STRENGTH OPTIMIZATION OF SPOT WELDING FOR HRSPO STEEL

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ABSTRACT

Welding process is one of the major process that forms the backbone of the fabrication as well as automobile industry. Due to the versatility of the welding methods incorporated in the industry, every type of welding shows a unique characteristic of the weld. The basic approach of the working of the spot welding process is that the metal at the contact of the work piece is allowed to flow through the work piece which in turn results into the melting of the metal. The melting of the metal is squeezed and allowed to cool to form the weld. But due to some uncertain changes in the input parameters, there is an issue of the decreasing the strength of the weld which decreases the effectiveness of the welded joint. Our research work is based on the same issue.in our research work we have conducted the strength optimization of Hot rolled skinned pickled and oiled steel which is being welded on the spot welding machine. The method for investigation used in our analysis is response surface methodology.

Keywords: Spot Welding, Steel, RSM.

I.   INTRODUCTION

The resisting spot welding is one of the most common method amongst the various welding processes used in the automobile as well as fabrication industry. In the resistance spot welding, the process consists of pressing the metal which is being welded are held together with the help of the electrode. The electrodes are basically the rods of material which are good conductor of electricity. Generally copper electrodes are preferred due to best electrical conductivity.as the both electrode and the work piece are good conductor of electricity, they get melted due to the phenomenon of heating effect of electric current. As a result of the generated heat the work piece gets melted and due to the pressure exerted by the electrode, the metal gets squeezed to form a homogeneous joint. The electrode pressure also play an important role in the squeezing of the molten metal. But most of the times the issue happens that due to poor pressure of the electrode and due to the fluctuations in the input parameter, the strength of the weld joint is affected up to noticeable extent.

II.   METHODOLOGY

Before starting the analysis work, we have conducted some literature survey as follows.

1] In the research work "Parametric optimization of resistance spot welding for multi spot welded lap shear specimen to predict weld strength" in the Hindawi Publishing Corporation International Journal of Manufacturing Engineering Volume 2014, Article ID 154784 by thong chai arunchai et. Al, the final conclusion of the research work was successful implementation of the developed model in auto body plant industry at Thailand. [1]

2] In the dissertation work published by P. Muthu in the journal Scido, Mechanics and Mechanical Engineering 2019; 23:64–69 with the article entitled as "Optimization of the Process Parameters of Resistance Spot Welding of AISI 316l Sheets Using Taguchi Method", The final conclusion of the dissertation work was the electrode diameter was supposed to be the most influential parameter for the defined model. [2]

3] a review on optimization of resistance spot Welding of aluminum components used in Automotive industry" published by Shruti Naik et al in the journal International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN: 2349-2163 Issue 04, Volume 4 (April 2017). In their analysis they reviewed various parameters that are responsible in deciding the quality of the welded joint. [3]

4] Optimization of Resistance Spot welding Parameters Using Taguchi Method" conducted by shailesh kumar vishwakarma et.al,the conclusion of the research work was found that the welding current was the most significant parameter for the model defined by them. [4]

5] In the research paper published by Laxminarayan A.K. in the paper "Identification of optimum friction stir spot welding process parameters controlling the properties of low carbon automotive steel joints" published in Elsevier Journal of materials research & technology in 2015, the conclusion of the research work was dwell time was a significant parameter for the model defined by them for the tensile shear fracture load failure. [5]

6] In the scholar article published by "Spot Welding Parameter Optimization to Improve Weld Characteristics for Dissimilar Metals"by Aravinthan Arumugam, the outcome of the experimentation work was that the optimized welding schedule proved to be effective than that of the regular schedules of the welding.[6]

7] the research article entitled "optimization of resistance spot welding process parameters of AISI 304l and AISI 1020 welded joints" in the journal International Research Journal of Engineering and Technology (IRJET) presented by H A shende & N A Kadam. The parameters for the analysis were welding time, hold time, welding pressure, welding current and nugget diameter. The final outcome of the experimentation work was hold time does not have noticeable impact on the nugget diameter. Also the welding current plays an influential role in the nugget diameter. [7]

8] Research Article entitled as "review on optimization techniques used in rsw parameters for similar and dissimilar metals sheets joining" published under International Research Journal of Engineering and Technology by sushree Sefali mishra et al showed various parameters related to the quality of weld.Also her research article emphasized on the various techiniques of optimizing the process parameters.

9] In the research paper entitled "Experiment on Optimization of Robot Welding Process Parameters" under the journal International Journal of Recent Technology and Engineering (IJRTE) by g Dillibabu et al, they employed taguchi method for the optimization of process parameters the conclusion of their research work was they have optimized the process parameters such as welding time, welding current & electrode force. [9]

10] Research article entitled as "parametric optimization of gas metal arc welding process With the help of taguchi method on tensile strength" published under International Research Journal of Engineering and Technology (IRJET) by Raj kumar yadav et al Concluded their research work with a conclusion that wire feed rate was found most influential parameter for the tensile strength. [10]

III.   MODELING AND ANALYSIS

Problem definition: In the fabrication of the welding component, the joint was failed before the load defined by the user. Hence it was a challenging task to improve the strength of the joint in order to satisfy the strength to be beared by the component.

