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Study of Hardfacing of Grey Cast Iron (ASTM G2500) under Different Process Parameters

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Abstract:- **This paper is basically aimed on the study of hardfacing and its conditions to prevent solid particle erosion. Solid particle erosion is a major area of concern in number of engineering systems, for instance those using coal conversion systems. Reduced power plant efficiency, downtime of the equipment, repairs, costs extra due to solid particle erosion has led to various techniques to combat solid particle erosion. One technique is to apply hardfacing layers to the components subjected to erosive environments. The hardfacing layers are highly resistant to spalling and erosion due to strong metallurgical bond with the substrate material and a wide range of hard alloys can be applied in order to achieve the best efficiency in a corrosive environment. The current research aims on studying the hardfacing of grey cast iron ASTM 2500 under various parameters and thus observes the results obtained from different parameters to get the optimum hardfacing conditions. In this current study, hardfacing was done using Tungsten inert gas welding under two different parameters and the results were discussed accordingly.**

Key words ; TIG, Hardfacing, Cast iron, Erosion.

INTRODUCTION:

Hardfacing is basically a metalworking process where harder or tougher material is applied to a softer or comparatively less harder base metal. The hardfacing material is in form of specialized electrodes for arc welding or filler rod for oxyacetylene and TIG welding. Hardfacing may be applied to a new part during production to increase its wear resistance, or it may be used to restore a worn-down surface. Hardfacing by TIG welding is a surfacing operation applied to extend the service life of industrial components, new components, or used as a part of maintenance program. Hardfacing increase the wear resistant characteristic of substrate material because:

1. Hardfacing deposit increase the hardness as compare to base material.
2. Hardfacing deposit leads to change in microstructure's shape and size which leads to improvement in wear resistance, abrasion, impact, adhesion (metal-to-metal), heat, corrosion or any combination of these factors.

Uses of Hardsurfacing

There are basically two main areas where hardfacing is used:

1. To reclaim worn parts.
2. The protection of new metal parts against the loss of metal.

Reasons for Hardsurfacing

Hardfacing is done to:

1. Reduce costs, hard surfacing a worn metal part to like new condition is usually 25 - 75% of the cost of a replacement part.
2. Prolong equipment life, Surfacing extends life 30 - 300 times, depending upon application, as compared to that of a non-surfaced part.
3. Reduce downtime, because parts last longer, fewer shutdowns are required to replace them.
4. Reduce inventory of spare parts.

EXPERIMENTATION

For conducting the research, nine cast iron samples of ASTM 2500 grade were taken, each having dimensions of 25X25X5 mm. The samples were cut from a long CI slab with the help of Hacksaw blade. The samples were prepared for experimentation by removing any impurities, rust, inclusions or any other dimensional inaccuracy by Surface Grinding Machine. After achieving the plain and clear surfaces of the specimens, the hardfacing was done on samples one after one using different parameters.

There were different techniques of hardfacing available for conducting the study; hence a brief research was done on choosing the technique to be used between Shielded metal arc welding and Tungsten inert gas welding. Seven samples were taken, three for TIG, three for SMAW and one without hardfacing to check the hardness of the base metal. After hardfacing, the hardness values obtained on Rockwell hardness testing machine were as follows when only single layer was considered at a given current and voltage value:

Table No. 1
Hardness values of TIG, SMAW

S. No.	Technique Used	Operating Current In Amperes	Hardness Values In HRC
1	TIG	80	40
		90	41
		100	41
2	SMAW	80	27
		90	29
		100	31

BASE METAL	17 HRC

There was least spatter obtained in TIG and the weld bead width was larger in TIG than SMAW for a given amount of hardfacing electrode and given deposition rate. Also as per the above table, the hardness obtained was better in TIG than SMAW, so it was accordingly selected for the research.

OPERATION

The Prepared samples were hardfaced on three different currents viz 80, 90,100 Amperes as per the specification of the electrode. The electrode selected is a commercial hardfacing electrode specially used for cast iron materials for making non-machinable welds, with a trade name of ULTRA_7016.Its very economic for conducting hardfacing of large and bulk structures of gas power plants, air blowers, heat generators, combustion chambers etc and is easily available.

Nine samples were taken and were marked by number punch from 0 to 8.After marking, the samples were taken to TIG welding machine and the samples were hardfaced on the given current range and with different number of hardfacing layers.

The electrode was used as a filler wire in the process and feed given was manual and totally dependent on operator’s judgement to obtain uniform layers, since there was no semi or fully automatic system available for feed mechanism and speed input.

Fig No. 1 Hard faced Samples

HARDNESS TESTING

After applying each layer of hardfacing, the specimens were allowed to cool gradually and they were cleaned with the help of a steel brush to remove any slag, inclusions or any other impurity. Finally when all samples were prepared, they were placed in ash for cooling for about six hours.

