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Taguchi Analysis of Process Parameter in Resistance Spot Welding For Coated Steel S460mc Material: Ultimate Tensile Strength

Vipul M. Pate[1], Dr. Mohammad Israr[2]
[1]*Research Scholar, Department of Mechanical engineering, Rai University, Ahmedabad, India*
[2]*Principal, Dungarpur College of Engineering and Technology, Dungarpur, Rajasthan, India*

Abstract: ***A review of the resistance spot welding process is given, followed by a literature study of the known issues when welding galvanized coated steels and some of the methods explored to address those issues. This study presents a systematic approach to determine effect of process parameters on ultimate tensile strength as a primary & initial measure of weld quality and subsequently tip diameter. To achieve the objective an attempt has been made to select important welding parameters like weld current, weld cycle, hold time using quality tools, available literature and on scientific reasons. On the selected parameters, Experiment have been conducted as per Taguchi method and fixed the levels for the parameters. The experiment has three factors and all factors are at two levels. To have wide spectrum of analysis and variability with time experiments are conducted. Taguchi Analysis has been used for determining most significant parameters affecting the spot weld parameters. Study of the degradation mechanisms of the uncoated electrode revealed that electrode tip life was due to more thnthe typical alloying and material loss as well as gross electrode deformation.***

Keywords: ***resistance spot welding; coated steel; process parameters; taguchi analysis; electrode; ultimate tensile strength***

I. INTRODUCTION

Resistance Spot Welding is one of the oldest and main method of the electric welding processes in use by industry today for joining sheet steel components. In industries increased the use of zinc coated steels or galvanized coated steels because of their good corrosion resistance and low cost. The weld is made by a combination of heat, pressure, and time. However, the Galvanized coating has increased the difficulty of welding due to its lower electrical resistance and melting temperature. It has led to a drastic reduction in Weldability as well as electrode tip life. Poor Weldability requires more care to be taken when setting weld parameters. The purpose of this work is to explore the performance and behaviour of the electrode.

II. ANALYSIS OF ULTIMATE TENSILE STRENGTH

In an experiment, purposeful changes are made to the independent variables and the resulting behavior of the dependent variable is observed. A design of experiment (DOE) is a plan for doing the experiments. In the context of DOE, we will call the independent variables as factors and the dependent variable as response. DOEs are performed mainly for two purposes:

A. To identify important factors affecting the response, and

B. To optimize the response.

In present study general full factorial method was adopted for the design of experiments to identify important factors affecting the response and to optimize the response using MINITAB 18 software. Three factors i.e Weld Current (kA), Weld Time (cycle) and Hold Time (cycle) are selected as variables and ultimate tensile strength is selected as response parameter.

Factor and Levels Information

TABLE1 FACTORS AND LEVELS VALUES

Sr. No.	Factors	Low	High
1	Weld Current(kA)	10.8	11.0
2	Weld Time(cycle)	20	35
3	Hold Time(cycle)	45	50

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TABLE 2
EXPERIMENTAL DATA FOR INDENTATION

Experiments	Weld Current (kA)	Weld Time (Cycle)	Hold Time (Cycle)	UTS (N/mm^2)
1	10.8	20	45	81.176
2	10.8	20	45	85.450
3	10.8	20	45	87.320
4	10.8	20	45	82.780
5	10.8	20	50	98.224
6	10.8	20	50	95.120
7	10.8	20	50	102.605
8	10.8	20	50	98.120
9	10.8	35	45	90.132
10	10.8	35	45	91.540
11	10.8	35	45	88.392
12	10.8	35	45	92.455
13	10.8	35	50	100.560
14	10.8	35	50	105.230
15	10.8	35	50	102.205
16	10.8	35	50	101.870
17	11.0	20	45	90.560
18	11.0	20	45	93.110
19	11.0	20	45	95.210
20	11.0	20	45	93.420
21	11.0	20	50	105.620
22	11.0	20	50	104.230
23	11.0	20	50	101.540
24	11.0	20	50	102.211
25	11.0	35	45	95.210
26	11.0	35	45	96.321
27	11.0	35	45	98.230
28	11.0	35	45	100.101
29	11.0	35	50	105.211
30	11.0	35	50	107.542
31	11.0	35	50	109.127
32	11.0	35	50	108.628

