DESIGN,DEVELOPMENT,OPTIMIZATION &ANALYSIS OF RESISTANCE SPOT WELDING

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ABSTRACT

Resistance welding is fusion welding process in which a very high current & low voltage is passes through weld for shorter time. Due to this amperage heats the part due to the contact resistance and melts it. In this process pressure on to the joint has been maintained continuously & fused metal combine together. The sch. representation of the resistance welding process is shown in figure. The main requirement of the process is the low voltage and high current power supply. This is obtained by means of step down transformer with a provision to have different tapings on the primary side. The secondary winding's are connected to the electrodes, which are made of copper to reduce their electrical resistance. The time of electric supply needs to be closely controlled so that the heat released is just enough to melt the joint and the subsequent fusion takes place due to the force (forge welding on the joint). Force required can be provided either mechanically, hydraulically or pneumatically. This experimental study is based on an investigation of the effect and optimization of welding parameters. The combination of the optimum welding.The different parameters of welding process such as welding current, welding voltage, wire diameter s input parameters and welding time as output parameter is considered. Effective utilization of resources with efficient output is desirable. Thermal Analysis with heat flux provides firm base to the optimization parameters.

Keyword : - *Spot Welding, Taguchi Method, Thermal Analysis, Heat Flux Analysis*

1. INTRODUCTION

Welding is the process for joining different material. Welding used to joins various metals by using no of processes. common everyday used items i.e. Automobile cars, aircraft, ships, machinery, household appliances depends upon welding for their economical construction. Resistance spot welding is getting significant importance in car, bus and railway bodies etc.due to automatic and fast process. The major factors controlling this process are current, time, electrode force, contact resistance, property of electrode material, sheet materials, surface condition etc. the quality is best judged by nugget size and joint strength. This study presents a systematic approach to determine effect of process parameters(electrode force, weld time and current) on tensile shear strength of resistance weld joint of mild steel using Taguchi method. A general introduction for principle, working and parameters of spot welding is given below. Resistance Spot Welding (RSW) is among the oldest of the electric welding method that used in the industry and it is useful and accepted method in joining metal Spot welding is widely used in welding carbon steel because they have higher electrical resistance and lower thermal conductivity than the electrode that made from copper. The Spot welding is commonly being used in automobile industry, where it is used to weld the sheet metal forming a car.

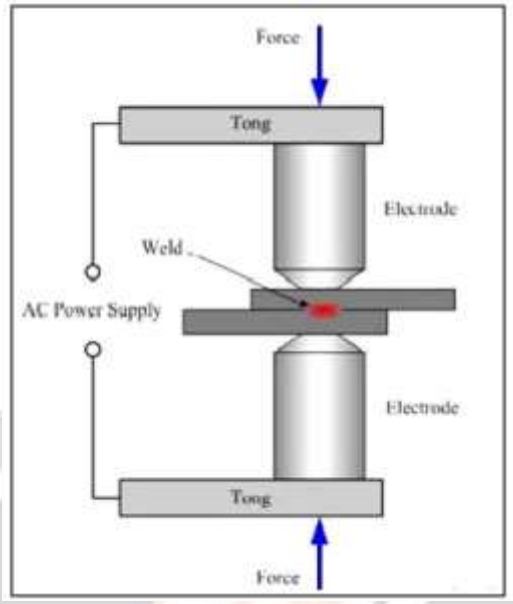


Fig 1. Resistance Spot Welding

2. LITERATURE REVIEW

After Studying the Literature it can be concluded that a lot of work has been done in the field of process parameter optimization of good quality weld.

Manoj Raut et al [1] studied on an investigation of the effect and optimization of welding parameters on the tensile shear strength in the Resistance Spot Welding (RSW) process. The experimental studies were conducted under varying electrode forces, welding currents, andwelding times. The settings of welding parameters were determined by using the Taguchi experimental design of L18 Orthogonal array method. The combination of the optimum welding parameters have determined by using the analysis of Signal-to-Noise (S/N) ratio.

A. G. Thakur et al. [2] this research studied the effects of six welding parameters i.e. weld time , squeeze time ,preheating current, welding current, hold time and electrode pressure on the nugget diameter and tensile shear (T-S) strength of the weld joint of steel. In this research complicated behaviour of this process must be analysed for good quality weld. In this paper Taguchi quality design concepts has been under study to calculate analysis of variance, *F* test value & signal-to-noise (S/N) ratio (dB) for highlight the most valuable parameters which influence performance of spot welding.

