IMPROVING THE WELDING QUALITY BY TUNGSTEN ELECTRODE COMPOSITION IN RESISTANCE (PROJECTION) WELDING PROCESS

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Abstract: This paper explains about the key performance of specific material Tungsten electrode combination with Copper alloy to have a improved quality in Projection spot welding process, This copper alloy is specific combination than the regular Copper alloys, it will improve the conductivity, also the current flow is higher than the specification, it gives improved welding quality, the wear out of the materials is reducing trend so the life time of electrode is increased. The strength of the welded steel was found to increase in push of load test, The wear behavior of the copper alloy and tungsten composite revealed long time usage it gives more life time.

Keywords: Projection nugget, Push off load, strength, Quality improvements, Electrode life time increase, Resistance welding.

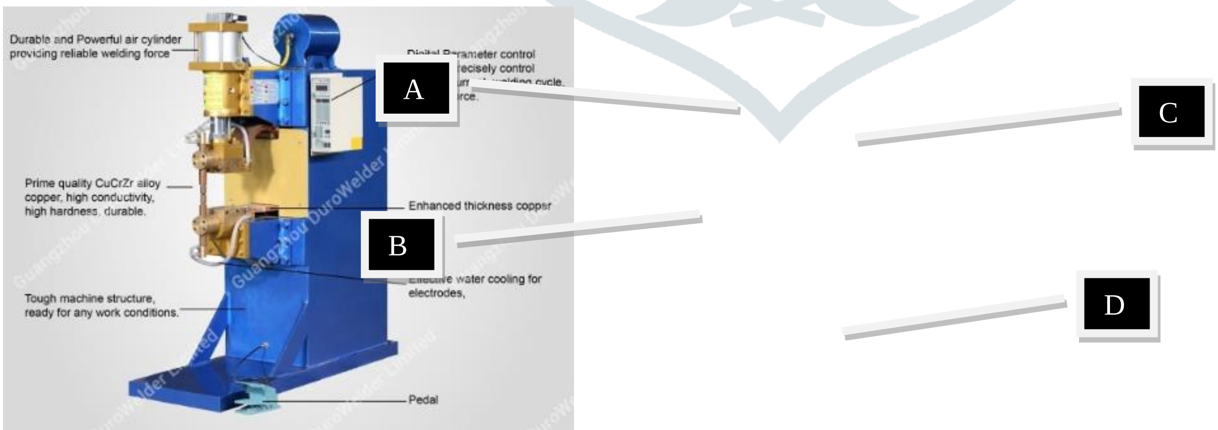
1) INTRODUCTION

Spot welding process is a method which joins the one or two sheet steel components for building BIW construction, in automotive or in Aero space industries. In all welding process, metal sheets are compressed with two or more sheet metals (Low carbon sheets) with specific based electrodes and an electric current is applied across the electrodes, Because of the mating (or faying) surface, the applied electric current is high enough to provide sufficient heat onto the surface contact point of the metal sheets. Over time, this repeated heating and pressing operation may contribute to electrode deformation, breakdown, softening, and mushrooming (Ref 2). When this occurs, a large current is required to accomplish the task due to the enlargement of the welding tips. This will continue until the deformed electrode is replaced. The welding behaves as per sheet combination, with zinc coating or Zinc annealing sheets,.

Let's talk about the Projection spot welding process, the process parameters are same as Spot welding process, but instead of welding two sheets metals, we weld MS coated or None coated fasteners in Sheet metal, fasteners like… Bolt, Nuts, stud etc… there is huge different specification in fasteners which give strength and load requirements to with hold as they are commonly known to offer a unique

combination of high strength and hardness with excellent electrical conductivity. The high thermal and electrical conductivities of copper make it suitable for spot

Fig 1.1 Schematic Diagram of Projection welding System or set up



a) CYLINDER UNITS WITH HIGH FORCE.
b) ELECTRODE
c) CONTROLLER AND DC or AC POWER SOURCE
d) MACHINE UNITS

Projection weld fasteners generally produce stronger, more precise welds than spot weld fasteners. The process uses two flat electrodes; the top one descends straight downward to produce complete compression, and the fastener projections turn to liquid nuggets and initiate fusion. Spot welding fuses fasteners without projections. The process shows its advantages when working in corners or other areas where a projection fastener wouldn't fuse properly, or in areas difficult for the electrodes on a press-type welder to reach.
Choosing which process to use—spot or projection welding—depends, like anything else, on the application of process and the load required. So the electrode type and load requirements place the major role to define the process parameters.