III.TAGUCHI ANALYSIS: ULTIMATE TENSILE STRENGTH (N/MM^2) VERSUS WC, WT HT

TABLE 3
RESPONSE TABLE FOR SIGNAL TO NOISE RATIOS

Level	WC	WT	HT
1	39.43	39.50	39.20
2	40.02	39.94	40.25
Delta	0.59	0.44	1.05
Rank	2	3	1

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TABLE 4
RESPONSE TABLE FOR MEANS

Levels	WC	WT	HT
1	93.95	94.79	91.34
2	100.39	99.55	103.00
Delta	6.44	4.75	11.66
Rank	2	3	1

TABLE 5
RESPONSE TABLE FOR STANDARD DEVIATION

Levels	WC	WT	HT
1	2.391	2.401	2.144
2	1.920	1.910	2.167
Delta	0.471	0.490	0.023
Rank	2	1	3

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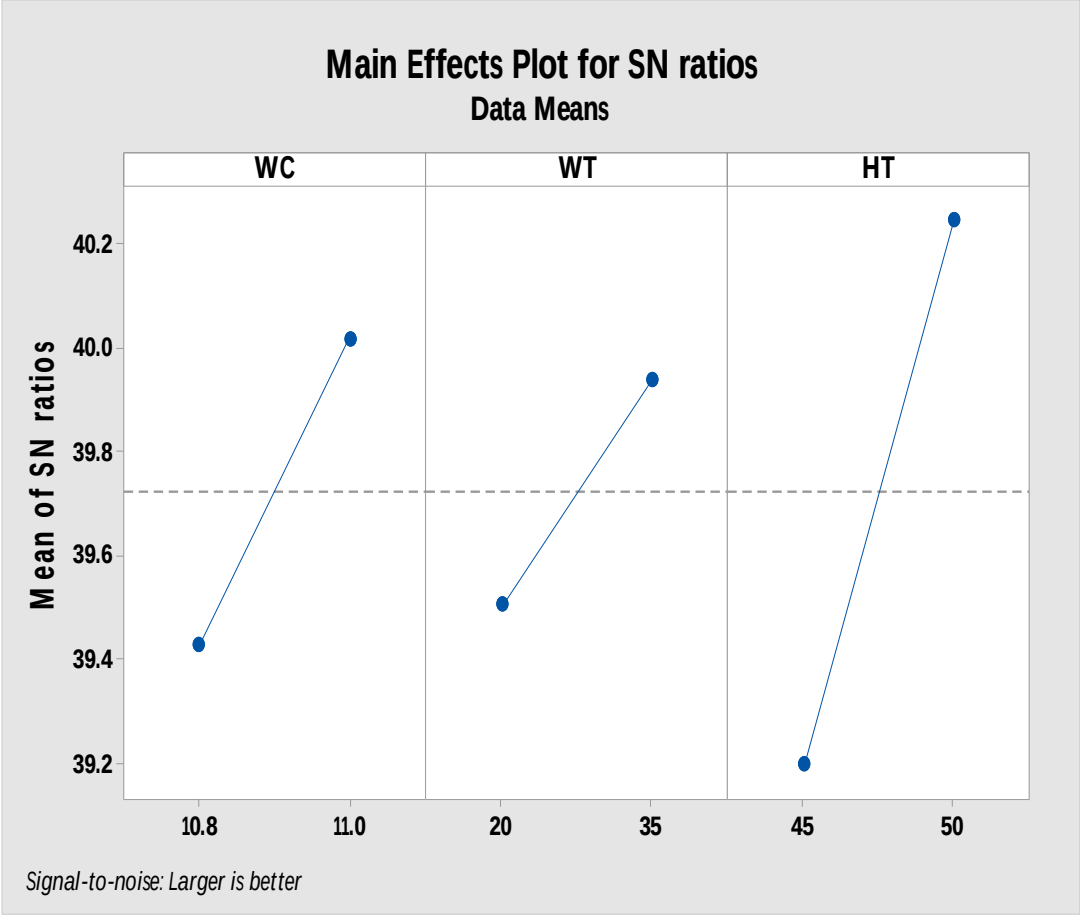

