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Design Optimization and Analysis of Spot Welding In SS202 and GI Sheet

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Abstract : *Resistance spot welding is one of the suitable production methods for welding all kinds of sheet metal works. Spot welding process has excellent techno-economic benefits such as low cost, Low operating electric power, Zero tool wear and Adoptability of Automation which make alternative choice of Automobile body assemblies an electro conductive contact surface is created between the work pieces by pressing them together.SS202 and GI sheet plays an Important Role in automotive and food processing industry for Superior properties of high corrosion resistant. Weld voltage, Weld current and electrode force are the input parameters of spot welding process and Hardness values of welded joints are the response parameter.L_9Design of experiment are used to find higher hardness values of spot welded joints. The hardness values of spot welded joint are optimized by Signal to Noise ratio and analyzed by ANOVA method.*

Keywords: Galvanized Iron (GI), Analysis of variance (ANOVA).

INTRODUCTION

Welding is a process in which two or more parts are joined permanently at their touching surfaces by a suitable application of heat and/or pressure. Often a filler material is added to facilitate coalescence. The assembled parts that are joined by welding are called a weldment. Welding is primarily used in metal parts and their alloys.

Resistance welding is one of the oldest of the electric welding processes in use by industry today. The weld is made by a combination of heat, pressure, and time. As the name resistance welding implies, it is the resistance of the material to be welded to current flow that causes a localized heating in the part. The pressure exerted by the tongs and electrode tips, through which the current flows, holds the parts to be welded in intimate contact before, during and after the welding current time cycle. The required amount of time current flows in the joint is determined by material thickness and type, the amount of current flowing, and the cross-sectional area of the welding tip contact surfaces. In the illustration below a complete secondary resistance spot welding circuit is illustrated. For clarity, the various parts of the resistance spot welding machine are identified.

PRINCIPLE OF RESISTANCE SPOT WELDING:

Resistance welding is accomplished when current is caused to flow through electrode tips and the separate pieces of metal to be joined. The resistance of the base metal to electrical current flow causes localized heating in the joint, and the weld is made. The resistance spot weld is unique because the actual weld nugget is formed internally in relation to the surface of the base metal.

SPOT WELDING PARAMETERS:

Heat Generation:

A modification of Ohm’s Law may be made when watts and heat are considered synonymous. When current is passed through a conductor the electrical resistance of the conductor to current flow will cause heat to be generated.

The basic formula for heat generation may be stated:

$$H = I^2R$$

Where, H = Heat
I = Welding Current
R = Resistance

The secondary portion of a resistance spot welding circuit, including the parts to be welded, is actually a series of resistances. The total additive value of this electrical resistance affects the current output of the resistance spot welding machine and the heat generation of the circuit.

Welding current:

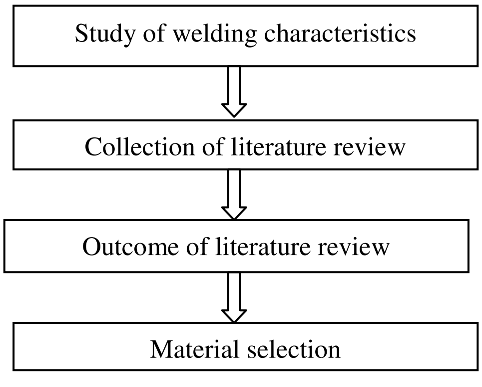
The welding current is the most important parameter in resistance welding which determines the heat generation by a power of square as shown in the formula. The size of the weld nugget increases rapidly with increasing welding current, but too high current will result in expulsions and electrode deteriorations. Types of the welding current applied in resistance welding including the single phase alternating current (AC) that is still the most used in production, the three phase direct current (DC), the condensator discharge (CD), and the newly developed middle frequency inverter DC. Usually the root mean square (RMS) values of the welding current are used in the machine parameter settings and the process controls. It is often the tedious job of the welding engineers to find the optimized welding current and time for each individual welding application.

Welding time:

The heat generation is directly proportional to the welding time. Due to the heat transfer from the weld zone to the base metals and to the electrodes, as well as the heat loss from the free surfaces to the surroundings, a minimum welding current as well as a minimum welding time will be needed to make a weld. If the welding current is too low, simply increasing the welding time alone will not produce a weld. When the welding current is high enough, the size of the weld nugget increases with increasing welding time until it reaches a size similar to the electrode tip contact area. If the welding time is prolonged, expulsion will occur or in the worst cases the electrode may stick to the workpiece.