2) LITERATURE SURVEY

The effects of these parameters on weld penetration requirements have been studied

1. Projection welding fastener leg specification to be studied in advance for the load requirements as per base metal selection.
2. Welding quality depends on the machine specifications.
3. Effect of process parameters in resistance welding is controlled and results can be improved.

3) OBJECTIVES OF PROJECT

Objective of this experimental project are as follows,

1) Optimizing the process parameters within the machine capacity.
2) Improving the welding quality to achieve more push off load.
3) To give more strength to fastener to ensure passenger safety,
4) Design of experiment.

4) METHODOLOGY AND MATERIAL

4.1) Methodology

HSLA sheet for welding process is selected with 2mm thickness, sheets are with stamping holes min 8.2mm dia two sided holes are punched, the samples are 50mm length and 10mm width, as shown in Fig 1.2, the work piece of HSLA is of copper 0.12, Mn 1.4, Si 0.25, S 0.025,P 0.03, which has yield strength max 560, Mpa maz 640. Refer Fig 1.3.
The compositions of grades are selected because the welding quality and results are visible. So that other material can be easily improved from these mechanical compositions, the experiments are performed with 30 piece samples, with push off load experiment machine.
After welding, leg penetration will be checked with teardown (Destructive testing process) in Quality lab, all legs are checked as specimens welded with fasteners, the important dimensions of the weld bead geometry were measured.

(Figure 1.2) of sheets for welding

Chemical Comp (%) (BSK 46)	C	Mn	Si	S	P	
	0.12 max	0.8 – 1.4	0.25 max	0.01- 0.025	0.03 max	
Others	**Chemical Composition (%), max** Nb:0. 08 max / Al: 0. 02 min / N: 80 PPM max /Cu:0.2 max Mo+ Ni:0.4 max / Cr :- 0.2 max **Carbon Equivalent (CE):- 0.41 Max** C.E.= (C+(Mn/6)+((Cr+Mo+V)/5)+((Cu+Ni)/15)) Tramp/Trace elements other than specified should not exceed 0.2% in total by weight					
Mech Props	UTS(Mpa)	YS(Mpa)	% E	Bend Radius 180 °	Charpy (J)	Fatigue Str (Mpa)
	500-640	460 - 560	21 min	1 t	90 min	285 min

(Figure 1.3) of Mech & Chem properties

To meet the objective, experimental set up sis arranged first of all. The experimental setup consists of semi-automatic AC welding welding machine with control over welding parameters such as welding current, welding speed, pressure, FRL units etc. The experiment done by establishing the range of process parameters based on trial experiments and theoretical background of process parameter range selection from AWS (American Welding Society) Handbook titled "Weld ability of metals and alloys" The experimental readings is to be then taken like weld penetration, weld width and weld push off load readings, The push off load test with attached machine os validated and calibrated as per industry norms and which complies to welding audits and IATF audit requirements
The welding quality is improved as per the electrode output and welding zone which is monitored.

4.2) Material

HSLA alloy is used as a base metal for resistance welding, has thickness 2 mm. Welded specimen dimension is 50mm in length and 10 mm in width, and cleaned the surface of the plates and all the four edges of rectangular shaped metal plates are properly finished. All specimens are welded by plain single sheet.

Table 1 Chemical composition of HSLA as per the test report

Element	S	Mn	Si	Cr	Cu	P	Fe	Zn	Mg
% Weight	0.024	1.14	0.25	--	0.12	0.03	--	--	--

Welding electrode for Experiment

Trial is planned with copper zirconium and Tungsten electrode combinations to get the better result as per below table/

Chemical composition of Copper zirconium

Element	Si	Fe	Cu	Mn	Mg	Zr	Ai
% weight		0.0050	99.9			0.050-0.15	0.0050

Chemical composition of Tungsten copper

Element	Si	Fe	Cu	Mn	W	Zn	Ti
% weight			47		99.9		

5) PROCESS PARAMETERS

Identification of Process Parameters

A. Welding Current and voltage

It controls the melting point of fastener legs and thereby the weld deposition happens in the sheet metal. It also controls the depth of penetration and thereby the extent of dilution of the weld metal by the base metal. also the welding electrode property controls the current flow flawlessly till the full peak is delivered.

