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A Review Paper on Optimization of Process Parameter of Resistance Spot Welding

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Abstract: Resistance spot welding is commonly used in sheet joining in the aerospace industry and automotive industry, because it has the advantage which is high-production assembly lines, high speed and suitability for automation. Resistance Spot Welding (RSW) is widely used for its low cost, simple mechanism, high speed and applicability for automation. It depends on the amount of current flowing and resistance of the base metal to produce the heat necessary to make the spot weld. There are various process parameters such as weld current, electrode force and, weld time which affects the weld nugget and its strength. So it is necessary to optimize the process parameters of resistance spot welding process. Therefore it is very important to understand the behavior of spot welds and their failure characteristics.
Keywords: Optimization, Resistance spot welding, Steel sheet, Tensile Shear Strength, Welding parameters.

I. INTRODUCTION

Resistance spot welding (RSW) is an important metal joining process and widely used in sheet metal fabrication. It has got lot of applications in the field of, rail coach manufacturing, aerospace and nuclear sectors, electric and electronic industries and automobile industries. It can be used on a variety of materials such as nickel, low carbon steel, aluminum, titanium, copper alloy, high strength low alloy steel and stainless steel [1]. In Robotics it is also plays an important role [2]. Reference [3] stated that the modern vehicle contains 2500 to 5000 spot welds. Simplicity, high speed, low cost and automation possibility are among the advantages of this process [4].

It is a process of joining by fusion at discreet spots at the interface of work pieces, two or more metal parts are joined. At their interface heat is generates when resistance to current flow through the metal work pieces and at the interface of work pieces temperature rises. The metal will begin to fuse when the melting point of the metal is reached, and a nugget begins to form. The current is then switched off and the nugget is cooled down to solidify under pressure [5]. The amount of heat produced is a function of time, current and resistance between the work pieces. Current, time, contact resistance, property of the electrode material, electrode force, sheet materials, surface condition etc. are the major factors controlling this process [6].

A. Mechanism of Resistance Spot Welding Process

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

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.

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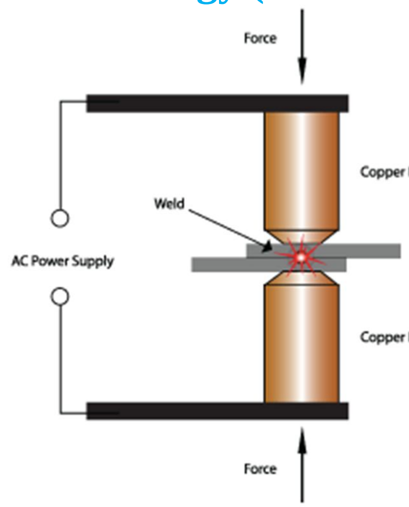

Fig. 1: Working Principle of Resistance Spot Welding Process

II. LITERATURE SURVEY

Reference [7] used Sorpas software to assist design of resistance welding parts and joints. Important time and money can be saved with the use of Sorpas software that simulates the process of resistance welding. It determines welding parameters, how welding parameters can be optimized for various conditions in production, and forecasts the microstructure of the parts after welding.

Reference [8] presented the welding process design and parameter optimization of resistance spot welding used in joining of low carbon steel sheet of thickness 0.8 mm and metal strips of cross section 10 x 5mm for electrical motor applications. They used Taguchi method for optimization of parameters. Welding current and weld time (current- 3.5kA and time- 10 cycles) were selected as input parameters from Taguchi analysis. After experiment result showed that the weld quality was within adequate interval.

Reference [9] used Taguchi method to determine the values of welding parameter. This paper is based on an examination of the effect and optimization of welding parameters on the tensile shear strength in the RSW process. The experiment was conducted under varying welding currents, electrode forces and welding times. To determine the combination of the optimum welding parameters analysis of Signal-to-Noise (S/N) ratio is used. The experimental results show that in spot welding, the welding parameters are the important factors for the strength of the welded joint. This may decrease or increase the strength of the welding joint. So we can say that for the maximum strength of the spot welded joint the combination of the suitable parameters is necessary.

