

Optimization of Welding Parameters of Submerged Arc Welding Process Using Taguchi Method

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Abstract— Submerged Arc Welding is one of the predominant welding tactics in enterprise due to its inherent advantages, inclusive of deep penetration and a easy bead. Lots of vital units of enter parameters are worried in Submerged Arc Welding Process which desires to be managed to get the desired weld bead first-class. The studies on controlling metallic switch modes in SAW technique is critical to excessive first-class welding procedures. Quality has now turn out to be an critical difficulty in today’s production world. Experiments are carried out the usage of submerged arc technique parameters viz. welding current, arc voltage and welding speed (Trolley speed) on slight steel(IS2062) of 6 mm thickness, to have a look at the impact of those parameters on welding strength. The experiments are designed the usage of Taguchi method (with Taguchi L9 orthogonal array) thinking about 3 elements and 3 levels.

Index Terms: Welding Parameters, Submerged Arc Welding, Taguchi Method, regression analysis.

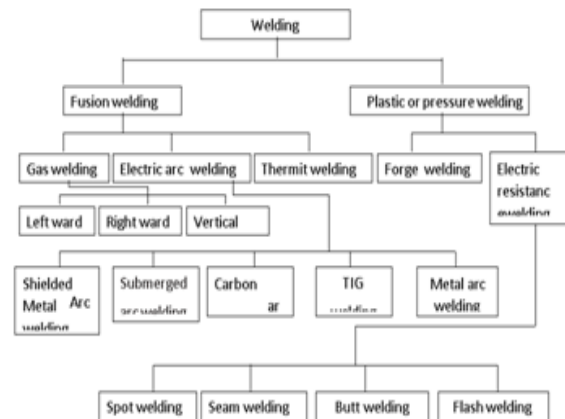
1. INTRODUCTION

The maximum extensively used welding techniques in industries and studies agencies are guard metallic arc welding (SMAW), fueloline metallic arc welding (GMAW), fueloline tungsten arc welding (GTAW) and submerged arc welding (SAW). The SAW manner is regularly favored as it gives excessive manufacturing rate, excessive melting efficiency, ease of automation and occasional operator ability requirement. It turned into first utilized in industries with inside the mid 1930’s as a single-cord welding gadget. It turned into similarly evolved into two-cord or 3 cord gadgets due to excessive productiveness necessities after the Second World War. Recently, five-cord SAW gadget has additionally been evolved

to get excessive welding pace and excessive productiveness.

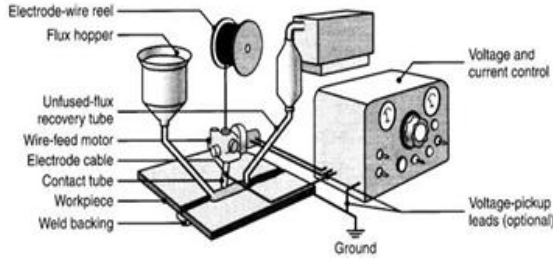
2. WELDING

Welding is a fabrication manner wherein or extra components are fused collectively by way of heat, pressure, or each forming a be a part of because the components cool. Welding is normally used on metals and thermoplastics however also can be used on wood. The finished welded joint can be called a weldment.



3. SUBMERGED ARC WELDING (SAW)

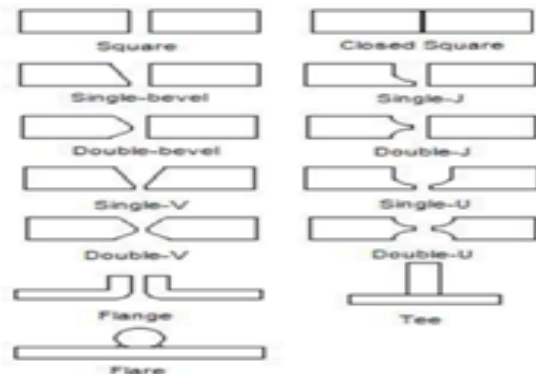
The managed welding present day presents the warmth to fuse the filler rod, determine metallic and flux that's furnished from flux hopper. The flux bureaucracy a pitcher like slag this is lighter in weight than the deposited weld metallic and floats at the floor as a defensive cowl towards oxidization of the steel. The cord pace is managed with the aid of using a cord feeder to regulate the deposition charge in keeping with distinct warmthness input.