B. Arm end pressure & Cooling

Welding pressure is controlled with the FRL unit of min 5 Bar pressure, were the sufficient pressure is given to penetrate the welding in the base metal, also it ensure the fastener not shrinked and affected, Cooling pressure of min 5 LPM to keep the electrode to cool conditions so that no defects are generated.

C. Process parameters limit

The Controller process parameters are identified like welding voltage, welding current, pressure, Arm end cool temperature, input current 440V, Arm end KA as 12 to 18. 10 to 18V,

6) DESIGN OF EXPERIMENT

In design of experiment taken the reading of all of the process parameters, the following table consists design of experiment.

Table 1.4 Experimental results for samples

Sl no	Parameter	Set value	Response S 1	S 2	S 3	S 4	S5
1	Base Current	17.0	8.2	7.9	8.2	7.9	8
	Base Pressure	0.30					
2	Base Current	17.00	8.1	8	8.3	8	7.3
	Low Pressure	0.28					
3	Base Current	17.00	7.8	8	8	8	7.6
	High Pressure	0.32					
4	High Current	18.00	8.1	8	8.3	8.6	7.6
	Base Pressure	0.30					
5	Low Current	16.00	9	8.2	8	8.2	7.6
	Base Pressure	0.30					
6	High Current	18.00	9.2	8.2	8.9	9	7.5
	Low Pressure	0.28					
7	High Current	18.00	8.5	8.2	9	7.2	8
	High Pressure	0.32					
8	Low Current	16.00	8.3	9	9	7.6	7.3
	Low Pressure	0.28					
9	Low Current	16.00	9	7.3	7.6	7.9	7.9
	High Pressure	0.32					

7) RESULT AND DISCUSSION

7.1 Effect of process parameter on welding output

QUALIFIED PARAMETERS					SCHEDULE NO					1
Gun Alignment Blue match condition	Weld Current I (KA)	Weld Current II (KA)	Weld Cycle I (cyc)	Cool I (Cyc)	Weld Cycle II (cyc)	Slope (Cyc)	Squeeze time (cyc)	Hold	Air pressure (Mpa)	Allowable Deviation (%)
OK	15	0	14	0	0	1	35	10	0.3	10%

Sl no	Parameter	Set value	Response																				OK %
			S1	S2	S3	S4	S5	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5	
								Free From Thread Damage					Free from Burning - Visual Check					Free From Burr - Visual Check					
1	Base Current Base Pressure	15.0 0.30	9.2	8.9	8.6	7.9	8	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	100
2	Base Current Low Pressure	15.00 0.28	8.1	8	9	8	9	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	100
3	Base Current High Pressure	15.00 0.32	9	8	8	8	8.2	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	100
4	High Current Base Pressure	16.00 0.30	8.1	8	8.3	8.6	8.3	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	100
5	Low Current Base Pressure	14.00 0.30	9	8.2	8.6	8.2	7.6	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	100
6	High Current Low Pressure	16.00 0.28	9.2	8.2	8.9	9	7.5	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	100
7	High Current High Pressure	16.00 0.32	8.5	8.2	9	7.2	8	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	100
8	Low Current Low Pressure	14.00 0.28	8.3	9	9	7.6	7.3	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	100
9	Low Current High Pressure	14.00 0.32	9	7.3	7.6	7.9	7.9	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	100

7.2 Effect of load results in copper zirconium

The test report taken with the copper alloy and Zirconium copper alloy for the projection welding and the results are validated as below fig 1.5.