Method of approach:

The levels were defined on the basis of pilot experimentation which is being conducted before the actual experimentation. The levels chosen for the experimentation are as follows:

Table 1. Levels for the experimentation.

Parameter	Lower Value	Middle Value	Higher Value
Voltage	20KV	22.5KV	25KV
Current	18KA	20KA	22KA
Hold time	1Sec	2Sec	3Sec

The orthogonal array obtained from the Minitab software is used to set the trials or runs. The experimentation is conducted on the basis of the array readings and the strength for the stated run is mentioned in the column.

Table 2. Array of readings after conduction of experimentation.

Std Order	Run Order	PtType	Blocks	Voltage	Current	Hold Time	Strength
8	1	1	1	25	22	3	46

3	2	0	1	22.5	20	2	40
12	3	1	1	25	18	1	51
9	4	0	1	22.5	20	2	43
11	5	0	1	22.5	20	2	43
5	6	1	1	20	18	3	39
1	7	1	1	20	18	1	31
6	8	1	1	25	18	3	36
7	9	1	1	20	22	3	46
14	10	0	1	22.5	20	2	42
10	11	0	1	22.5	20	2	40
13	12	0	1	22.5	20	2	43
4	13	1	1	25	22	1	53
2	14	1	1	20	22	1	55

IV.   RESULTS AND DISCUSSION

The data obtained after the successful trials of experimentation is introduced in the minitab software and the same set of readings is used to analyze by using the response surface methodology. the regression equation obtained for the above model is stated as

Strength = -80 - 7.8 Voltage + 14.50 Current + 32.0 Hold Time + 0.447 Voltage*Voltage - 0.475 Voltage*Current - 1.050 Voltage*Hold Time - 0.562 Current*Hold Time

Also the graphs obtained in the software were as follows:

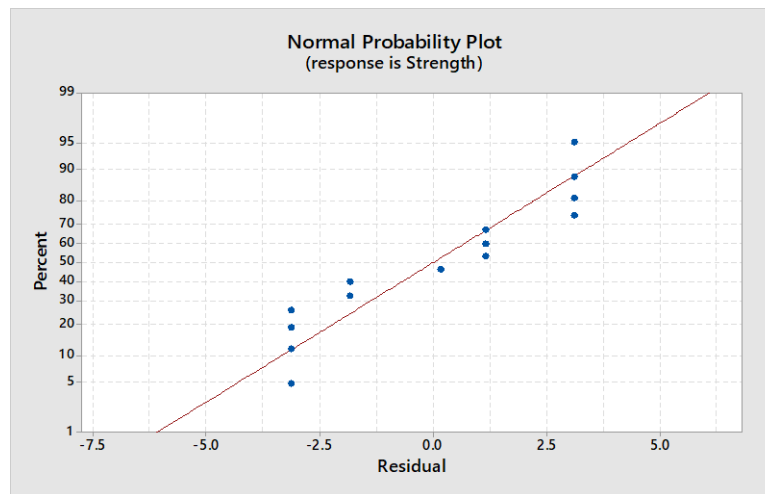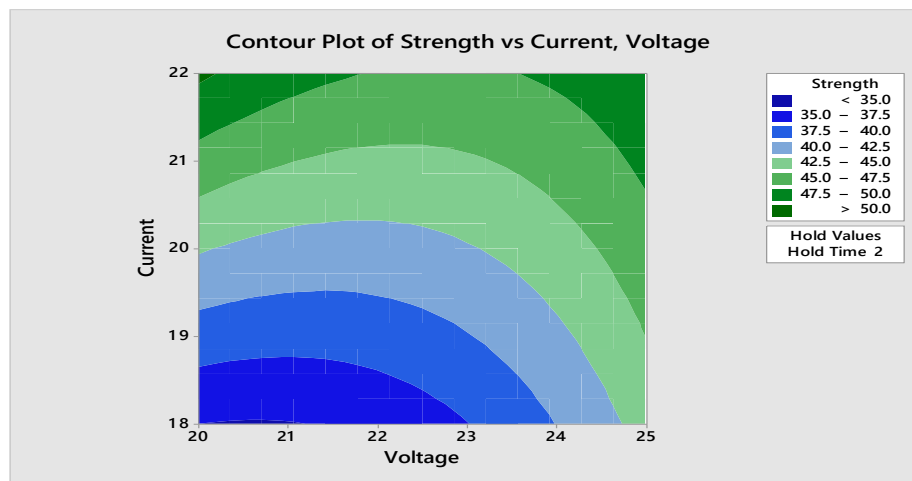**Figure 1:** Normal probability plot for HRSPO steel

Figure 2: Contour Plot for Voltage & Current.

V.   CONCLUSION

From the above analysis we have successfully conducted the experimentation and the conclusion of our research work was found to the welding current played an influential role in the analysis of our model. The optimization is also conducted in our research work to get an optimized set of values which is being employed for the further production.

VI.   REFERENCES

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