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Experimental Investigation of Mig Welding Using SS 304 & SS 410

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Abstract: *The much more important factors influencing the efficiency, effectiveness, and MIG welding costs are the requirements for MIG welding. Welding current, welding voltage, gas flow rate, wire feed rate, and so on are some of the welding parameters. They have an effect on the weld power and weld pool geometry of steel while welding. The optimized parameters and the best parameter combinations for the desired quality can be found using the DOE process. After the GMAW method, the results were analyzed and calculated in terms of penetration, tensile strength, and hardness value for all specimens. According to the findings, a rising welding current has an effect on the depth of penetration value. From the Taguchi optimization, the optimal parametric setting has been obtained as 150 AMPS VOLT-22 Gas pressures 5 and majorly tensile strength influenced with Gas pressure is 47%. During the tensile test, weld joints are fracture occurred at parent material. Test plates were analyzed through the non-destructive method. During the NDT, mild porosity was found on test plate -2, but it also within the limit.*

I. INTRODUCTION

Welding is the operation of connecting two materials by adding intense heat, friction, and (or) fillers. Welding processes have developed to fit every industrial need imaginable. The two popular forms of welding are arc welding and gas arc welding.

1.1 MIG welding

Advantage Fabricated Metals uses a variety of welding techniques. TIG, which has the abbreviation of Tungsten Inert Gas welding, and MIG, which stands for Metal Inert Gas welding, are the two most popular welding methods we use.

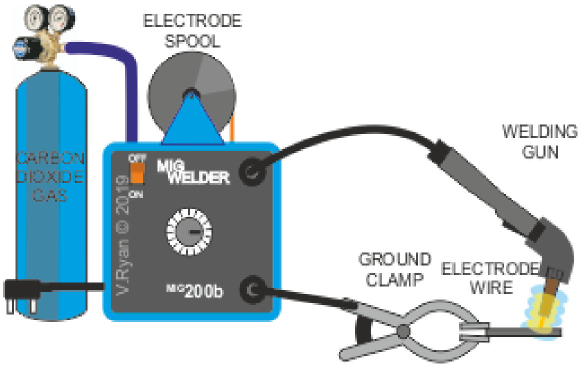

Fig 1. MIG welding

A standard MIG welding method is depicted in the diagram below, which shows an arc created among the wire electrode and workpiece. The electrode melted within the arc during MIG welding and is stored as filler material. The shielding gas prevents the weld while solidification by avoiding atmospheric pollution. The shielding gas also serves to maintain the arc, allowing the metal to flow seamlessly from the welding wire to the molten weld tank.

MIG is used to connect a number of components and, according to the material to be attached, the gases used to form arc vary. To weld mild steel, aluminum, titanium, and alloy metals, an argon CO2 mix is usually used. Helium is used to weld copper and stainless steel, as well as mild steel and titanium, in a high-speed operation. Welding carbon and low alloy steel are often achieved using carbon dioxide. Other metals typically welded with the MIG process include magnesium and cast iron.

II. LITERATURE SURVEY

Izzatul Aini Ibrahim1, [1] et al. was investigated The GMAW technique is at the forefront, the way in arc welding process production, with higher efficiency and better quality., had been investigated The GMAW process is at the forefront of arc welding technology advancement, offering higher efficiency and consistency. D.S. Yawas,[2] et al. A 0.5 M hydrochloric acid and corrosive media for wet steam were examined to assess fatigue behavior in soldered austenitic stainless steel. The welding thermotherapy has been discovered to improve the mechanical characteristics, in particular tensile strength, of austenitic stainless steel while reducing the samples' transformation and thermal stress. These findings have been validated the microstructure assessment of the stainless steel specimen. M.N. Chougule [3] et al. was done by designing the arc and controlling the parameters input phase, the metal from the wire rod is controlled by GMAW soldering. High heating in one place, accompanied by rapid cooling during soldering, creates residual stress and distortion in welding and base metal. Various research activities have been oriented over the last few decades toward the regulation of welding process parameters with the intention of reducing stress and distortion residual, which are highly influenced by multiple parameters such as structural, material, and welding parameters. LI YAJIANG [4] et al. Residual stress distribution was evaluated experimentally in the high force steel grade HQ130 weld joint using the program ANSYS, with the help of finite element process (FEM). Soldering was undertaken using a 16 kJ/cm gas-screened arc welding. The weld joint analysis by FEM shows a stress gradient across the weld joint convergence region. Q.Wang[5] et al. The composition, microstructure, traction characteristics, and Ni-base Superalloy Fracturing of welded joints were investigated for their effects by gas tungsten arch welding Arch welding parameters. Results show that increased welding current and reduced welding speed lead to a significant amount of heat input into the welding pool as well as an improvement in welding pool's width and depth.