Shows A Typical Equipment Set-Up For Single Wire SAW Process

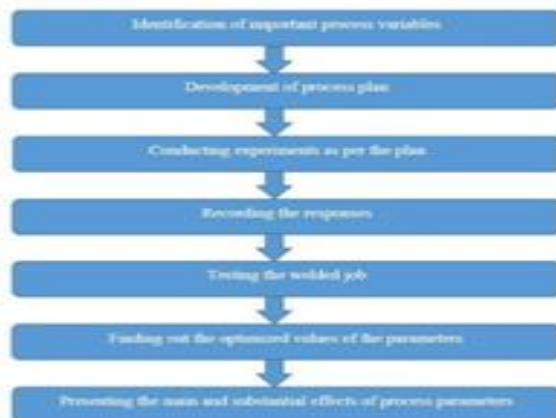
4. TYPES OF GROOVE WELDS

The primary use of groove welds is to attach structural participants which are aligned with inside the identical plane. Since groove welds are normally meant to transmit the total load of the participants they join, the weld ought to have the identical energy because the portions joined. There are many versions of groove welds and every is classed in keeping with its precise shape.



Shows Several Types of GrooveWelds

5. METHODOLOGY



In order to apprehend the impact of SAW parameters which include welding present day and journey velocity at the bodily and mechanical houses slight steel (IS2062), theas welded check specimens had been evaluated via way of means of weld geometry measurements to locate the connection among the welding parameters and weld geometry parameters. The outside and inner defects had been evaluated via way of means of visible exam and ultrasonic exam. The traverse hardness of the weld became received the usage of Vicker’s hardness measurements. The micro shape of the weld metallic, HAZ, and figure metallic became studied via way of means of metallographic and optical microscopy. The yield energy, tensile energy and percentage elongation of the weldment had been decided the usage of tensile testing. Impact durability and lateral growth had been decided the usage of Charpy effect testing.

6. EXPERIMENTAL PROCEDURE

6.1 MILD STEEL (IS2062)

As the carbon content material increases, alongside manganese, and particularly while chromium and molybdenum are added, the ability for hardening throughout welding increases. To save you hardening, the metal can be pre-heated some hundred degrees. On cooling, the pre-heated metal now has time to convert to a few segments aside from martensite by the point it reaches room temperature. This reduces hardness and inner stresses. Steel with inside the variety of 0.30-0.50% carbon typically calls for a few preheat, alongside low hydrogen welding practice. Preheat and inter by skip temperatures with inside the 200-400°F variety cowl maximum medium carbon

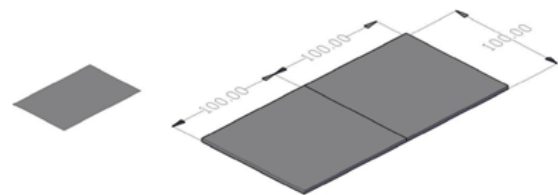


Figure6.1The Graphical Representation of Mild Steel(IS2062)

ELEMENT	C	S	P	SI	MN	AL	CU
PERCENTAGE	0.150	0.014	0.027	0.108	0.840	0.015	-

Chemical composition (wt.%) of the basemetal IS:2062

TEST PARAMETERS	VALUES
ULTIMATE TENSILE STRENGTH	468 MPA
YIELD STRESS	352 MPA
% ELONGATION	28 %

Tensile test observation of mild steel

6.2 FILLER METAL

The electrode having low carbon, natural tungsten or tungsten alloyed with thorium oxide or lanthanum-oxide, which offers a higher modern-day sporting capacity, it's miles utilized in submerged arc welding of moderate steel. This sort of electrode could be very smooth to strike and re-strike. Welding overall performance is exquisite with a completely smooth, low spatter arc generating a finely rippled bead floor with exquisite slag detach ability. moderate steels of the IS2062 kind can be used for packages along with meals managing equipment, systems in marine environments, petrochemical industries, chemical garage and transportation tanks, oil refining equipment.

Element	C	S	P	Si	Mn	Cu
Percentage	0.11	0.003	0.02	0.20	0.91	0.11

Chemical compositions (wt. %) of electrode E6013

6.3 SAW Flux

Role of fluxes in SAW is basically comparable that of coating in stick electrodes of SAW. Protection of weld pool from inactive protective gases generated through thermal decomposition of coating material. SAW fluxes can have an impact on the weld metallic composition considerably with inside the shape of addition or lack of alloying factors thru fuel oline metallic and slag metallic reactions. Few hygroscopic fluxes are baked (at250–300C for 1-2 hours) to get rid of the moisture. There are 4 styles of not unusual place SAW fluxes particularly fused flux, agglomerated flux, bonded flux and mechanical fluxes.