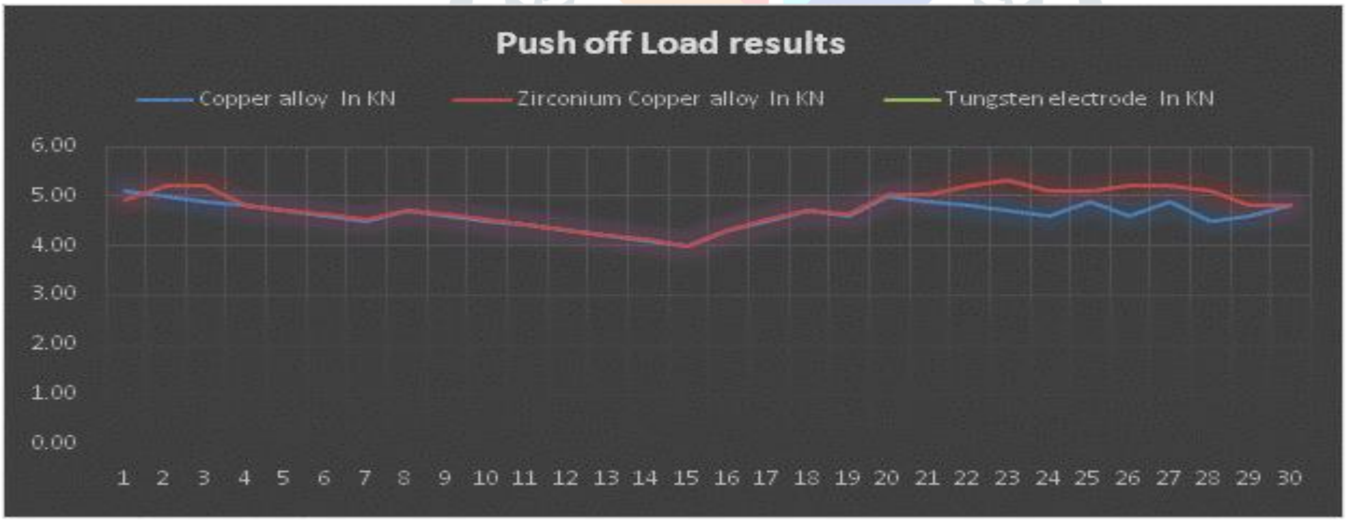


Fig 1.6

Trial	Copper alloy In KN	Zirconium Copper alloy In KN
1	5.10	4.90
2	5.00	5.20
3	4.90	5.20
4	4.80	4.80
5	4.70	4.70
6	4.60	4.60
7	4.50	4.50
8	4.70	4.70
9	4.60	4.60
10	4.50	4.50
11	4.40	4.40
12	4.30	4.30
13	4.20	4.20
14	4.10	4.10
15	4.00	4.00
16	4.30	4.30
17	4.50	4.50
18	4.70	4.70
19	4.60	4.60
20	5.00	5.00
21	4.90	5.00
22	4.80	5.20
23	4.70	5.30
24	4.60	5.10
25	4.90	5.10
26	4.60	5.20
27	4.90	5.20
28	4.50	5.10
29	4.60	4.80
30	4.80	4.80

7.2 Effect of load results in Tungsten copper

Detailed welding process done with the projection welding equipment with the standard practice on Tip dressing, alignments, Ensuring the pressure in FRL unit, water inputs as min 20 LPM, sheet metals with no rust and no contamination for this trial, 30 parts are welded to record the actual outputs, during this trial the life time of electrode found double the normal copper electrodes combinations. The tip dressing found normal and it ensures and delivers same output throughout the trial, it was found the KA is delivered fully to the base material without any unwanted losses. Thus the Push offload strength is increased min 1 KN extra than the copper alloys, push off load details are shown in table 1.7