III. PROBLEM IDENTIFICATION

The joining of these two stainless sheets of steel is difficult with the conventional welding process because of the High input of heat from these Welding processes. The high input causes metallurgical changes near the Weld zone (HAZ), which deteriorates the mechanical proprieties. As a consequence, Electron Beam Welding is used to join these two metals together. The Electron Beam Welding Method, like other Welding Techniques, has parameters that affect weld performance. Thus, the main problem to obtain a suitable combination of parameters that will give sound welds. Obtaining appropriate depth of penetration is the main reformat from Electron Beam welding. It is time-consuming as well as wastage of material to do trial welds with different parameters for obtaining a required depth of penetration. The whole process can be made efficient by developing a method to obtain the required depth of penetration with a simple set of parameters rather than for multiple welds.

OBJECTIVE:

In this work, first, a detailed study of MIG Welding and process parameters is made. Then problems in welding of Austenitic stainless steel with ferritic stainless stool using conventional Welding process are analyzed. Then, using a conventional welding technique, problems in welding Austenitic stainless steel with ferritic stainless steel are investigated.

IV. MATERIAL DETAILS

A. SS304 STEEL

Grade 304 is the most common martensitic stainless steel; It could be hardened with a "quench and temper" thermal process, like most non-stainless steels. It includes at least 11.5 percent chromium, which is just enough to have corrosion resistance. Since hardening, tempering, and polishing, the corrosion resistance is maximized. Grade 304 is a grade that is often given with hardening but machinable for high strength, moderate thermal, and corrosion resistance applications.

Table 1. Chemical Properties of SS304 Steel

Material	C%	M%	Si%	Cr%	Ni	S%	P%	N%
SS 304	0.08	2	0.75	18	10.5	0.030	0.045	0.10

B. SS410 STEEL

SS 410 is stainless steel that can be heat-treated and is martensitic in nature. To develop a surface almost free of defects, the fusion practice is regulated. It is used in challenging medical accessories because it has the greatest balance of wear resistance and corrosion resistance.

Table 2. Chemical Properties of SS410 Steel

C	Mn	Si	S	P	Cr	S	Mo	N
0.15	1	1	1	0.04	13.5	0.030	-	-

Any observable object whose value represents a condition of a physical structure is referred to as a physical property. Changes in a system's physical properties may be used to characterize the transitions between momentary states. Observables are physical features that can be measured. They aren't modal in any way.

Table 3. Physical Properties of Steel

S.NO	PROPERTIES	VALUE
1.	Ultimate Tensile strength (Mpa)	517
2.	Yield Stress (Mpa)	265
3.	Elongation (%)	30
4.	Density (Kg/m^3)	7.7
5.	Poisson's ratio	0.27-0.30

V. EXPERIMENTAL DESIGN

A. TAGUCHI Method

Essentially, initial fisher developed experimental design techniques. However, experimental design approaches are overly complicated and difficult to apply. In addition, many trials must be conducted with the increasing number of method characteristics. To address this issue, the Taguchi approach employs a unique arrangement of orthogonal arrays to analyze the whole Space with the parameter limited number of tests. In order to measure output features that deviate from the objective values, the experimental results then are translated into a signal-to-notch (S/N) relationship.

Table 4. L_4 Array formation

AMPS	VOLTS	GAS PRESSURE
150	18	4
150	22	5
170	18	5
170	22	4

B. HARDNESS TEST (ROCKWELL)

Rockwell Hardness devices using a machine for direct read-out to calculate the hardness number depending on the degree of diamond or steel ball penetration. Deep penetration suggested the inclusion of a substance with a low Rockwell Hardness number. A low penetration, but on the other hand, means a substance with a huge Rockwell Hardness number. The Rockwell Hardness values are dependent on the depth at penetrator is powered by a definite light or "minor" load versus a definite heavy or "major" load.

Table 5. Hardness Value-HRB Value-After Weld

SAMPLES	S1	S2	S3	S4
SS304	64			
	65	62	64	65
SS410	70			
	76	72	76	77

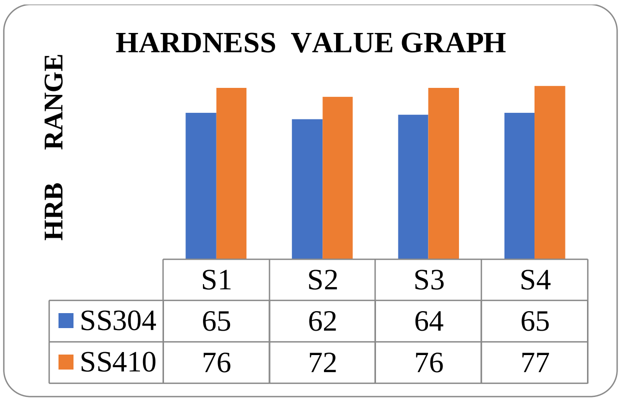

Fig 2. Compression graph hardness SS304 & SS410

C. TENSILE TEST

The mechanical characteristics of the friction-processed joints are evaluated through tensile testing. A tensile test helps assess the tensile characteristics such as tensile strength, performance strength, elongation percentage, and elasticity modulus, and area reduction percent.

