REVIEW ON OPTIMIZATION TECHNIQUES USED IN RSW PARAMETERS FOR SIMILAR AND DISSIMILAR METALS SHEETS JOINING

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Abstract - : *Resistance spot welding is a frequently used technique for thin metal sheets joining. The process is mostly adopted in automobile industries. This is robot enabled so also performs or operates at high speed. For RSW the most promising operating parameters are electrode load, current and time. Again the time also involves different times as weld time, squeeze time, hold time and off time. Here in this paper different optimization techniques used for optimization of RSW operating process parameters are so far discussed. The discussion is broadened to both similar and dissimilar metal joining.*

Key Words: RSW, optimization, operating parameter

1. INTRODUCTION

Resistance spot welding is a conventional welding technique used to join thin metal sheets. Basically this is a method of joining in case of automobile body parts where it may join similar as well as dissimilar metal sheets according to strength requirement. There are thousands of spot in a automobile body there spot welding is required and it is performed by resistance spot welding (RSW). Main parameters which have tremendous effect on the joint strength are current, electrode force and time. Whole spot welding setup with the circuits is shown in figure 1. Again the time is classified as squeeze time, hold time, weld time and off time shown in figure 2. Among all these times weld time is the most effective time. But squeeze time and hold time also have effect on the weld nugget which drastically has effect on the joint strength.

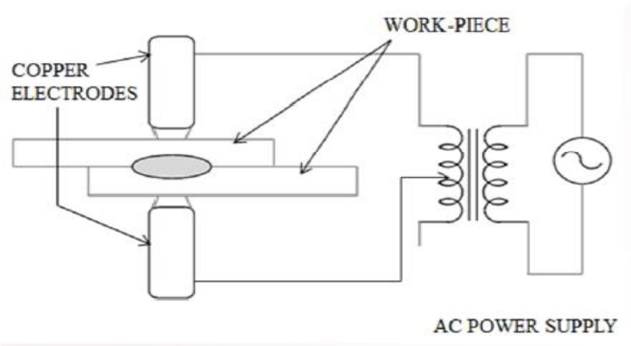

Figure 1 : RSW experimental set up with circuit **[1]**

Performing the experiment is not the only requirement for us but to improve the joint strength. For the strength improvement or optimization of joint strength there are different optimization techniques. Different researchers have used different optimization techniques with different operating parameters and have given different results.

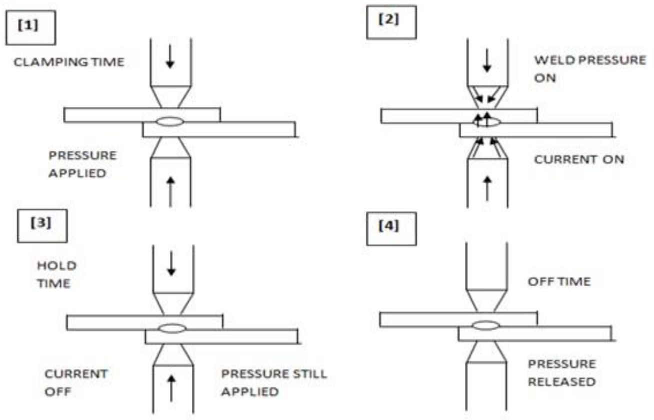

Figure 2 : step wise supply of current and pressure at different times

2. LITERATURE REVIEW

Different researchers are working on different aspects of resistance spot welding like geometry, tool geometry, nugget size, strength, operating parameters etc. But in all aspects the main objective is to obtain the optimal result to get good joint strength and durability.

k. Taher chaouch et. al. [**2**] in 2013 gave elaborate study on development of weld nugget in dissymmetric assemblies. Coated steel sheets of ESG10/10(Zn coated mild steel) and DO6G10/10(dual phase steel) were used. Simulation was done by electro-thermal-metallurgical model in finite element code SYSWELD. In this experimentation contact condition and thermal contact resistance were determined using LIMATB. This analysis was based on nugget development in identical sheets, dissimilar sheet weld, effect of thickness ratio, combined effect of thickness ratio and dissymmetry and development of weld nugget in three sheet configuration. In identical sheet joining initial heating was found in sheet interface which propagates in plate in a symmetric fashion. In case of dissimal sheets the authors found that initial heating is in the interface but gradually overheating shifted to more thickness sheet and melting occurred in the interface but near to resistive sheets. Thickness ratio is defined as the ratio of thick plate to thin plate. A decrease in local heating with the increase in thickness ratio was found. Maximum temperature shift was found to be in thick plate side. In the combined effect refocus of molten material occurred on the plane of symmetry of work-piece. Here nugget was having larger volume and more regular shape and diameter was constant along the thickness. Similar three sheet joining study gave the information that 1st heating zone appeared in interface but nugget formed at corner of middle sheet and found to be symmetric. But in case of dissimilar three sheets joining the location of heat effected zone is more complex one.

