A Review Paper On Optimization Of Process Parameter Of Spot Welding By Multi Objective Taguchi

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Abstract - ***The automotive industries choose resistance welding for manufacturing because of the great advantages this process has to offer. When over 5000 welds need to be made in a typical car, a process where each weld takes less than a second is of great importance. The process is also adaptable to robotic manipulation so the speed is extremely fast. It is excellent for the sheet metals used in automotive construction, and because no filler metal is needed, the complex wire feed systems in many arc welding processes are avoided. Hence this paper is directed towards the optimization process parameter of resistance spot welding process and simultaneously consider multiple quality characteristics tensile strength and nugget dia. using Multi Objective Taguchi Method. The experiment is conducted with varying Electrode force, current and weld time. The optimum welding parameter is obtain using signal to noise ratio and significant level is analyzed using analysis of variance. After considering all the parameters this study represent the systematic approach the effect of process parameter (Electrode force, current and weld time) on the tensile strength of resistance weld joint D-Grade as per IS 531 :1994.***

Key Words: **Resistance spot welding, Optimization, Multi Objective Taguchi Method**

1.INTRODUCTION

Thousands of automobile products need sheet metal components in tremendous quantity world over. High volume of production at lowest possible cost is the driving potential of sheet metal technology which is undergoing technological transformations due to flourishing of automobile industry globally. Sheet metal components are of strategic importance especially in automotive industry. The tensile shear strength, nugget diameter, burr size, dimensional accuracy, profile correctness, surface smoothness etc. are of great concern as quality characteristics of the resistance spot welding products. Sheet thickness and process parameter is the key of increasing productivity of sheet metal welding process.

The resistance spot welding involves optimization of input process parameter and the product quality parameters. The obvious shear strength phenomena of resistance spot welding and development of process robustness with respect to tensile shear strength and nugget diameter formation is of technical importance. The challenge for manufacturing engineers is of determining the optimum process parameter for spot welding machine sheets without high tensile strength or internal defects at a lower manufacturing cost, depending on the material, the input process parameter, and the process

Current research on the control of spot welding operations aim is to improve the monitoring and control of the quality of components. The motivation is the reduction of rejected volume, the reduction of manual quality control, and the high cost of rejection. Correct parameter choice for a new product manufactured by sheet metal spot welding is determined empirically by performing a large number of expensive tests. The electrode force, current, time and the sheet thickness are the major factors that determine the shear strength and the quality of the work piece Spot welding has a large number of inputs. Each of these inputs has an associated variation that leads to variations in the final part. Optimizations of manufacturing processes and parameters control are known to have direct impact on the production line maintenance and operations. Among the most important tools for manufacturing processes optimization is the design of experiments (DOE) approach. In Taguchi method, quality is measured by the deviation of a characteristic or attribute from its target value. A loss function is developed which is a measure of this deviation. Uncontrollable factors also known as noise factors, cause such deviation and thereby lead to loss. Elimination of these noise factors is impractical and often impossible. This study seeks to minimize the effects of noise and to determine the optimal level of the important controllable factors based on the concept of robustness. The objective of this study is to understand the creation of a product or process design that is insensitive to all possible combinations of uncontrollable noise factors and is at the same time effective and cost-efficient as a result of setting the key controllable factors at certain levels. The central purpose of this study is to understand and evaluate the impact of Taguchi methods in quality engineering and management for product or process parameters optimization. This study also presents a step by step approach to the optimization of a production process by the utilization of Taguchi methods of experimental design.

1.1 Mechanism Of Resistance Spot Welding Process

Resistance spot welding is commonly used in the automotive industry for joining thin sheet metals. Compared with other welding processes such as arc welding processes, resistance spot welding is fast, easily automated and easily maintained. This welding is a complicated process which involves interaction of electrical, thermal, mechanical and metallurgical phenomena. In this process, the materials to be joined are brought together under pressure by a pair of electrodes and then a high electric current is passed through the work pieces between the electrodes. Due to contact resistance and Joule heating, a molten weld nugget is formed in the work pieces. The work pieces are joined as solidification of the weld pool occurs. Moreover, force is applied before, during and after the application Of electric current, to maintain the electric current continuity and to provide the pressure necessary to form the weld nugget. The total heat generation between two sheets per unit time is defined as the product of the current intensity squared, multiplied by the total Resistance and the welding efficiency.

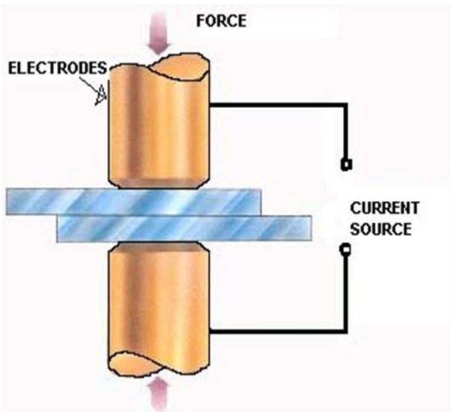

Fig -1: **Working Principle Of Resistance Spot Welding Process.**

The heat generated is expressed by the equation,
$E=I^2*R*t$
Where- E is the heat energy,
I is the current,
R is the electrical resistance
t is the time that the current is applied.

1.2 Steps Involved in Taguchi method

The use of the parameter design of the Taguchi method to optimize a process with multiple performance characteristics includes the following steps:
a) Define the problem.
b) Selection of factors and number of levels.
c) Selection of appropriate Orthogonal Array (OA).
d) Performing the experiments
e) Statistical analysis and interpretation of experimental results.
f) Determination of optimal condition.
g) Confirmation run or experiment be used.