Fig. 1 Main effects plot for ultimate tensile strength

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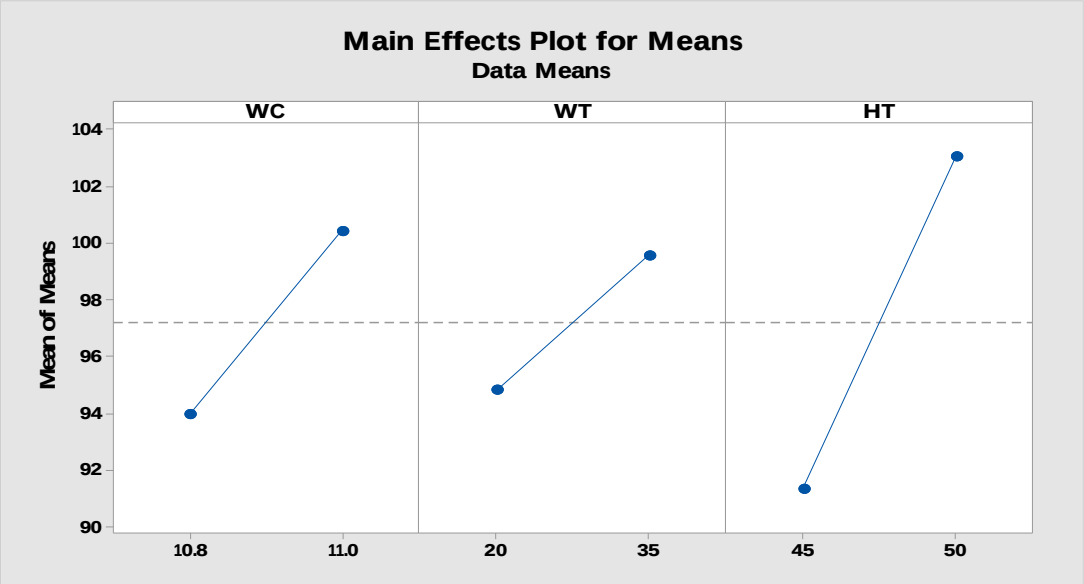

