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Effect of Varying Welding Current With Constant Voltage on The Hardness of The Weld Bead of Similar or Different Materials

KEYWORDS: Welding current, Charpy Impact Test, Brinell hardness test, Joint Preparation.

Sunil Kumar	Abhinay Kumar	Pardeep Kumar
J.K Enterprises, Jalandhar Road Nasrala, Distt-Hoshiarpur (Punjab) - 146022	Vill- Padyalag, P.O- Dadhol, Teh. - Ghumarwin, Distt- Bilaspur (H.P)	V.P.O- Sahiba, Teh. - Balachaur, Distt- SBS Nagar, -144525

ABSTRACT *The need to achieve higher productivity and stringent safety requirement have put growing emphasis on the use of automated welding systems and submerged arc welding is employed in semiautomatic or automatic mode in industry. In this type of automated applications, the control of the weld bead has become very essential this is due to the fact that mechanical strength of the weld does not only depends upon the composition of the metal but it is also affected by the shape of the weld bead formed during the welding. The acceptable shape of the weld bead depends upon a number of factors such as current, voltage, welding speedetc. In this paper, the effect of varying welding current with constant voltage on the hardness of the weld bead of similar or different materials has been studied. The materials used in the study are stainless steel and mild steel. The tests which are used for the hardness testing are Brinell hardness test and Charpy Impact test.*

Introduction

Welding is the most common, economical and efficient way of joining the two similar or dissimilar metals permanently and effectively. It is basically the easiest and simple process of joining two or more pieces of metal to make them act as a single entity. Thewelding process involves higher number of variables than those involved in any other manufacturing process. There are numerous number of applications of the welding process like in heavy machineries such as cranes,printing presses and textiles industries etc. The welding process or we can say welders are also employed in the primary metal industries like mills, iron foundries. In such industries most of the work is related to maintenance and repair of different facilities and equipment. They are also employed in the electronic and electrical equipment companies.

In every kind of welding process, the temperature distribution decides the final weld bead dimensions and its mechanical properties. To control and obtain the required shape and quality of weld beads optimization of the various process parameters like current and welding speed, type of polarity used, voltage etc. is required. In this study, welding current during the experimentation is varied because welding current is the most influential parameter and this is due to the fact that it affects bead shape of the weld and it also controls the rate of electrode melting during the process and therefore, it can also controls the deposition rate of the electrode flux, heat affected zone and the amount in which the base metal is melted.If the current during the experimentation is too high the penetration will also be too high and due to this the resulting weld may tend to melt through the metal being joined. Hence, sometimes high current may also leads to waste of electrodes in the form of excessive reinforcement and it also produces undercut in the weld bead. Hence, this over welding can increases weld shrinkage and causes greater distortion. Width of the weld bead increases with welding current until a critical value is reached and then starts decreasing if the DCEP polarity used during the process. But when DCEN polarity is used, the bead width increases as the current increasesfor entire period of time during the experimentation. If the current is too low, then, inadequate penetration, overlapping and unstable arc may occur.

Methodology

Procedure of Experiment

The whole procedure of this process performed is as under:

1. Establishment of objective function.
2. Selection of factors to be evaluated.
3. Selection of the material, welding process and methods of testing hardness.
4. Welding of different pieces at different current with constant voltage.
5. Testing of hardness of weld bead using Brinell hardness test and Charpy Impact test.
6. Analysis of result.

Experimental details

Work piece Materials, Electrodes and Machine

The materials which are used in the study are stainless steel and mild steel. Thepieces procured were 60mm long, 50mm in width and having 5mm thickness. Nine pieces of each Mild Steel and Stainless Steel were used for the experimentation having the same dimensions. The equipment used for the welding the material was Automatic Metal Arc Welding having provision of changing the current and voltage as required for the study. The electrode used for the study was general Purpose, low spatter, all positionand having stable arc electrode giving fine ripped bead and is useful in any welding shop for fabrication and maintenance work in mild steel.