Reference [10] shows for joining two sheets of 1.00 mm they considered welding current, weld and hold time as a welding parameters. The Multi objective Taguchi Method (MTM), response surface method (RSM) and Taguchi experimental design method has been used to develop the response models and to optimize the multiple quality characteristics which are width of HAZ and radius of weld nugget. After the experiment the results shows that the developed model can be adequately used to predict the size of weld zone which can improve the welding quality and performance in RSW.

Reference [11] in the year 2009 made a study on resistance spot welding (RSW) of dissimilar metal between AISI 304 austenitic stainless steel and mild steel, having medium range thickness. The spot welding of dissimilar metals of medium range thickness (0.8 mm to 1.2 mm S.S. sheets and M.S.) was carried out by varying the welding parameters such as welding current, welding force and welding time. They used a polynomial equation of first order to correlate weld time with weld strength, weld current and weld force was developed.

Reference [12] investigated the properties of unlike resistance spot welds (RSW) between austenitic CrNi stainless steel and low carbon steel. The thickness of the welded unlike materials was 2 mm. They reported that the Heat affected zone (HAZ) of the low carbon steel sheet had been found wider than the HAZ of the austenitic stainless steel. In the fusion zone the hardness was found to be higher.

Reference [13] have studied the effect of process parameters on austenitic stainless steel 304L such as arc intensity, applied load and welding duration on the mechanical characteristics of the weld joint. The results showed that the applied load seems to be the control factor of the mechanical characteristics of weld joint compared to the current intensity and welding duration.

Reference [14] used CRCA (close rolled close annealing) steel sheets and thickness is 2mm. They studied on the effect and the optimization of the welding parameters such as welding current, welding time, & electrode force on the tensile shear strength of the resistance spot welded joints. To analyze the effect of these parameters on tensile shear strength values and to find the optimal process parameters levels Taguchi method was used. The welding current was found to be the most effective factor in spot welding process. The contribution of weld time, electrode force and welding current towards tensile strength is 42.19%, 7.85% and 49.72% respectively and it was determined by the ANOVA method.

Reference [15] determines effect of process parameters initial measure of tensile strength, nugget diameter, penetration and weld quality. By the use of Taguchi method some welding parameters like weld cycle, welding current, hold time & cool cycle using quality tools were selected. On the basis of ANOVA method, weld cycle are found as the highly effective parameters on indentation, interaction between weld cycle & weld current and interaction between weld current, hold time & weld cycle whereas hold time, cool time and weld current were less effective factors.

Reference [16] used Taguchi method to investigated effect of process parameters on resistance spot welding (RSW). They have taken welding time, welding current, electrode force and electrode diameter parameters for their study. By the using of ANOVA method the current and electrode force were the most influence factors on welding process.

Reference [17] used austenitic stainless steel type 304 for researched on spot welding. The relationship of hardness distribution, welding current and nugget diameter was investigated. They found out that welding current does not much affect the hardness distribution and increasing welding current gives large nugget diameter.

Reference [18] used 1050 Aluminum metal as a material and stated that with an increasing exhausting pressure an identical welding current, nugget penetration increases. The results suggested that near the fusion boundary on the 1050 material, fracture always occurs. At the fusion boundary the hardness increases.

Reference [19] used Taguchi method for an investigation on the effect and optimization of welding parameters on the tensile shear strength of spot welded SAE 1010 steel sheet. By using the analysis of signal-to-noise(S/N) ratio an optimum parameter combination for the maximum tensile shear strength was obtained. The experimental results confirmed the legality of the used Taguchi method for enhancing the welding performance and optimizing the welding parameters in resistance spot welding (RSW) operations.

III. CONCLUSION

The work presented here is an overview of recent works of Resistance Spot Welding (RSW) process and future references. From above discussion it can be concluded that the resistance welding process is highly rely on the process parameter such as welding current, weld time, electrode force. Some research papers also concluded that with use of Taguchi method and ANOVA there is increase in tensile strength. In spot weld increasing welding current, increases the nugget size and however increasing welding current does not increase the hardness distribution. The weld time and welding current increments have resulted diameters increment at the welded zones.

