Resistance Spot Welding

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ME 669 - Design for Manufacturing
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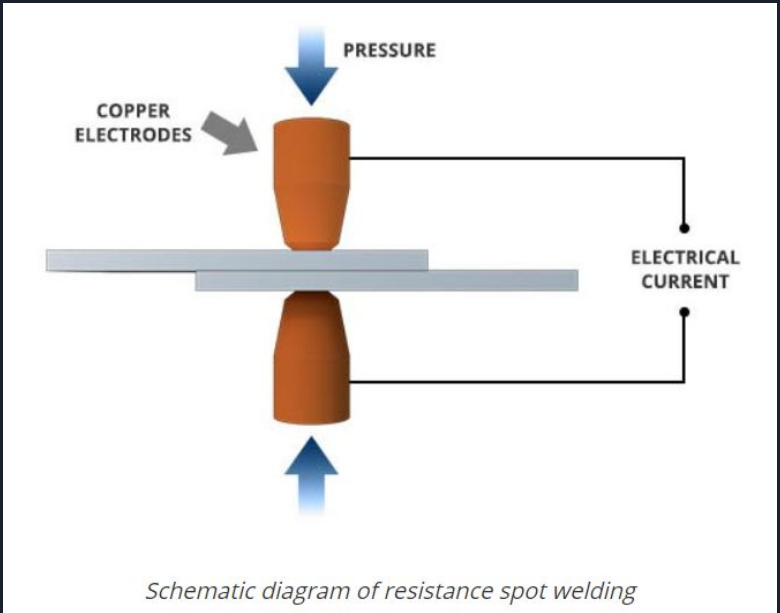
Working Principle



Schematic diagram of resistance spot welding

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Resistance Spot Welding is a thermo-electric process where heat is generated at the interface of the parts to be joined by passing an electrical current through them or a precisely controlled time and under a controlled pressure (also called force).

Resistance spot welding is simple heat generation process which is based on principle that the passage of current through a resistance generates heat.

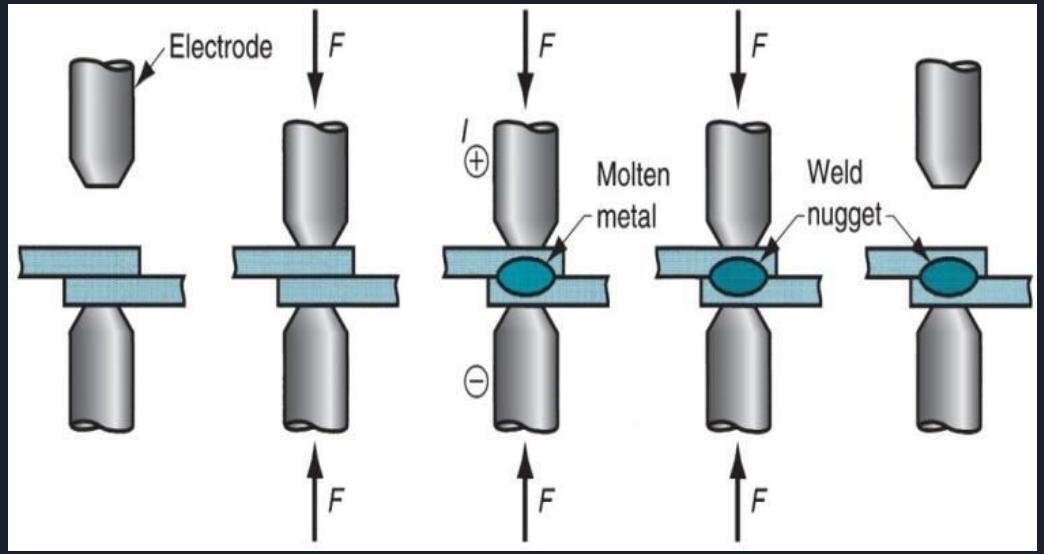
According to Joule's law of heating: $Q = I^2Rt$,

Where,
'Q' = heat generated during RSW,
'I' = welding current,
'R' = resistance setup at the interface
't' = welding time employed

Physical Phenomena

The process involves applying pressure and heat to the weld area using shaped alloy copper electrodes which convey a high electrical current at low voltages through the workpieces.