The Specifications of the electrode are given below:

Table 1: Specification of the Electrode

CLASSIFICATION & CODING	DIAMETER(mm)	CURRENT RANGE (Amp)
AWS: E6013	2.50	60-80
IS: 313-412	3.15	80-120
I.S.O: E 333R 12	4.00	120-160

The experimental data used for the experimentation are given below:

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SR. NO	MATERIAL	CURRENT (AMPERE)
1.	M.S.-M.S.	100
2.	S.S.-S.S.	100
3.	M.S.-S.S.	100
4.	M.S.-M.S.	125
5.	S.S.-S.S.	125
6.	M.S.-S.S.	125
7.	M.S.-M.S.	150
8.	S.S.-S.S.	150
9.	M.S.-S.S.	150

Table 2: Parameters for the Experimentation

Formulae Used:
For the Charpyimpact test, the work pieces were cut as per the machine specifications and the dimensions of the work piece were 120mm in length and 10 mm in width.

IMPACT TEST ENERGY = ENERGY / CROSSSECTIONAL AREA OF PIECE

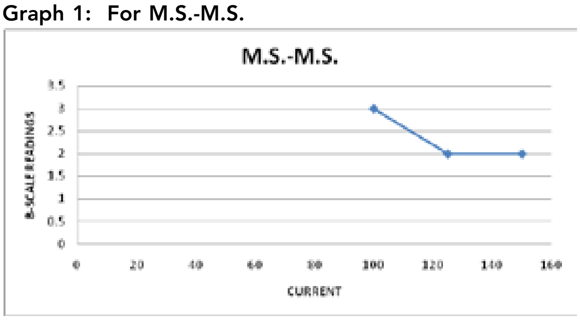
CROSSSECTIONAL AREA OF PIECE = 1200mm^2

Results and Analysis
Brinell hardness Test
Table 3: Experimental data for Brinell hardness Test

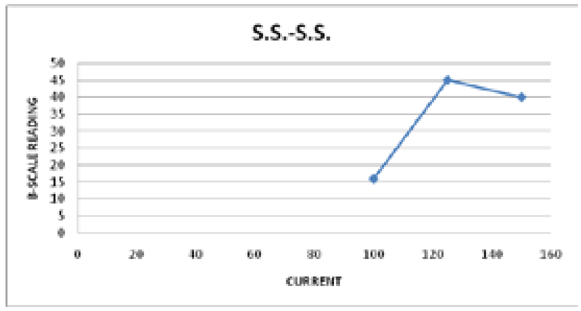
SR. NO	MATERIAL	CURRENT (AMPERE)	B-SCALE READINGS **(BHN)**
1.	M.S.-M.S.	100	3
2.	S.S.-S.S.	100	16
3.	M.S.-S.S.	100	40
4.	M.S.-M.S.	125	2
5.	S.S.-S.S.	125	45
6.	M.S.-S.S.	125	29
7.	M.S.-M.S.	150	2
8.	S.S.-S.S.	150	40
9.	M.S.-S.S.	150	34

The results obtained from thebrinell hardness test are shown below in the form of graphs:

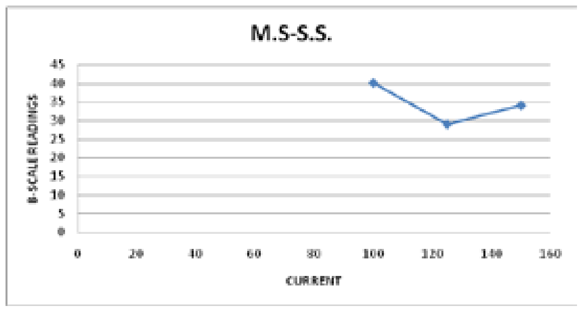
Graph 1: For M.S.-M.S.



Graph 2: For S.S.-S.S.



Graph 3: For M.S.-S.S.