The samples prepared were tested for their surface hardness. The surfaces of the specimens were prepared for hardness testing with the help of surface grinder by grinding their surfaces. The grinding was done on each sample to get a clean, clear and uniform surface, so that it rests well on the testing table of hardness testing machine as well to obtain accurate values of hardness on plain surface.

Rockwell Hardness Testing

Rockwell hardness tester was used to determine the hardness of different hardfaced workpieces. Before commencing the test all the weld beads were prepared by keeping weld bead top surface flat with help of surface grinder. The scale used was HRC. The indentation was made with the help of diameter tip indenter. The Rockwell scale is a hardness scale based on indentation hardness of a material. The Rockwell test determines the hardness by measuring the depth of penetration of an indenter under a large load compared to the penetration made by a preload. After the hardfacing and surface grinding was done, the photograph of the indented surfaces of the specimen is shown in figure-2

Fig No. 2 Surface Grounded Sample showing indentation after Rockwell test

RESULTS AND DISCUSSIONS

The below table shows the hardness values of different samples obtained by varying current (in the given range of hardfacing electrode) and number of hardfacing layers

S. No.	Sample No.	Number of Hard Facing Layers	Operating Current In Amperes	Hardness values In HRC
1	0	1	80	38
2	1	2	80	46
3	2	3	80	48
4	3	1	90	39
5	4	2	90	48
6	5	3	90	51
7	6	1	100	39
8	7	2	100	49
9	8	3	100	52

Table No. 2 Hardness Values of samples

From the above table it is apparent that the hardness of the surface varies with variation in both current and the number of hardfacing layers. With the variation in current, there are some slight variations in the surface hardness of the specimens. With increase in the value of the current the surface hardness of the specimens was slightly increased. On the other hand, the number of hardfacing layers has a very significant effect on the surface hardness of the specimens. With the increase in the number of hardfacing layers, the surface hardness of the specimens was significantly increased.

This apparent rise in the surface hardness of the specimens with the increased number of layers of hard alloy is mainly due to the effect of dilution. Dilution is the process in which the base metal diffuses into the melted layer of the hardened alloy, which ultimately affects the properties of the added alloy. The effect of dilution is maximum in the first hardfaced layer and the effect of dilution keep on decreasing on the subsequent layers added. That’s why the surface hardness of the specimens with three layers is higher than the specimens with lesser number of layers and the hardness with two layers is higher than the specimens with single layer of the hard alloy.

CONCLUSION

From the results and observations obtained from the experiments, we can safely conclude that the variations in the number of hardfacing layers have a significant effect on the hardness of the topmost layer. this apparent increase in hardness is mainly due to the dilution effect in the lower layers. The first layer was mostly affected by dilution that is why the hardness of the first layer is lower than the other samples with more than one layers.

Although the variation in current does not affect the surface hardness as much as the variation in the number of the hardfaced layers, it does slightly affect the surface hardness of the specimens. When straight polarity is applied we can conclude that with increase in current there is a slight increase in the surface hardness.

FUTURE EXPANSION

This study can be further extended to investigate the erosion wear and other wear mechanisms of cast iron. The process selected for hardfacing in the above experiments was TIG, can be altered with other welding techniques used for hardfacing like gas welding, shielded metal arc welding, powder spraying, submerged arc welding etc. the specimens prepared can be further examined and tested for their microstructure study, erosion testing, micro hardness testing, weld bead penetration and reinforcement.

SUMMARY

This study basically goals on the observing the hardfacing conditions that are obtained by changing a set of process parameters. An estimated number of cast iron samples are prepared with estimated dimensions and are cleaned for hardfacing operation. The cleaned samples are hardfaced at different parameters to get the different results. The samples are surface grounded for hardness testing and the results are compiled.

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REFERENCES

[1] Chatterjee S., Pal T.K., Wear behaviour of hardfacing deposits on cast iron, Wear 255 (2003) 417–425.
[2] Finnie I., Corrosion–Erosion Behaviour of Materials, Metallurgical Society of AIME, New York, 1980, p. 118
[3] Kotecki D.J., Ogborn J.S., Abrasion resistance of iron-based hardfacing alloys, Weld. J. 74 (8) (1995) 269-s–278-s.
[4] Menon R., New developments in hardfacing alloys, Weld. J. 75 Feb (1996) 43–49
[5] Noble D.N., Abrasive wear resistance of hardfacing weld deposits, Metal Construct. 17 (9) (1985) 605–611.
[6] Stevenson A.N.J., Hutchings I.M., Wear of hardfacing white cast irons by solid particle erosion, Wear 186–187 (1995) 150–158.
[7] Sapate S.G., Rao A.V.R., Effect of carbide volume fraction on erosive wear behaviour of hardfacing cast irons, Wear 256 (2004) 774–786.
[8] T.K. Pal ,S. Chatterjee , (2006), Solid particle erosion behavior of hardfacing deposits on cast iron—Influence of deposit microstructure and erodent particles- Wear 261 (2006) 1069–1079.