Table 6. Taguchi Analysis Result-SN Ratio

TEST PLATE NO	THICK mm	WIDTH mm	CSA mm^2	TENSILE LOAD KN	TENSILE STRENGTH N/mm^2
1	3.00	11.78	35.34	18.21	515.28
2	3.00	10.98	32.94	17.58	533.70
3	3.00	11.57	34.71	18.12	522.04
4	3.00	11.62	34.86	17.16	509.47

Table 7. S-N Ratio for Tensile strength

TEST PLATE NO	AMPS	VOLTS	GAS PRESSURE	TENSILE LOAD KN	TENSILE STRENGTH N/mm^2	SNRA1
1	150	18	4	18.21	515.28	54.2409
2	150	22	5	17.58	533.70	54.5459
3	170	18	5	18.12	522.04	54.3541
4	170	22	4	17.16	509.47	54.1424

VI. DEPTH OF PNETRATION

Adaptive measurements of the welded bead, such as a small penetration depth, may lead to a solder system failure, as penetration determines a sold joint's stress-bearing strength. In order to prevent these cases, the variables input or welding process that impacts the penetration of a welding bead must be properly selected and calibrated to ensure proper penetration of a sold bead and, therefore, high-quality joint. Researchers have used a variety of techniques to forecast the impact of Variables of weld methods for the geometry of weld beads and thus efficiency.

Table 8. Various Sizes of Bead Width, Depth of Penetration and Heat Affected Zone-SS410 & SS304 GMAW

SAMPLES	AREA	MEAN	MIN	MAX	ANGLE	LENGTH
1	0.194	63.826	36.148	108.395	0	5.587
	0.061	89.778	41.667	113.667	90	1.759
2	0.25	72.857	30	114.667	0	6.24
	0.043	53.284	34	73.333	90	1.801
3	0.243	68.324	47.333	94.667	0	7.3
	0.06	66.543	36	80.333	90	1.8
4	0.283	106.14	91	114.333	0	7.929
	0.065	92.582	69.667	109.333	90	1.821

VII. NON-DESTRUCTIVE TESTING

A. Nondestructive Testing

The aim of non-destructive research and testing is to acquire information about materials or systems, whether physically, chemical, mechanically, or metallurgical. NDT methods vary from basic to complex. The most basic is the visual inspection. Opposed surface defects in the naked eye may be exposed through penetration or magnetic techniques. If significant Surface deficiencies are detected, there is always no point in progressing to a more complex analysis of the interior using techniques such as ultrasonic or radiography.

Table 9. Penetrant Test Report

PLATE NO	CURRENT	VOLT	GAS PRESSURE	INDICATIONS	RESULT
T/P 1	150	18	4	NI	Accept
T/P 2	150	22	5	Por	Accept
T/P 3	170	18	5	NI	Accept
T/P 4	170	22	4	NI	Accept

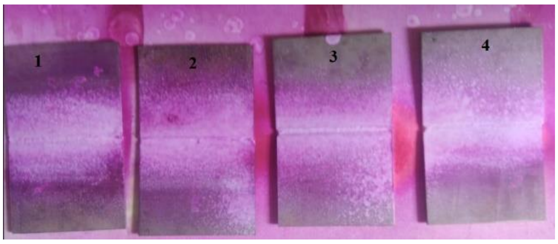

Fig 3. Penetrant test plates

VIII. RESULT AND CONCLUSION

From the investigation, the mechanical property of GMAW butt welding of SS304 & SS410 steel welding conclusions were summarized as following the tensile strength value. GMAW process plate was a comparatively satisfied value obtained at 2nd sample (150 AMPS VOLT-22 Gas pressures 5) than another test plate. It also induces high impact strength. According to Taguchi design, optimal control factor obtained A2-150 AMPS, B3VOLT-22, C1-Gas pressures 4. Through this parameter, we can achieve a maximum tensile strength of dissimilar grades. Bead geometry analysis investigated through IMAGE J software almost all the test plates were found equal depth of penetration. During the tensile test, weld joints are fracture occurred at parent material. During the NDT, mild porosity was found on test plate -2, but it also within the limit.

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