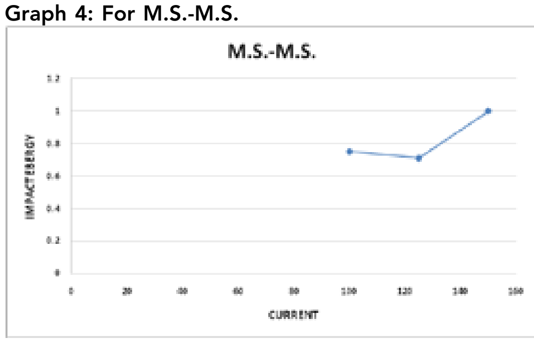
From the graphs, it is clear that the maximum hardness of 45 BHN has been found when the S.S.-S.S. are welded together at 125 amp current.

Charpy Impact Test
Table 4: Experimental data for Charpy Impact Test

SR. NO	MATERIAL	CURRENT (AMPERE)	ENERGY READING (mmkg)	IMPACT ENERGY (kg/mm)
1.	M.S.-M.S.	100	900	0.75
2.	S.S.-S.S.	100	350	0.29
3.	M.S.-S.S.	100	400	0.33
4.	M.S.-M.S.	125	850	0.71
5.	S.S.-S.S.	125	400	0.33
6.	M.S.-S.S.	125	400	0.33
7.	M.S.-M.S.	150	1200	1
8.	S.S.-S.S.	150	200	0.16
9.	M.S.-S.S.	150	300	0.25

The results which are obtained from the Charpy Impact test are shown below in the form of graphs:

Graph 4: For M.S.-M.S.



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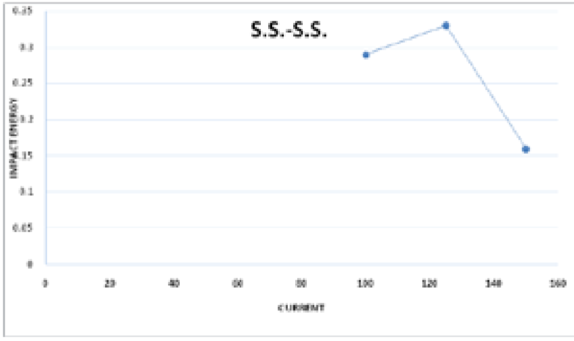
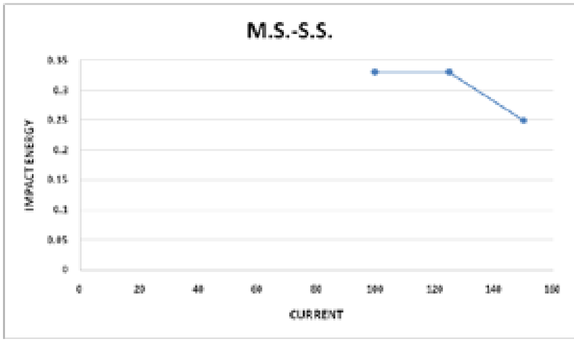
Graph 5: For S.S.-S.S.



Graph 6: For M.S.-S.S.



From the above graphs it has found that when the welding current is 150 amp and when M.S.-M.S. are welded then, it has the maximum impact energy of 1 kg/mm.

Conclusions

The conclusions on the basis of experimental results presented and analyzed are drawn, to investigate the effect of varying welding current with constant voltage on the hardness of the weld bead of similar or different materials.

When the M.S.-M.S. are welded, then it provides the maximum hardness of 3BHN and maximum impact energy among all of 1 kg/mm at 100 amp and 150 amp respectively.

When the S.S.-S.S. are welded together, then it has the maximum hardness among all of 45BHN and impact energy of 0.33kg/mm at 125 amperes.

In case of dissimilar metals when the M.S.-S.S. are welded then maximum hardness of 40BHN has been found at 100 amp and maximum impact energy of 0.33kg/mm was found at both the 100 and 125 amp welding current.

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