M. Aghakhani et al. [3] this research is studied design of experimental a mathematical model developed using various welding parameters i.e. welding voltage (V), gas flow rate , wire feed rate ,welding speed (S), nozzle-to-plate distance (N)and gas flow rate (G) on weld dilution. From calculated data from this model S/N ratio to be calculated. By using this S/N ratio the input parameter are to be optimized for better productivity & good quality of welding. This model is based on regression for preplanning of weld parameter. In fabrication industry during welding the input welding parameters is important for proper welding with higher productivity.

N.B.Mustafa et al. [4] describes prediction of weld penetration as influenced by FCAW process parameters of welding current, arc voltage, nozzle-to-plate distance, electrode-to - work angle and welding speed . Optimization of these parameters to maximize weld penetration is also investigated.

B. A. Shukla, et al. [5] focused on the investigation of CO welding parameters to maximize the weld strength using Response Surface Methodology. Welding current, welding voltage, wire feed rate and gas pressure was taken as input parameters while the response was only weld strength. Central Composite Design was chosen for the experimental design. RSM based model has been developed to determine the weld strength attained by various

welding parameters. The quadratic models developed using RSM shows high accuracy and can be used for prediction within the limits of the factors investigated.

Jadeja Digvijay et al. [6] this research highlights that studing conducting a series of independent rather than factorial designs is more efficient. This paper explained how factorial designs are more improved & effective tool rather than conducting a series of independent studies. Finally, in this research it show that how factorial designs is the only way to examine interaction effects.

N.S.Patel [7] identified in TIG welding process most of welding parameters like welding current, welding speed, depth to width ratio are generally used in research work. Also identify TIG welding carried out on different materials like mild steel , titanium alloy, brass, carbon, stainless steel etc.

Dr. K. Lalit Narayan [8] studied optimization of process parameters using Response Surface Methodology. Experiments were conducted based on central composite Face Centered Cubic design and mathematical models were developed correlating the important controllable resistance spot welding process parameters like Voltage (V), Travel speed (S) and welding current (I) with weld bead penetration. Author also examines the models direct and interaction effects of the process parameters on weld bead penetration were studied and further the process parameters were optimized. The obtained results help in selecting quickly the process parameters to achieve the desired quality. The optimized values of the various input parameters can be summarized as like optimum arc voltage, optimum travel speed & optimum welding current.

3. PROBLEM STATEMENT

Performing spot resistance welding following problems are arises in Apurva Industries. This parameter affects quality & productivity of this firm.

1. Fatigue to operator by means of continues pedaling.
2. force requirement is greater extent & which is manual
3. Cycle time for particular process is more.
4. Single spot at a time.
5. Requirement of employees are more
6. Electrodes wear off.

4. METHODOLOGY

A Scientific approach to plan the experiments is a necessary for better of experimental results. By the statistical design of experiments the process of planning the experiment is carried out, so that appropriate data will be collected and analyse by statistical methods resulting in valid and objective conclusion. As we involving towards our objective for solving the problem statement data involves experimental error, statistical methodology which fatherly analyzed. Thus experimental problem can be divided in to two aspects: the statistical analysis of the data & the design of the experiments. The design of experiments employed directly affect or impacts on methods of analysis. In quality engineering Taguchi is a comprehensive system. In Taguchi method involves effective application of engineering strategies rather than advanced statistical techniques.This method includes both shop-floor &upstream quality engineering. The variability and remain cost-effective, and robust design is to be reduced efficiently by upstream methods for large –scale production and market place. Shop-floor techniques provide cost based real time methods for monitoring and maintaining quality in production. The design of experiment is first step for solving this critical problem & analysis of taguchi design is second.

1) power available at o/p of transformer

$$= \frac{\text{KVA Raiting}}{\text{Primary Voltage} * 1.41} * 1000$$

$$= \frac{15 \text{ kva}}{230 * 1.41} * 1000$$

=46253.5Amp.

2) requirement of welding parameter

This parameter calculated by using some empirical equations, these are as:

- Electrode tip dia =

  =2.54+ (t1+t2)

  =2.54 + (2+2)

  =6.54mm

- Weld Time =2.36(t1+t2)

  =2.36(2+2)

  =9.44Cycles/Sec.

