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Dry Sliding Wear Resistance Investigation of 316l by Induction Hardening Process

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ABSTRACT

This work investigates on induction hardening process in order to improve the wear behaviour of the material. The hardness of the material is increased up to 200% by this process. Induction hardening process were done to 3 different specimens - 1 minute, 2 minutes, and 3 minutes and named as IH1, IH2, and IH3 respectively. A pin on disc machine is used to conduct wear test, so that wear loss can be determined. The specimens are to be magnified by metallographic test such as optical microscope & scanning electron microscope. The untreated specimen is used to compare with the treated specimen. The best specimen is chosen which determines the life of material & improves the better wear resistance. The hardness of untreated material and treated material were compared.

Keywords: Induction Hardening, Pin on Disc Machine, Metallographic test, Wear Resistance.

I. INTRODUCTION

Stainless steels are present day materials. Stainless steel is the non-specific name for various diverse steels utilized fundamentally for their imperviousness to erosion. Stainless steel is not a solitary material but rather the name for a group of erosion resistance steel in metallurgy, stainless steel is characterized as a ferrous combination with at least 10% chromium content. The name begins from the way that stainless steel does not recolor, consume or rust as effectively as common steel. This material is likewise called erosion safe steel when it is not point by point precisely to its combination sort and grade, especially in the flight business. Accordingly, there are presently unique and effectively open evaluations and surface completions of stainless steel, to suit nature to which the material will be subjected lifetime.

It comprises of chromium (16-26%), nickel (6-12%) and press. Other alloying components (e.g. molybdenum) might be added or altered by the coveted properties to create subsidiary evaluations that are characterized in the models (e.g. 1.4404). The austenitic gathering contains more evaluations, that are utilized as a part of more prominent amounts, than some other class of stainless steel.

AISI 316L austenitic stainless steel is outstanding for its best parity of carbon, chromium, nickel and molybdenum for consumption resistance. In this way, this material is regularly utilized for high temperature conditions, forcefully destructive condition and atomic reactor applications. Be that as it may, a moderately low hardness (200 HV), coming about in the poor wear resistance, is a critical impediment of this steel, that is the explanation behind its restricted utilize. Under states of calculable mechanical wear (glue or grating), this material ought to be described by reasonable wear insurance. An austenitic structure, which can't be solidified by the ordinary warmth treatment, causes that there is no simple approach to enhance the wear resistance of this steel.

II. METHODS AND MATERIAL

Flame hardening is a surface-solidifying technique that includes warming a metal with a high-temperature fire, trailed by extinguishing. It is utilized on medium carbon, gentle or composite steels or cast iron to create a hard, wear-safe surface. Flame hardening utilizes coordinate impingement of an oxy-gas fire onto a characterized surface territory.

Flame hardening is a quick, efficient strategy for specifically solidifying particular regions on the surface of a section. This procedure is connected to choose metal surfaces of carbon and amalgam steels, cast and flexible irons and some stainless steels, trailed by a suitable extinguishing strategy. Flame hardening in its least complex shape is the warming up of steel to its solidifying temperature by a fire and after that extinguishing in water or oil. It is utilized to deliver a hard case on the surface of an extensive variety of mechanical segments.

Table 1. Chemical Composition of 316L stainless steel

Grade	**C**	**Mn**	**Si**	**P**	**S**	**Cr**	**Mo**	**Ni**	**N**
316L	0.3	2.0	0.75	0.045	0.03	16-18	2-3	10-14	0.10

The rod sort 316 L review stainless steel were cut into little bits of length 30mm, width 8 mm, with the assistance of wire cut EDM process. A disc of 316 L material is utilized, with 165mm measurement and 8mm thickness. The pin material was subjected to flame hardening process and the disc material was surface hardened as far as possible.

Process parameters:

Experiments were conducted on pin disc machine and the following parameters were varied. The load was applied by keeping the speed of rotation, sliding distance, sliding velocity and the time constant for one set of readings.