Nilesh T. Mohite et. al. [**3**] in 2014 experimented on similar metal sheet joining by resistance spot welding to get optimal geometrical parameters for better strength of weld joint. Material chosen was AISI 1008 of thickness 1.2mm and the geometrical parameters chosen were Distance between welds, Overlapping length, Distance of weld from the edge towards the percentage improvement of joint strength. Here L9 orthogonal array is used as design of experiment and each experiment was repeated 5 times each. The conclusions drawn from the prescribed experiment was that the most significant factor affecting tensile strength is geometry parameter distance between two welds followed by overlapping length and distance of weld from edge. From response table it is found that distance between welds has greatest effect on tensile strength and it followed by dist of weld from edge and overlapping length. From Taguchi's design of experiment (DOE), it was found that distance between welds(level-3), overlapping length(level-1) and distance of weld(level-2) from the edge (A3-B1-C2) had given the maximum tensile strength value. For this parametric combination prediction of tensile strength is done according to Taguchi and it is 115.90 N/mm2. For this experiment tensile strength is 116.335 N/mm2. This is very close to predicted value, indicating that the use of Taguchi Design for analysis and optimization of control parameters is appropriate.

M. Ishak et. al. [**4**] in 2014 joined AISI 301 and AISI 1020 sheets by resistance spot welding. Both tensile test and charpy test were performed to find out optimal process parameters. Input parameters were taken as current, electrode force and squeeze time. L9 orthogonal array was found out for experimentation by Taguchi DOE. Calculation of S/N ratio and analysis of variance were performed to get optimal input parameter values to get maximum tensile strength and hardness. Regression analysis was performed and surface contours were plotted to compare relation between parameters and responses. Due to an increase in the width and depth of the weld nugget the tensile strength and Charpy impact energy were found to be higher. The weld nugget dimensions (weld width and penetration depth) for optimum weld condition (OP), were highest when comparing all joints. No IMCs were visible at any joints. The descending order of parameters that has most influence on the response in this research was Welding Current> Welding Pressure> Welding Squeeze Time.

B. D. Parmar et.al. [**5**] in 2015 experimented on resistance spot welding of galvanized steel and performed optimization of parameters like current and welding time only. They put other parameters like electrode force, squeeze time, hold time and off time as constant. Taguchi method of optimization along with ANOVA was performed to optimize the process parameters to get maximum tensile strength. From the optimization and variance data it was found that current and sheet thickness has most effect on the joint strength and cycle time was a less effective factor. From this experimentation the result was drawn that with the increase in current the weld strength increases and as the sheet thickness increases the strength decreases for same process parameters in both the cases.

A. Karad et.al. in [**6**] 2016 has experiment on mild steel sample specimen to optimise the tensile strength. Samples were put in a dimension of 100X25mm for tensile testing. Input parameters were taken electrode force, current, welding time and output parameter was tensile strength. Here in this experimentation they had taken the Taguchi optimization method to find out optimal input parameters to get maximum tensile strength. From the response surface methodology the optimal values of electrode force, current and time were found to be 536kgf, 10KA, 24 cycles respectively as optimal values.

T. Mathew Vinoth et.al. [**7**] in 2016 experimented on AISI 202 stainless steel and AISI 1018 mild steel of 2mm thickness each. Electrode force, current, welding time were taken as input parameter and tensile strength, hardness were taken as output parameter. L27 orthogonal array was chosen after design of experiment. From the experimentation and response surface methodology current and welding time were found to have maximum effect on tensile strength and hardness rather than electrode force. The maximum tensile strength of 16.773 KN could be obtained under the welding conditions of electrode resistant force 3.668 KN, weld current 11.256 KA and weld time 14.96 cycles. Under these welding conditions, the generation of heat to get resistant was optimum to create sufficient plastic deformation between the materials in spot welding.

Asif BUTT et.al. [**8**] in 2016 welded hot rolled low carbon steel by resistance spot welding process. Samples were 200 mm in length and 40 mm in width with an overlap of 40 mm. In this study micro-structural analysis of optimum parameter sample was performed. Optimum process parameters were determined using MINITAB software and a regression equation was generated based on which nugget size, breaking load and tensile strength were determined. The researchers here have found out the effect of only current on weld strength by varying the sheet thickness from 0.8 to 1 mm.

Jan vinas at. al. [**9**] in 2016 spot welded hot-dip galvanised micro-alloyed steel sheets of H260 LAD EN 110292/2000 and H340 LAD EN 10292/2000 of thickness 1 mm. Experiments were performed by keeping current and time as variables but keeping the electrode load constant. Load bearing capacity of joint was determined by static tensile test using STN 051122 standards. Dimensions and inner defects were determined by metallurgical analysis by light optical microscope. The authors here used the welding machine BPK 20. From this experimentation results drawn were as increase in weld current gradually increasing the load bearing capacity of weld joints. A brass layer was observed near electrode and weld surface contact area, which was proved by EDX analysis.

3. CONCLUSIONS

This study was broadly regarding the optimization of resistance spot welding techniques with both similar and dissimilar metal joining with similar or dissimilar thicknesses. From this review study the following points are drawn as conclusions:-

- Resistance spot welding is a completer parameter based joining process where the operating parameters are current, electrode force, time, electrode geometry, sheet thickness etc.
- Out of all process parameter current and electrode force have maximum and drastic effect on the joint strength.
- S/N ratio is an important determination in calculate the scares and disturbances.
- Fabrication in RSW is possible using both similar and dissimilar metals with both same as well as different thicknesses.
- Taguchi is a most frequently used optimization method with analysis of variance, while genetic algorithm and response surface methods are also used.

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