ELEMENT	C	S	SI	P	AL	MN
PERCENTAGE	0.052	0.006	0.530	0.027	0.012	1.560

Chemical compositions (wt. %) of Flux

6.4 PLAN OF EXPERIMENTS

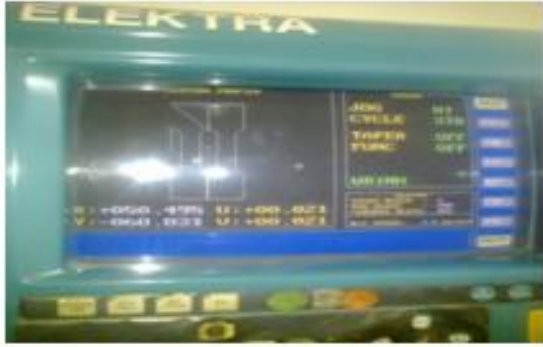
An essential degree in reaction floor version technology through Taguchi L9 orthogonal array is the making plans of experiments. The elements that have a full-size affect on weld strength, hardness and effect check of submerged arc welding have been diagnosed they may be arc voltage, welding pace and contemporary of submerged arc welding. Nine trials have been finished the use of 6 mm thick moderate Steel specimens to decide most and minimal values of submerged arc welding parameters. The technique parameter and their degree are tabled below

Factors	Notation	Unit	Factor Level		
			1	2	3
Voltage	V	Volts	-1	0	+1
Welding speed	S	m/min	-1	0	+1
Current	C	Amps	-1	0	+1

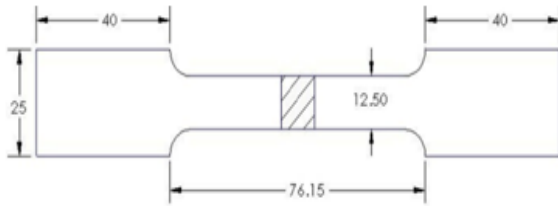
Process parameters and their coded values

6.5 ELECTRIC DISCHARGE MACHINING (EDM)

Wire reduce EDM brought with inside the overdue 1960s', and has revolutionized the device and die, mold, and metalworking industries. It might be the maximum thrilling and assorted system device advanced remaining fifty years, and has severa benefits to offer. It can system something this is electrically conductive no matter the hardness, from enormously not unusual place substances which includes device steel, aluminum, copper, and graphite, to amazing space-age alloys inclusive of titanium, carbide, polycrystalline diamond compacts and conductive ceramics. The twine does now no longer contact the workpiece, so there's no bodily stress imparted at the workpiece as in comparison to grinding wheels and milling cutters. The accuracy, floor end and time required to finish a task is extraordinarily predictable, making it a lot simpler to quote, EDM leaves a completely random sample at the floor in comparison to tooling marks left with the aid of using milling cutters and grinding wheel. The EDM manner leaves no residual burrs at the workpiece, which reduces or gets rid of the want for next completing operations.



Wire cut Electro Discharge Machining



All dimensions are in mm
Tensile test specimen

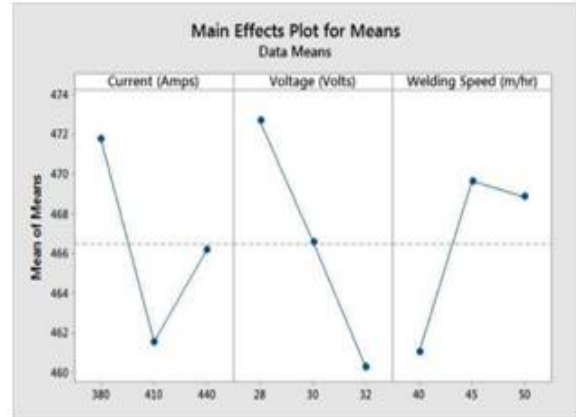
7. RESULT AND DISCUSSION

7.1 ORTHOGONAL ARRAY EXPERIMENTAL DESIGN AND THE S/N RATIO

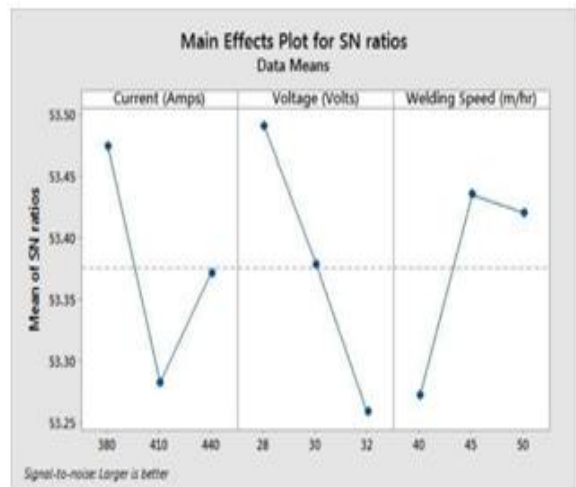
In this study, 9 experiments have been had to evaluation the welding parameters the usage of the L9 orthogonal array. In order to assess the affected of every decided-on thing at the responses, the S/N ratios for every manage thing needed to be calculated. The alerts indicated that the impact at the common responses and the noises have been measured via way of means of the impact of the deviations from the common responses, which might designate the sensitiveness of the experimental output to the noise factors. The appropriate S/N ratio ought to be selected via way of means of the usage of preceding knowledge, information and know-how of the process.

