maintain the TIG arc has a drooping or constant current characteristic which provides an essentially constant current output when the arc length is varied over several millimetres. Hence, the natural variations in the arc length which occur in manual welding have little effect on welding current. The capacity to limit the current to the set value is equally crucial when the electrode is short circuited to the work piece, otherwise excessively high current will flow, damaging the electrode. Open circuit voltage of power source ranges from 60 to 80 V.

2. MATERIAL

SS 410 is the basic martensitic stainless steel; like most non-stainless steels it can be hardened by a "quench-and-temper" heat treatment. It contains a minimum of 11.5 per cent chromium, just sufficient to give corrosion resistance properties. It achieves maximum corrosion resistance when it

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has been hardened and tempered and then polished. Grade 410 is a general purpose grade often supplied in the hardened, but still machinable condition, for applications where high strength and moderate heat and corrosion resistance are required. Martensitic stainless steels are optimized for high hardness, and other properties are to some degree compromised. Fabrication must be by methods that allow for poor weld ability and usually the need for a final heat treatment. Corrosion resistance of the martensitic grades is lower than that of the common austenitic grades, and their useful operating temperature range is limited by their loss of ductility at sub-zero temperatures and loss of strength by over-tempering at elevated temperatures.

3. EXPERIMENTATION

A well planned set of experiments, in which all parameters of interest are varied over a specified range, is a much better approach to obtain systematic data. Mathematically speaking, such a complete set of experiments ought to give desired results. Usually the number of experiments and resources (materials and time) required are prohibitively large. Often the experimenter decides to perform a subset of the complete set of experiments to save on time and money! However, it does not easily lend itself to understanding of science behind the phenomenon. The analysis is not very easy (though it may be easy for the mathematician/statistician) and thus effects of various parameters on the observed data are not readily apparent. In many cases, particularly those in which some optimization is required, the method does not point to the best settings of parameter.

Fig.3.1 Tig welding machine

Table3.1. Experimental parameters

TRIAL NO.	VOLTAGE (V)	GAS FLOW RATE (Lit/min)	STRIKE OFF DISTANCE(mm)
1	25	4	1
2	25	6	1.5
3	25	8	2
4	30	4	1.5
5	30	6	2
6	30	8	1
7	35	4	2
8	35	6	1
9	35	8	1.5

Fig .3.2. Welded specimen

4 .TESTING AND RESULT

4.1.Hardness test result

Hardness systems use a direct readout machine determining the hardness number based upon the depth of penetration of either a diamond point or a steel ball. Deep penetration indicated a material having a low Rockwell Hardness number. However, a low penetration indicates a material having a high Rockwell Hardness number. The Rockwell Hardness number is based upon the difference in the depth to which a penetrator is driven by a definite light or "minor" load and a definite heavy or "Major" load. The ball penetrators are chucks that are made to hold 1/16" or 1/8" diameter hardened steel balls. Also available are ¼" and ½" ball penetrators for the testing of softer materials. There are two types of anvils that are used on the Rockwell hardness testers. The flat faceplate models are used for flat specimens. The "V" type anvils hold round specimens firmly. Test blocks or calibration blocks are flat steel or brass blocks, which have been tested and marked with the scale and Rockwell number. They should be used to check the accuracy and calibration of the tester frequently.

TRIAL NO.	VOLTAGE (V)	GAS FLOW RATE (Lit/min)	Stable.TRIKE OFF DISTANCE	HARDNESS (HRC)
1	25	4	1	26
2	25	6	1.5	28
3	25	8	2	28
4	30	4	1.5	32
5	30	6	2	32
6	30	8	1	36
7	35	4	2	38
8	35	6	1	36
9	35	8	1.5	38

Table . 4.1.Hardness result

Fig.3. Test specimen

4.2.Impact Result

Impact tests are used in studying the toughness of material. A material's toughness is a factor of its ability to absorb energy during plastic deformation. Brittle materials have low toughness as a result of the small amount of plastic deformation that they can endure. The impact value of a material can also change with temperature. Generally, at lower temperatures, the impact energy of a material is decreased. The size of the specimen may also affect the value of the Izod impact test because it may allow a different number of imperfections in the material, which can act as stress risers and lower the impact energy. In our experiment charpy impact test is performed to determine the impact strength.

TRIAL NO.	VOLTAGE (V)	GAS FLOW RATE (Lit/min)	Stable.TRIKE OFF DISTANCE	IMPACT(J)	HARDNESS (HRC)
1	25	4	1	38	26
2	25	6	1.5	62	28
3	25	8	2	36	28
4	30	4	1.5	140	32
5	30	6	2	86	32
6	30	8	1	82	36
7	35	4	2	72	38
8	35	6	1	120	36
9	35	8	1.5	126	38

Table. 4.1. Impact result

4.3. Ultrasonic testing

Concrete Ultrasonic inspection is a nondestructive method in which beams of high frequency sound waves are introduced into materials for the detection of subsurface flaws in the material. The sound waves travel through the material with some attendant loss of energy and are reflected at interfaces (cracks or flaws). The reflected beam is displayed and then analyzed to define the presence and location of flaws or discontinuities. Ultrasonic testing is used to find out the size and location of the defects. The most commonly used ultrasonic testing technique is pulse echo, wherein sound is introduced into a test object and reflections are returned to a receiver from internal imperfections or from the parts geometrical surfaces.

Fig.4.3..Ultrasonic Test

CONCLUSION

This study investigated mechanical characteristics under various process parameter such as voltage, gas flow rate, Strike off distance. The main effects plot for means is found for various welding performance. The best multi performance characteristics was obtained in tungsten inert gas welding for SS410 when voltage is 35V, gas flow rate is 8 L/min and strike off distance is 1.5 mm from main effects plot for means.

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The ANOVA of grey relation grade for multi performance characteristics reveals that voltage is the most significant parameter. The regression equation can be applied to predict better results for impact strength and hardness. The ultrasonic testing at this parameters showed more penetration which can be accepted for good quality weld. The main effect plots gives a better understanding of the effect of parameters namely voltage, gas flow rate and strike off distance on the dependent parameters namely impact strength and hardness. The main effect plot for grey relation grade gives the combined effect of dependent parameters on hardness and impact strength.

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