Fig. 2 Main effects plot for ultimate tensile strength

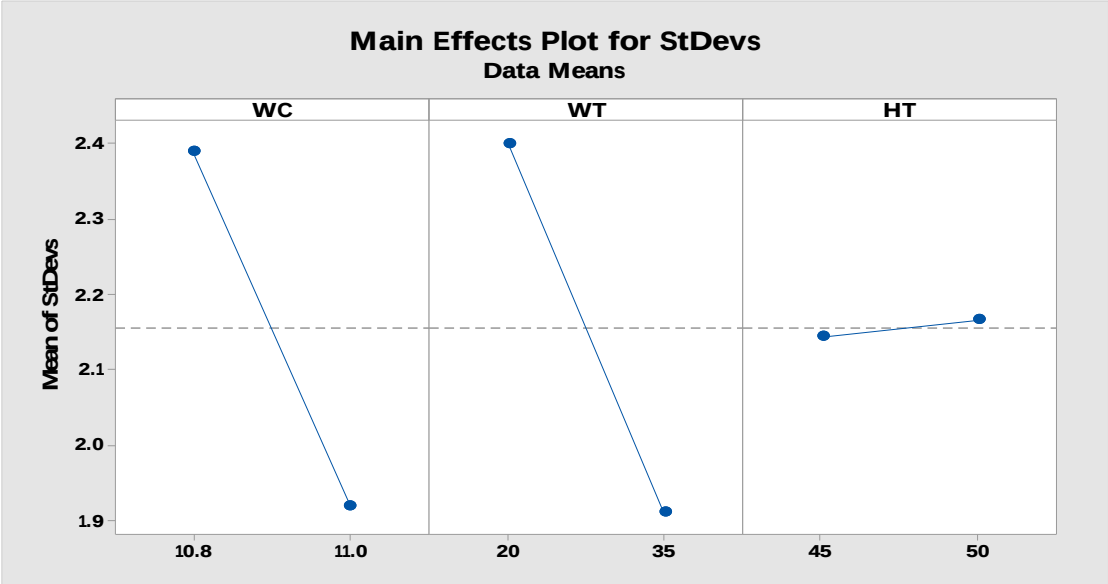

Fig. 3 Main effects plot for ultimate tensile strength

TABLE 6
TABLE FOR PREDICTED VALUES FOR PREDICTION

S/N Ratio	Mean	StDev	Ln(StDev)
38.6818	85.7395	2.62483	0.951393

TABLE 7
TABLE FOR PREDICTED VALUES FOR SETTINGS

WC	WT	HT
10.8	20	45

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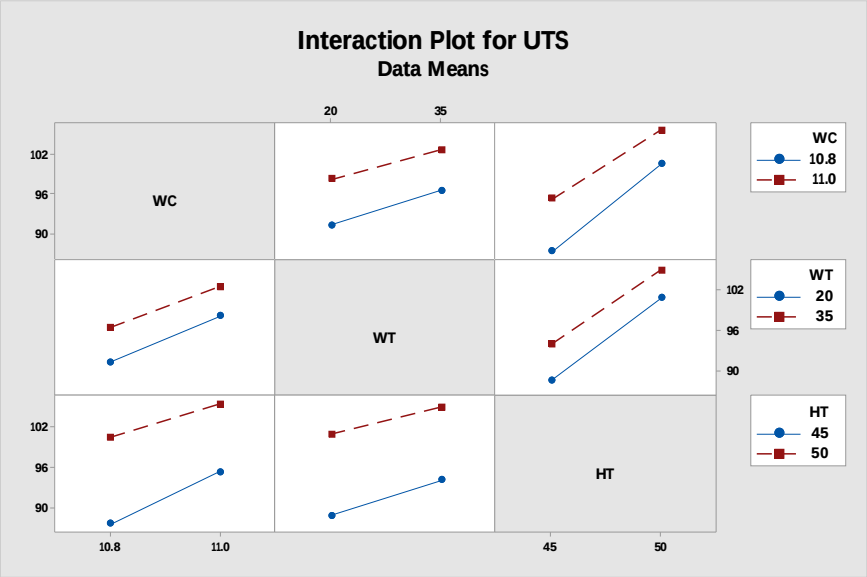

Fig. 4 Interaction plot for ultimate tensile strength

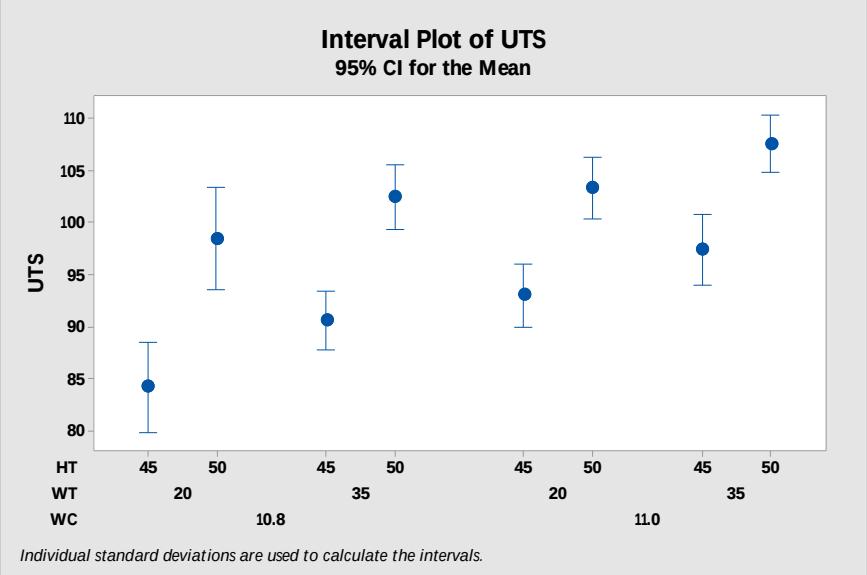

Fig. 5 Interval plot for ultimate tensile strength

IV. CONCLUSIONS

Taguchi Analysis was performed to identify the process parameters that are statistically significant. The purpose of the Taguchi Analysis is to investigate the significance of the process parameters which affect the ultimate tensile strength of RSW joints. The Taguchi Analysis results for ultimate tensile strength is given in Table. The results of Taguchi Analysis indicate that the UTS value is for weld current , weld time and hold time. Weld current has significant effect on ultimate tensile strength.