Due to the resistance the workpieces offered to the current flow, the material melts, fusing the parts, at which point the current is turned off, pressure from the electrodes is maintained and the molten “nugget” solidifies to form the joint.



The welding heat is generated by the electric current, which is transferred to the workpiece through copper alloy electrodes.

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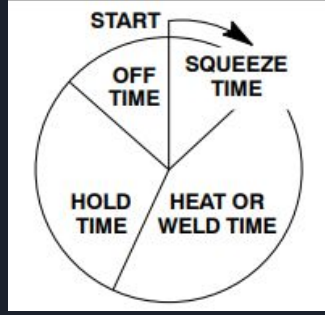
Process Variables



Applied Pressure (Electrode force, Diameter of the electrode contact surface):

If it is too low, expulsion may occur immediately. If it is high, the contact area will be large. It results in low current density and low contact resistance that will reduce heat generation and the size of the weld nugget.

Time (Squeeze time, Weld time, Hold time): 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.

Weld current: Heat generation by a power of square. The size of the weld nugget increases rapidly with increasing welding current, but too high current will result in expulsions.

Contact Resistance: contact resistance generally decreases with increasing temperature and it decreases almost proportionally with increasing pressure.

Material Properties: The resistivity of material influences heat generation. Thermal conductivity and the heat capacity influence the heat transfer

Surface Coatings

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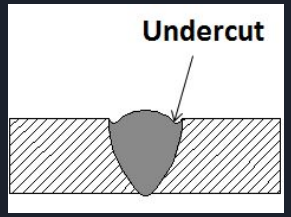
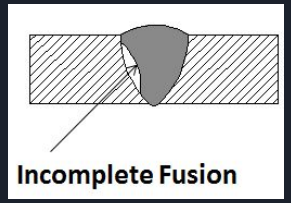
To avoid defects,

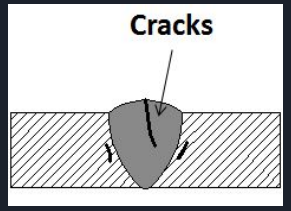


- Use a sufficiently high welding current with the appropriate arc voltage.
- Clean the metal.
- Use correct electrode diameter and angle.

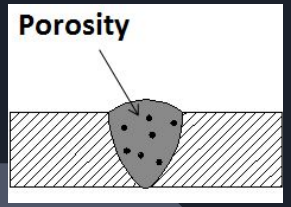


- Reduce the electrode's travel speed, but it also shouldn't be too slow.
- Use of proper electrode angle, with more heat directed towards thicker components.
- Use of proper current, reducing it when approaching thinner areas and free edges.

- Preheat the metal as required.
- Provide proper cooling of the weld area.
- Use proper joint design.
- Remove impurities.
- Make sure to weld a sufficient sectional area.
- Use proper welding speed and amperage current.



- Use dry electrodes and materials.
- Reduce arc travel speed, which will allow the gases to escape.
- Clean the materials before you begin welding.



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Applications

- Joining of vehicle body parts
- Fuel tanks
- Railway tracks
- Gas oil and water pipelines
- Turbine blades
- Aircraft/Aerospace

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Advantages

- Very short process time
- Operator safety because of low voltage
- Clean and environmentally friendly
- No consumables, such as brazing materials, solder, or welding rods
- A reliable electro-mechanical joint is formed
- Easy automation and cost-effectiveness

Limitations

- Low strength in the case of discontinuous welds
- High equipment cost
- Cracks in the Weld Area
- Asymmetrical Spot Weld Marks
- The thickness of welded sheets is limited (6 mm)

References:

Resistance Welding - types, parameters, & common issues

Spot Welding (With Diagram) | Metallurgy

Variables of Spot Welding | Metallurgy

Analysis of Process Parameters for Resistance Spot Welding Process Using Taguchi Method – A Review

Guidelines For Resistance Spot Welding

Most Common Welding Defects, Causes and Remedies - SLV

Resistance Spot Welding | AMADA WELD TECH

Fundamentals of Small Parts Resistance Welding

Resistance Spot Welding: Definition, Construction, Working Principle, Applications, Defects, Advantages, and Disadvantages

What is Spot Welding? (A Complete Welding Process Guide) - TWI

Thank You

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Have a nice day!