Welding force:

The welding force influences the resistance welding process by its effect on the contact resistance at the interfaces and on the contact area due to deformation of materials. The workpieces must be compressed with a certain force at the weld zone to enable the passage of the current. If the welding force is too low, expulsion may occur immediately after starting the welding current due to fact that the contact resistance is too high, resulting in rapid heat generation. If the welding force is high, the contact area will be large resulting in low current density and low contact resistance that will reduce heat generation and the size of weld nugget. In projection welding, the welding force causes the collapse of the projection in the workpiece, which changes the contact area and thereby the contact resistance and the current density. It further influences the heat development and the welding results.



EXPERIMENTAL PROCEDURE

Spot welding involves three stages; the first of which involves the electrodes being brought to the surface of the metal and applying a slight amount of pressure. The current from the electrodes is then applied briefly after which the current is removed but the electrodes remain in place for the material to cool. Weld times range from 0.01 sec to 0.63 sec depending on the thickness of the metal, the electrode force and the diameter of the electrodes themselves.The equipment used in the spot welding process consists of tool holders and electrodes. The tool holders function as a mechanism to hold the electrodes firmly in place and also support optional water hoses that cool the electrodes during welding. Tool holding methods include a paddle-type, light duty, universal, and regular offset. The electrodes generally are made of a low resistance alloy, usually copper, and are designed in many different shapes and sizes depending on the application needed.The two materials being welded together are known as the work pieces and must conduct electricity. The width of the work pieces is limited by the throat length of the welding apparatus and ranges typically from 5 to 50 inches (13 to 130 cm). Workpiece thickness can range from 0.008 to 1.25 inches (0.20 to 32 mm).After the current is removed from the workpiece, it is cooled via the coolant holes in the center of the electrodes. Both water and a brine solution may be used as coolants in spot welding mechanisms.

ANALYSIS AND OPTIMIZATION:

Taguchi method is a powerful tool in quality Optimization makes use of a special design of orthogonal array (OA) to examine Number of experiments used to design the orthogonal array for 2 factors and 3 levels of welding parameters

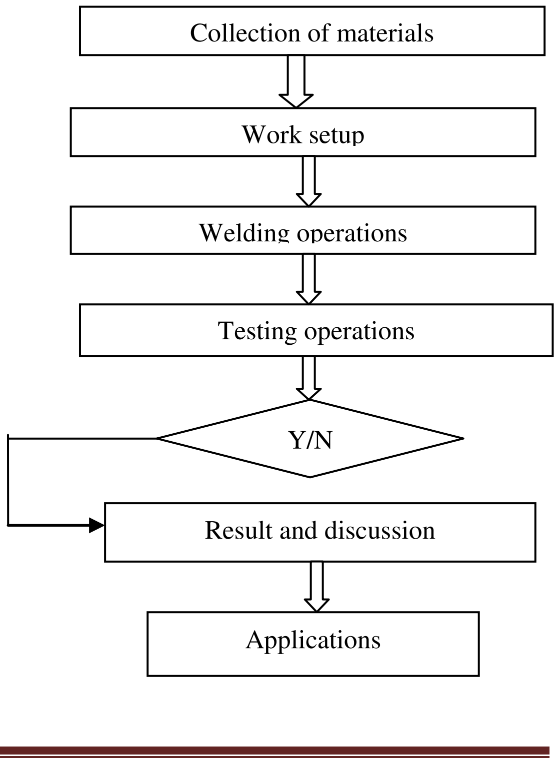


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Fig.1.Experimentation Methodology

Table L 9 Orthogonal array for weld parameters

Test numbers	Weld Voltage	Weld current
1	1	1
2	1	2
3	1	3
4	2	1
5	2	2
6	2	3
7	3	1
8	3	2
9	3	3

Table 2.Spot welded parameters of galvanised iron:

Voltage	Current	Resistance	Temperature
1	1	1	40.4
1	2	2	41.3
1	3	3	42.4
2	1	2	45.4
2	2	3	50.2
2	3	1	52.8
3	1	3	53.4
3	2	1	55.2
3	3	2	58.0
1	1	1	40.4