Current (Amps)	Voltage (Volts)	Welding Speed (m/hr)	Ultimate Strength (MPa)	S/N ratio
380	28	40	474.36	53.522
380	30	45	472.05	53.48
380	32	50	468.79	53.42
410	28	45	471.79	53.475
410	30	50	465.9	53.366
410	32	40	446.92	53.005
440	28	50	471.79	53.475
440	30	40	461.74	53.288
440	32	45	465.03	53.35

Experimental results using L9 orthogonal array



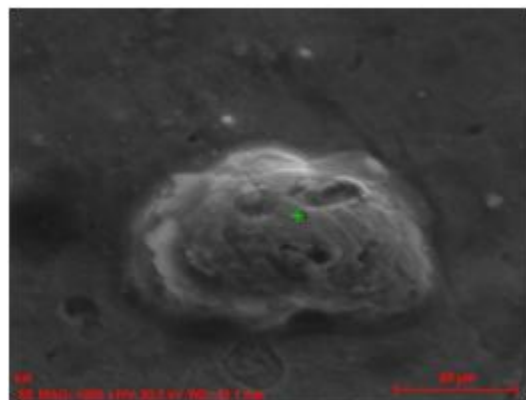
Effect of the welding parameters on the weld strength

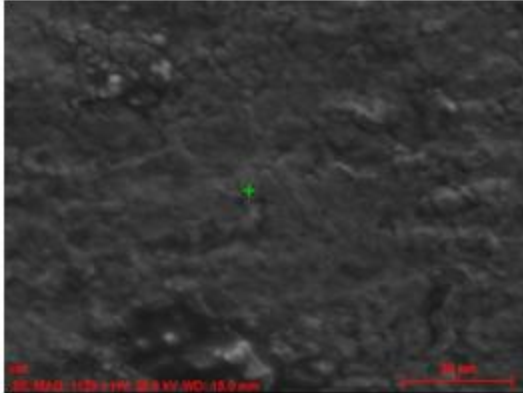


Effect of the welding parameters on the tensile strength S/N ratio

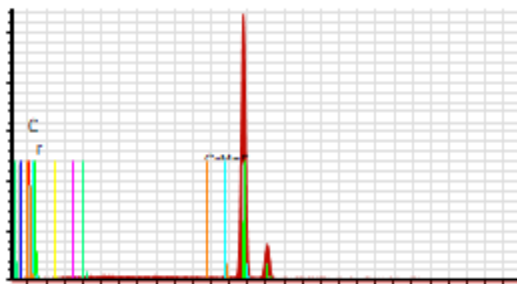
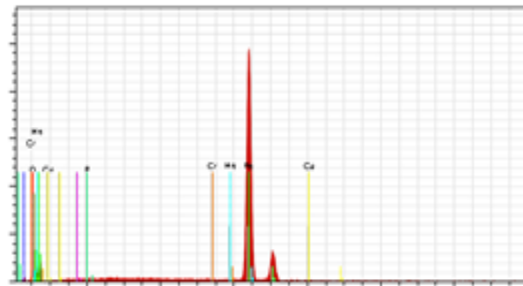
7.2 SEM & ENERGY DISPERSIVE X-RAY (EDX)

The distribution of varied factors throughout weld interface and detail distribution in numerous components is measured via way of means of gold standard parameters the usage of Energy Dispersive X-ray (EDX).





SEM Result for weld interface



EDX Result for weld interface

8. CONCLUSION

The Taguchi method's reaction desk has been proposed as a manner of analyzing the optimization of SAW method parameters for moderate metallic joint. The most reliable welding parameters had been decided with the aid of using weld strength. Voltage is the primary thing affecting the reaction. The modern-day additionally has a robust impact at the reaction growing welding pace results in a lower in reaction. A affirmation test became additionally carried out with a view to validate the most reliable method parameters values. The first rate to take a look at the weld look and mechanical homes imply that excessive voltage of moderate metallic 6mm

thick plates is sensible in industrialized applications. A generally homogenous microstructure and properly blended fusion quarter became produced with a particular factor strength of diverse steel joint.

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