- Current required =2195(t1+t2)

  =2195(2+2)

  =8780Amp

- Electrode Force =876(t1+t2)

  =876(2+2)

  =3504N

Table 1. Resistance Spot Welding Parameters

Sr. No.	Parameter	Unit
1	Welding Current	Ampere
2	Welding Voltage	Voltage
3	Wire Diameter	mm

These parameters has a drastic impact on the weld time but optimize setting of these parameters results in the required weld time depth obtaining which is very difficult and hence statistical and experimental way to resolve the problem is considered. The DOE process is divided into three main phases which encompass all experimentation approaches. The three phases are: 1. Planning Phase 2. The conducting phase 3. The analysis phase.

Table 2. Experimental Values And S/N Ratio

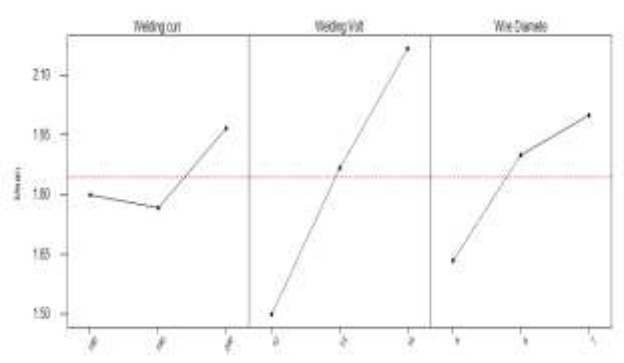
S.N.	**Welding Current**	**Welding Voltage**	**Wire Diameter**	**Welding time**	**S/N Ratio**
1	180	12	5	1.2	-1.5836
2	180	13	6	1.8	-5.1054
3	180	14	7	2.4	-7.6042
4	190	12	6	1.6	-4.0824
5	190	13	7	1.9	-5.5750
6	190	14	5	1.8	-5.1054
7	200	12	7	1.7	-4.6089

8	200	13	5	1.9	-5.5750
9	200	14	6	2.3	-7.2345

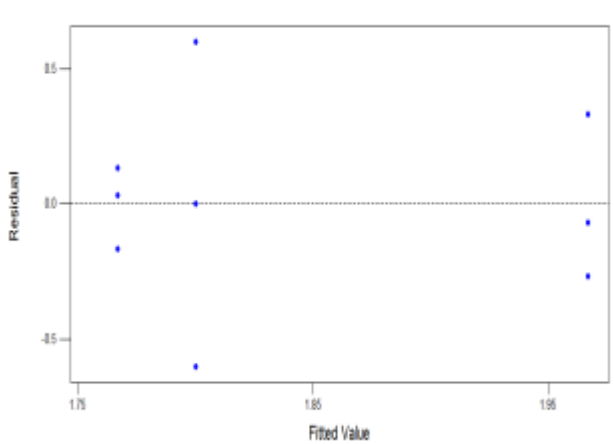
Table 3. Regression Analysis

Control factors	DOF	Sum of Squares	Mean Square	F	P
Welding Current	2	0.069	0.034	0.22	0.811
Welding Voltage	2	0.6689	0.3344	5.68	0.041
Wire Diameter	2	0.216	0.108	0.80	0.491
Error	6	0.3533	0.0589		

S = 0.1808 R-Sq = 86.2% R-Sq(adj) = 83.4%



Graph 1: Main Effect Plot for S/N Ratio



Graph 2: Residuals verses fitted values

The component is tested using ANSYS 14.5. Thermal analysis is carried to find the temperature distribution The Basic concept in FEA is that the body or structure may be divided into smaller elements of finite dimensions called"Finite Elements". The original body or the structure is then considered as an assemblage of these elements connected at a finite number of joints called "Nodes" or "Nodal Points".