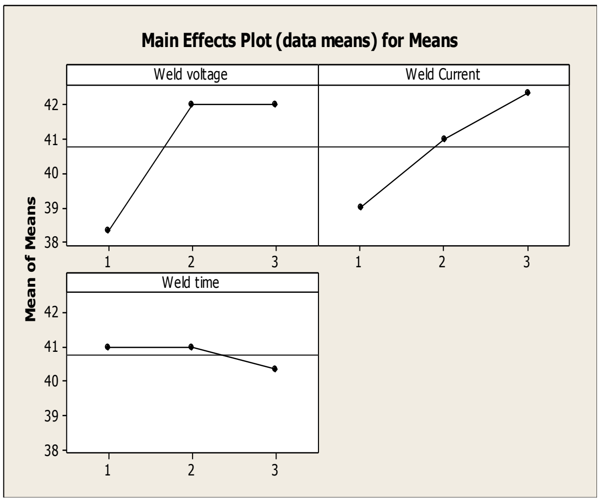

Figure2 Main effect plot for spot welding of stainless steel

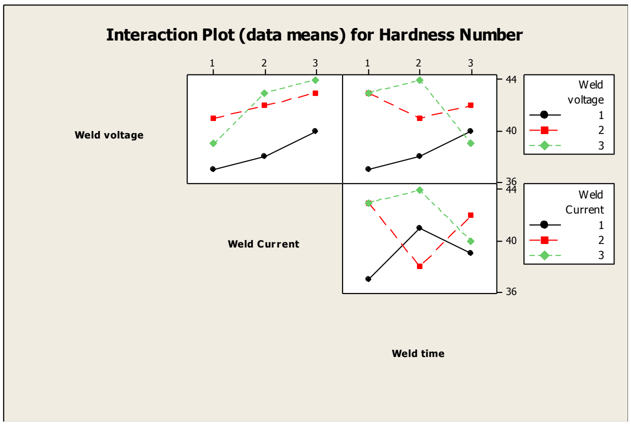

Figure 3 Interaction plot for Hardness number

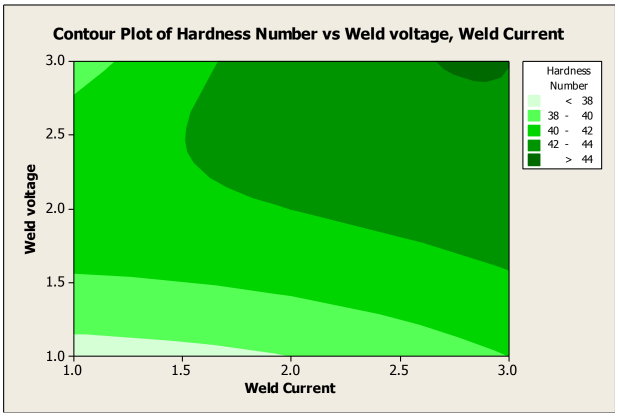

Figure 4 Contour plot of spot welding process parameters

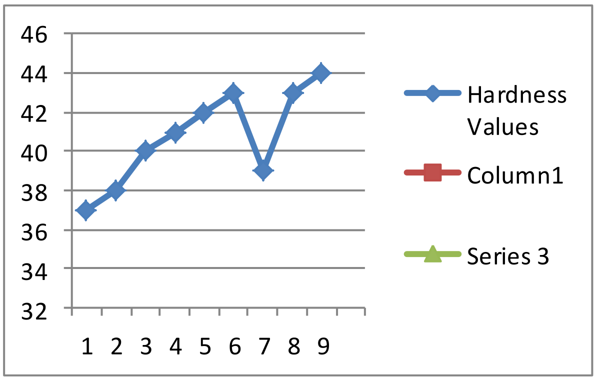

Figure 5 Hardness test values of Stainless steel

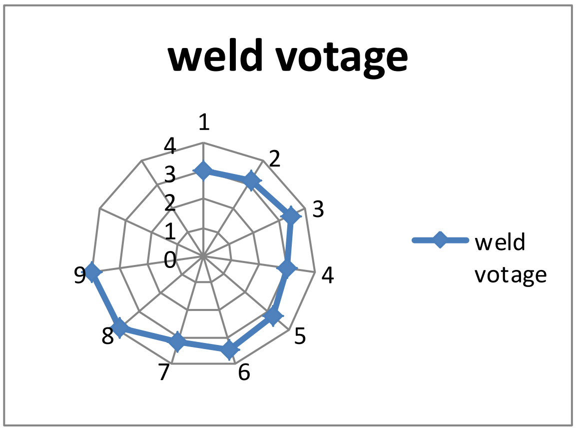

Figure 6 weld voltage

CONCLUSION

After conducting experiments on stainless steel and galvanized iron using spot welding machine.

- Spot welding machine is suitable for weld Stainless steel and Galvanized iron sheets with optimum weld parameters.
- Stainless steel and galvanized iron of Spot welded joints are provided good weld ability property and consume less electrical power.
- Spot welded joints having high hardness values of optimum weld voltage and weld current selected by spot welding machine.
- During spot welding process No tool wear is occur and produce sound weld joints.

Spot welding machine is suitable for weld components of automotive and medical applications

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