Pin on Disc:

DURING WEAR TEST ON PIN ON DISC MACHINE

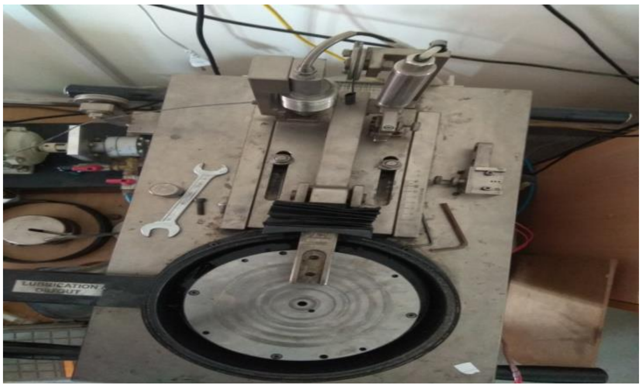

Figure 1. Pin on Disc Apparatus

The heaviness of the pins, both warmth treated and untreated are measured. At that point the pin is braced in the help. Before that the disc was settled in the rotor which is combined with engine by means of belt drive pulley. At that point the heap is connected against the pin upheld bar.

The pin on disc apparatus has a PC based controller, used to control the parameters of the pin on disc contraption. The parameters required are speed in rpm and load in Kg. In light of the parameters the framework will create the estimations of coefficient of grinding and estimations of frictional power for the given day and age in the interim of 5 minutes.

Specifications of Apparatus:

Pin diameter: 8mm
Pin length: 30mm
Disc diameter: 165mm
Disc thickness: 8mm
Applied load: 1 Kg
Speed of the rotor: 1000 rpm
Total time: 20 min

III. RESULTS AND DISCUSSION

Case depth through Optical Microscope

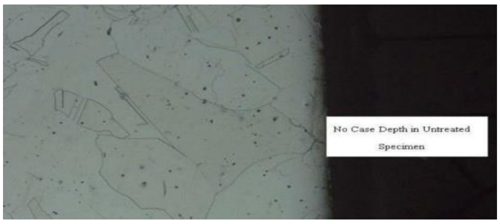

Figure 2. Untreated specimen

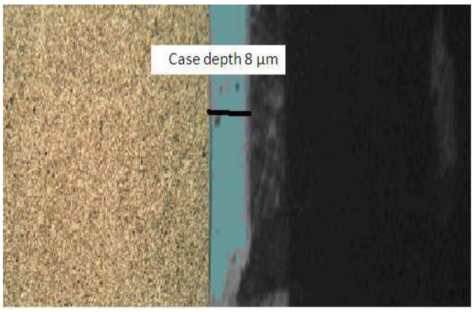

Figure 3. Induction hardening specimen for 1 minute

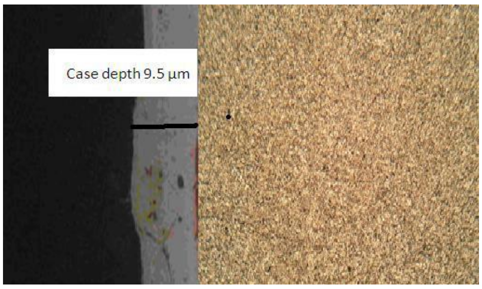

Figure 4. Induction hardening specimen for 2 minutes

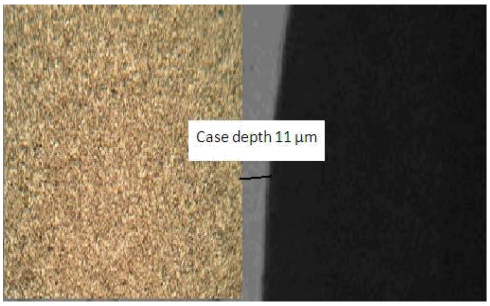

Figure 5. Induction hardening specimen for 3 minutes

From the above optical microscope results, it is noted that as the time of heat treatment increases, case depth also increases. It was noted that in an untreated specimen, no case depth was found. In induction hardening specimens, the case depth was found to be 8, 9.5, 11µm respectively.

A. Pin-on disc wear test

The wear specimens were subjected to induction hardening heat treatment.