2. REVIEW OF EXPERIMENTAL INVESTIGATION

A.K. Pandey, M. I. Khan, K. M. Moeed et al. (2013), represents that RSW has excellent techno-economic benefits such as low cost high production rate and adaptability for automation which make it an attractive choice for auto-body assemblies, truck cabins, rail vehicles and home appliances. It is one of the oldest of the electric welding processes in use by industry today. Furthermore, other metal-to-metal connections, such as wire-to-wire joints in the electronics industry, are accomplished by resistance spot welding. Application-specific measures, such as the diameter of the welding spot, determine the quality of the joint. The weld is made by a combination of heat, pressure, and time. As the name implies, it uses the resistance of the materials to the flow of current that causes localized heating between the parts to be joined.[1]

Norasiah Muhammad, Yupiter HP Manurung, Mohammad Hafidzi,SunhajiKiyaiAbas,GhalibTham,M.RidzwanAbd. Rahim et al. (2012), presented a systematic approach optimizing the weld zone developed by the resistance spot welding (RSW). This approach considers simultaneously the multiple quality characteristic (weld nugget and heat affected zone) using Multi-objective Taguchi Method (MTM). The experimental study was conducted under varying welding currents, weld and hold times for joining two sheets of 1.0mm low carbon steel. The setting of welding parameters was determined using Taguchi experimental design method and L9 orthogonal array was chosen. The optimum welding parameter for multi-objectives was obtained using multi signal to noise ratio (MSNR) and the significant level of the welding parameters was further analyzed using analysis of variance (ANOVA). Furthermore, the first order model for predicting the weld zone development was developed by using Response Surface Methodology (RSM). Confirmation experiment was conducted at an optimal condition for observing accuracy of the developed response surface model. Based on the confirmation test results, it is found out that the developed model can be effectively used to predict the size of weld zone which can improve the welding quality and performance in RSW.[2]

Hamid Eisazadeh, Mohsen Hamedi, Ayob Halvaee.et al. (2011),says that Resistance spot welding process (RSW) is one of important manufacturing processes in automotive industry for assembling bodies. Quality and strength of the welds and therefore body mainly are defined by quality of the weld nuggets. The most effective parameters in this process

are: current intensity, welding time, sheet thickness and material, geometry of electrodes, electrode force, and current shunting. In present research, a mechanical–electrical–thermal coupled model in a finite element analysis environment is made using. Via simulating this process, the phenomenon of nugget formation and the effects of process parameters on this phenomenon are studied. Moreover, the effects of welding parameters on temperature of faying surface are studied. Using this analysis, shape and size of weld nuggets are computed and validated by comparing them with experimental results from published articles. The methodology developed in this paper provides prediction of quality and shape of the weld nuggets with variation of each process parameter. In addition, the process can be economically optimized to manufacture quality automotive bodies.
The input parameters to the model can be adjusted to give different sizes of the weld nugget. As a result, optimum setting of the welding parameters for the desired quality and different materials of the work piece can be obtained through simulations, without performing large number of physical experiments. The following conclusions can be drawn from this study: If the electric current flow exceeds the flow necessary for nugget growth, causes a rapid growth of nugget. The nugget growth rate decreases as the current flow increases but the nugget size raises until melt spattering occurs. Therefore, space between nuggets affects current flow which means that to eliminate the current shunting more space between nuggets is necessary. Increasing electric cycles remarkably raises the contact surface temperature so that the contact zone melts leading to a big nugget but no melt spattering occurs. In fact, increase of welding time gives equilibrium to the melt pool. Increase of load on the electrodes decreases the nugget size as it raises the contact surface area. If the plate thickness is increased, the current flow needed for the formation of appropriate weld nugget increases. Decreasing the plate thickness lowers the electrode diameter.[3]

A.G.Thakur and V.M. Nandedkar (2010), represented a systematic approach to determine the effect of process parameter on Tensile strength of RSW austenitic stainless steel AISI 304 using Taguchi method.[4]

UgurEsme et al. (2009), represented that an investigation on the optimization and effect of welding parameters on the tensile shear strength of spot welded SAE 1010 steel sheet using Taguchi method. An optimum parameter combination for the maximum tensile shear strength was obtained by using the analysis of signal-to-noise(S/N) ratio. The confirmation tests indicated that it is possible to increase tensile shear strength significantly by using the proposed statistical technique. The experimental results confirmed the validity of the used Taguchi method for enhancing the welding performance and optimizing the welding parameters in resistance spot welding operations.[5]

S. Aslanlar A. Ogur.U. Ozsarac, E. Ilhan et al. (2008), represent the effects of welding time on the tensile-peel strength and tensile-shear strength of welding joints in electrical resistance spot welding of chromate micro-alloyed steel sheets having 1.2 mm thicknesses were investigated. The electrode pressure was fixed at 6 KN. The welding joints were exposed to tensile-peel and tensile-shear tests, and the effect of welding time on tensile-peel strength and tensile-shear strength was researched by using related period diagrams. The optimum welding times were obtained.[6]

3. CONCLUSIONS

Based on the observations of this Paper, it can be concluded that, Taguchi methods provide a systematic approach to a better understanding of the process and assist industrial engineers to discover the key process variables which affect the critical process or product characteristics. Taguchi's philosophy is more relevant in terms of working towards a target performance, which essentially reflects the continuous improvement attitude as there is no standard data for process parameter is available from the resistance welding manufacturer's association (American welding society)every time with respect to thickness of material to be welded company does the trial and error basis experiment for optimizing the process parameter with reference lower thickness parameter from resistance welding manufacturer's association standard table. So multi objective taguchi approach will be useful to find out the optimum level of parameter like Electrode force, current and weld time for resistance spot welding.

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