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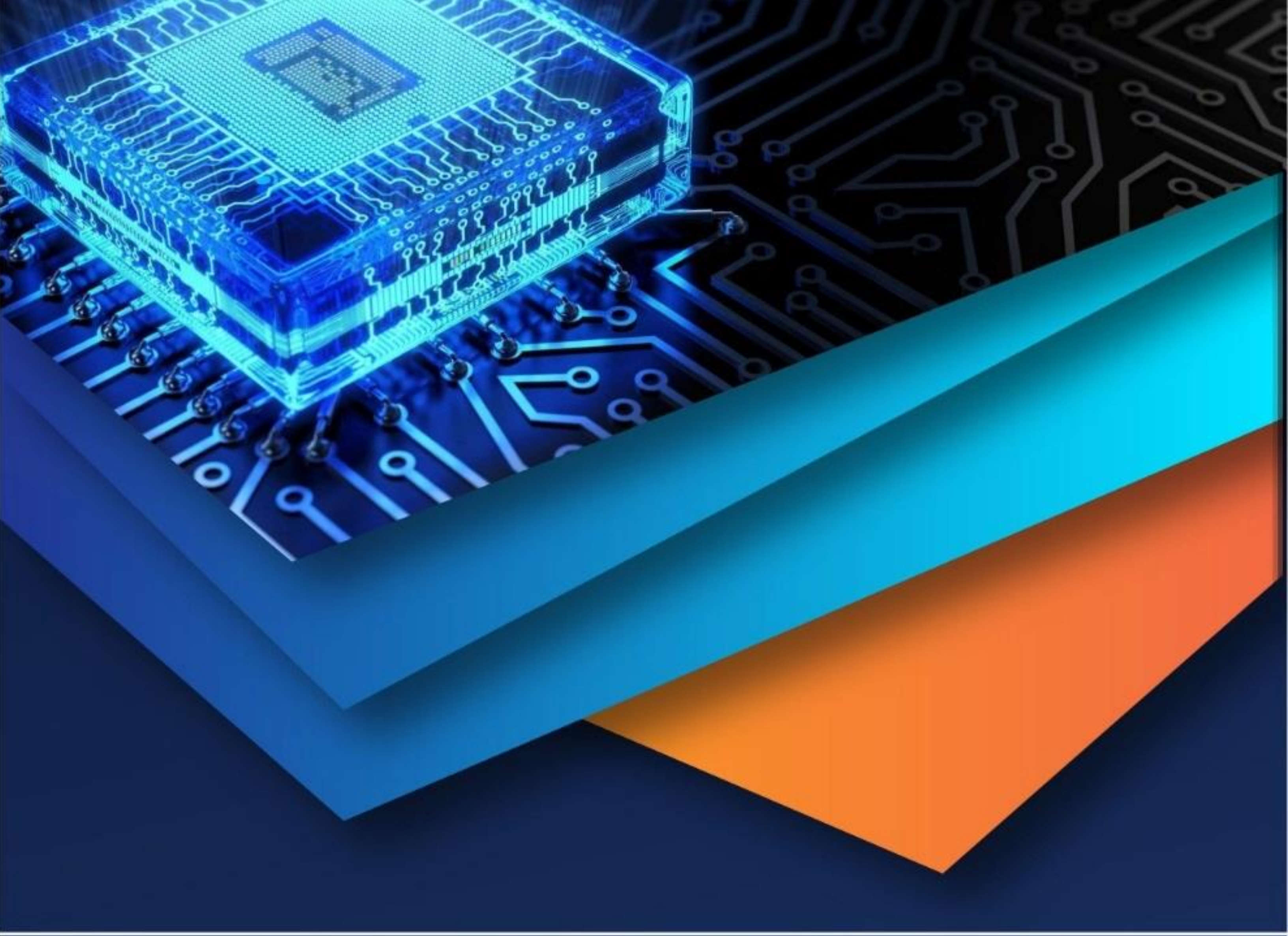

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