B. Morphology of worn pin

To characterize the wear behaviour of both untreated and induction hardening specimens, the scar of pin after wear test, was examined under scanning electron microscope. Fig 6 and Fig 7 shows the SEM images of induction hardening specimen before pin on disc test at 500X and 1000X magnification.

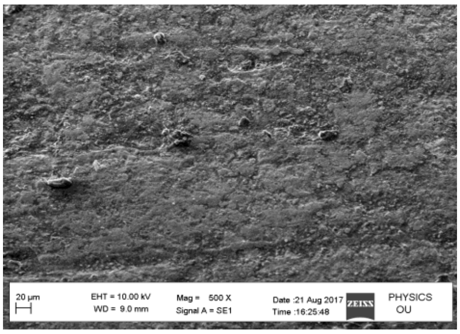

Figure 6. Induction hardening specimen at 500X

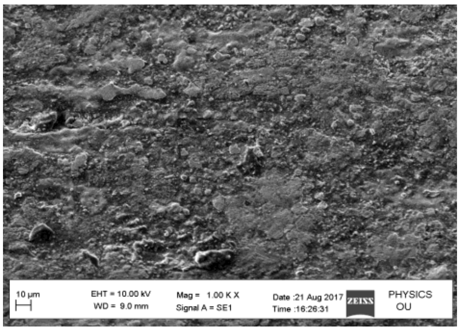

Figure 7. Induction hardening specimen at 1000X

Figure 8 and Figure 9 shows the SEM images wear scar of induction hardening specimen after pin on disc test at 500X and 1000X magnification.

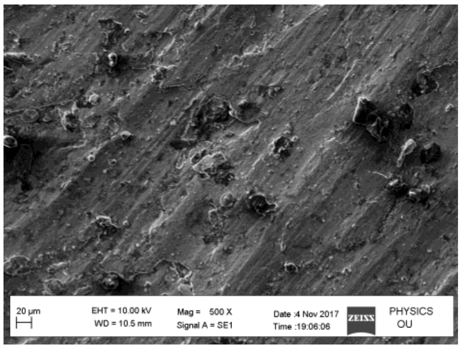

Figure 8. Induction hardening specimen at 500X

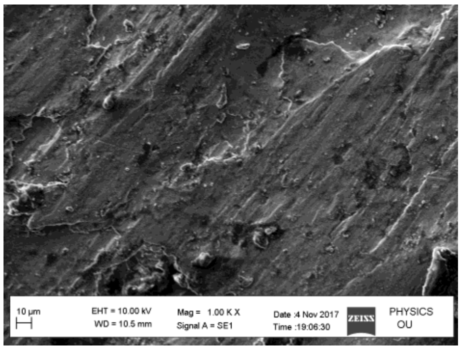

Figure 9. Induction hardening specimen at 1000X

C. Energy dispersive spectroscopy x-ray analysis

Figure 10 shows the energy dispersive spectroscopy x-ray analysis of AISI 316Laustenitic stainless steel induction hardening specimen.

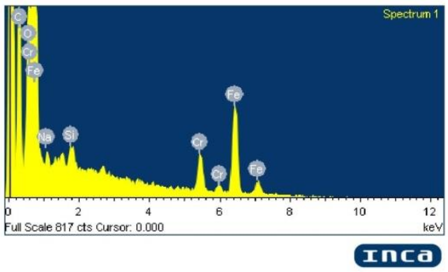

Figure10. EDX analysis of Induction hardening specimen

IV.CONCLUSIONS

Outcome of the above experiments assist to infer the following conclusions

1. Induction hardening treatment carried out at 1, 2, 3 minutes respectively on three different specimens IH1, IH2, IH3 respectively. Hardness increased at IH3 specimen.

2. Within the range of test variables used for sliding abrasion wear test, mild oxidative mode of wear was dominant. The main reason for the reduction in the wear rate was due to the strengthening of austenitic matrix by fine precipitates of carbide.

The above results assist to infer that AISI 316L has exhibited wear behavior response under induction hardening treatment.

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