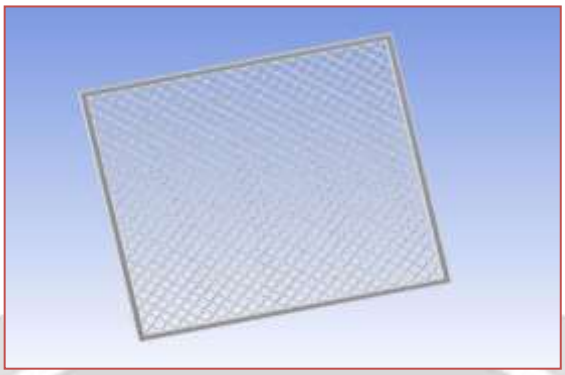


Fig. 2 Part Geometry

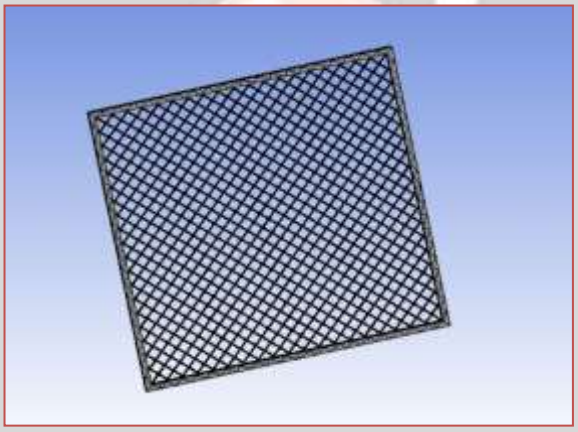


Fig. 3 Meshing

Mesh validation is done by changing the element size up to 118000 there is no change in results. So select minimum element (117690) to reduce computational time

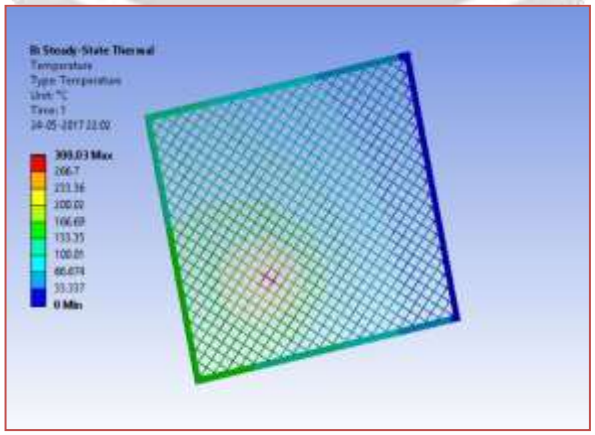


Fig.4 Temperature Distribution

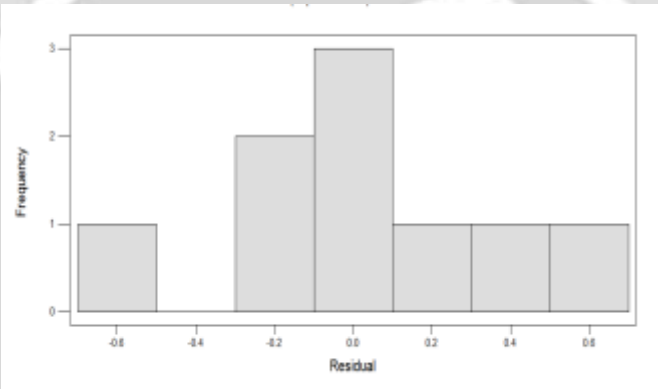
5. RESULT AND DISCUSSION

Table 4 shows the results of optimum parameters for optimum weld time.

Table 4. Optimal Values Of Process Parameter

Sr. No.	Parameter	Value
1	Welding Current	200
2	Welding Voltage	14
3	Wire Diameter	7

Graph 3 shows Histogram of the residuals showing the influence of various process parameters on response (Welding time) obtained in the skewed zone is presented.



Graph 3: Histogram of the Residuals

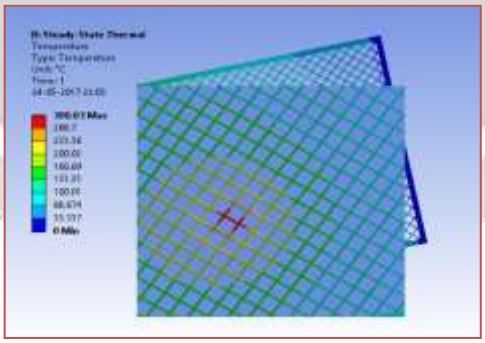


Fig 5 Temperature Distribution

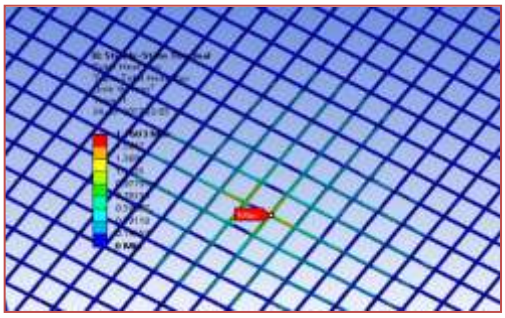


Fig 6 Heat Flux

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BIOGRAPHIES

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