Figure 4 shows that ultimate tensile strength increases with increase in weld current and weld time.

It is seen from the results of Taguchi Analysis that there is very good interaction between process parameter affecting the ultimate tensile strength since the responses at different levels of process parameters for a given level of parameter value are almost parallel.

V. ACKNOWLEDGMENT

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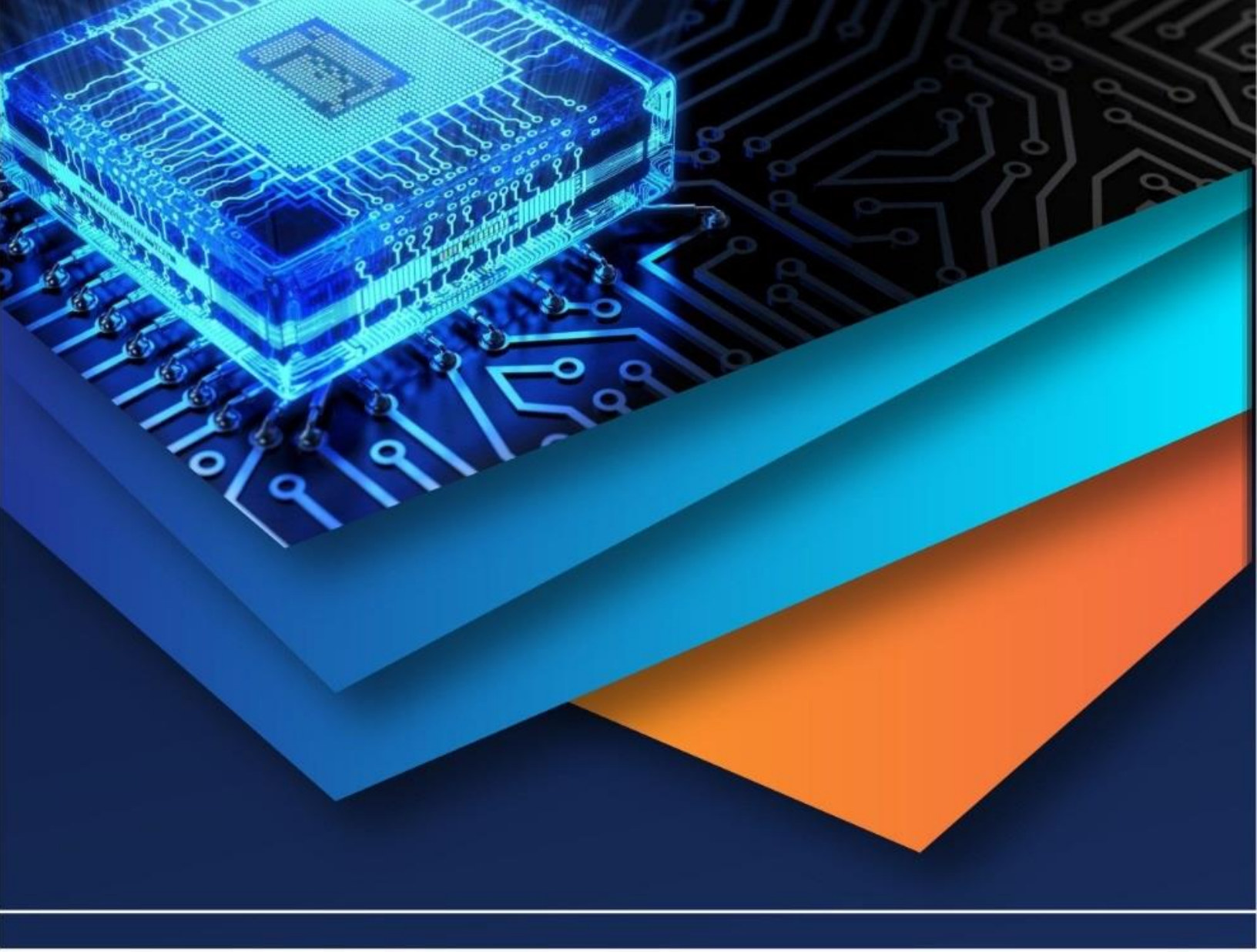

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