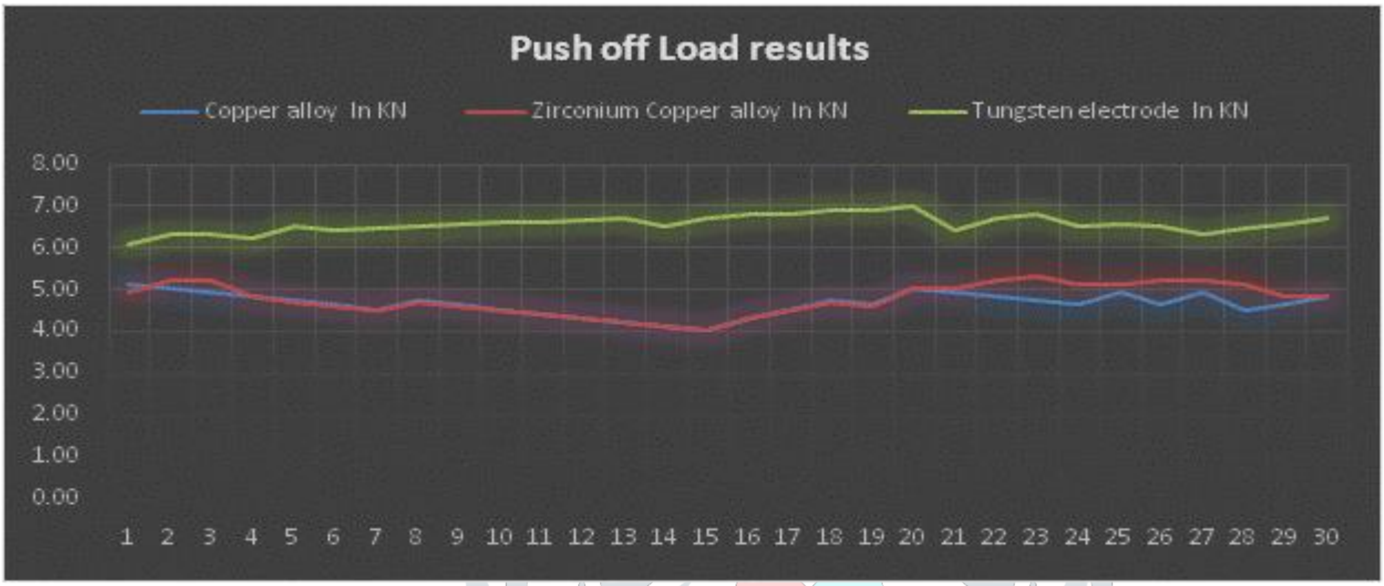


Table 1.8

Trial	Copper alloy	Zirconium Copper alloy	Tungsten electrode
	In KN	In KN	In KN
1	5.10	4.90	6.10
2	5.00	5.20	6.30
3	4.90	5.20	6.30
4	4.80	4.80	6.20
5	4.70	4.70	6.50
6	4.60	4.60	6.40
7	4.50	4.50	6.46
8	4.70	4.70	6.50
9	4.60	4.60	6.54
10	4.50	4.50	6.58
11	4.40	4.40	6.62
12	4.30	4.30	6.66
13	4.20	4.20	6.70
14	4.10	4.10	6.50
15	4.00	4.00	6.70
16	4.30	4.30	6.80
17	4.50	4.50	6.81
18	4.70	4.70	6.90
19	4.60	4.60	6.90
20	5.00	5.00	6.98
21	4.90	5.00	6.40
22	4.80	5.20	6.70
23	4.70	5.30	6.80
24	4.60	5.10	6.50
25	4.90	5.10	6.55
26	4.60	5.20	6.50
27	4.90	5.20	6.30
28	4.50	5.10	6.45
29	4.60	4.80	6.55
30	4.80	4.80	6.70

7.2 Evidences for results in tungsten electrode

Fig 1.9 welding push off load results

8) CONCLUSION

From the study and experiment what done got the results that Tungsten electrode copper alloy gives more conductivity throughout the path and gives more penetration results in Push off load as well. DOE results also given better results on No welding defects like, Burr, Offset, spatters, less penetration,

The parameter setting given a good results and the push off load with the HSLA combination and the output KA are measured and found the actual arm end output is increased because of the tungsten combinations, also tungsten electrode reduces the worn out, so operator need not tip dress as per standard every one hour, as per practical trial we found the tip dressing frequency os reduced to 3 hr once than the original every one hour, were cycle time of the process also benefited and the productivity also benefited, now as a collective results since the push off load increased as per table 1.8, Customer safety is ensured for long time. Finally

- Increasing in heat input increases the penetration, and nugget length.

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