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Wear Behaviour of Nitriding Coated AISI 52100 Steel

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Abstract **Increase in the lifetime of a component is done either by alloying with numerous appropriate materials before its producing or by appropriate coating on that once produced. So as to extend the lifetime of an element, the wear should be reduced. This study makes an attempt to enhance the service lifetime of AISI 52100 Tool and dies by modifying the surface through Nitride coating. The wear tests were performed during a pin on disc equipment as per ASTM G-99 standard. The wear resistance of Nitriding coated and uncoated steel was evaluated through a pin on disc take a look at employing a velocity of 0.3 m/s. The coefficient of friction, the wear rate and wear coefficient were determined on pins. Nitride pins gives less coefficient of friction and less wear rate.**

Keywords — NITRIDING, Pin on Disc, Wear Coefficient.

I. Introduction

Tribology is the study of science and engineering of interacting surfaces in relative motion. It includes the study and application of the principles of friction, lubrication and wear. Tribology is a branch of mechanical engineering and materials science.

II. Material Selection

A. AISI 52100 Steel

Alloy steels contain different varieties of steels that exceed the composition limits of Mn, C, Mo, Si, Ni, Va, and B set for carbon steels. They are designated by AISI four-digit numbers. They respond more quickly to mechanical and heat treatments than carbon steels.

B. Chemical Composition

AISI 52100 alloy steel is known as a high carbon, chromium containing low alloy steel. The following data sheet gives an overview of AISI 52100 alloy steel.

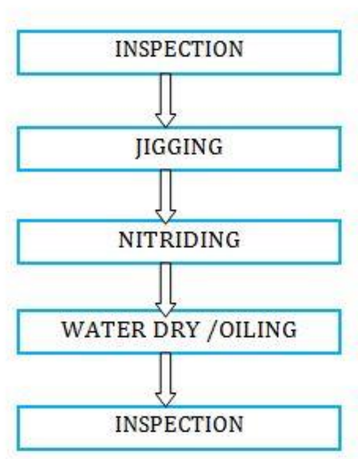
Element Content (%)

- Iron, Fe 96.5 - 97.32
- Chromium, Cr 1.30 - 1.60
- Carbon, C 0.980 - 1.10
- Manganese, Mn 0.250 - 0.450
- Silicon, Si 0.150 - 0.300
- Sulfur, S 0.0250
- Phosphorous, P 0.0250

III. EXPERIMENTAL WORK

NITRIDING

It is a process where nitrogen is added to the surface of steel parts using dissociated ammonia as the source. A thermal diffusion process that produces metal nitrides in the surface. Process is explained in the process flow chart in



Nitriding process flow chart

In order to check crack damages and rust prevention pin is inspected. Salt bath Nitriding process is done at 563˚ for 90 minutes. Pin is placed on the salt bath nitriding process in

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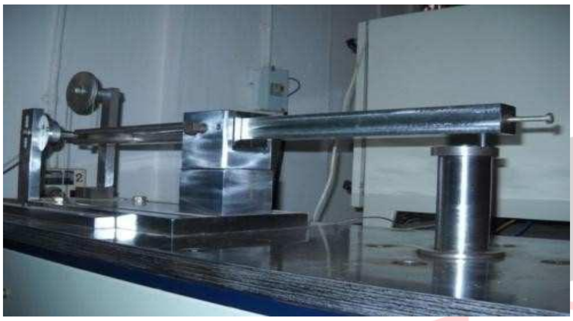
PIN ON DISC

The tests were carried out under 10 N applied load and for sliding velocity of 0.3 m/s for a constant sliding radius of 10 mm. During testing the tangential force was measured by a set of the load cell and monitored by Computerized data acquisition system. In all the cases coefficient of friction, wear rate and wear coefficient of the pin were estimated by taking four pins average value Wear performance of materials are commonly obtained from testing carried out in pin-on-disc equipment to ASTM G99 standard procedure. The photographic view of the pin on the disc is shown. It gives a laboratory standard method to carry out sliding and abrasion wear.

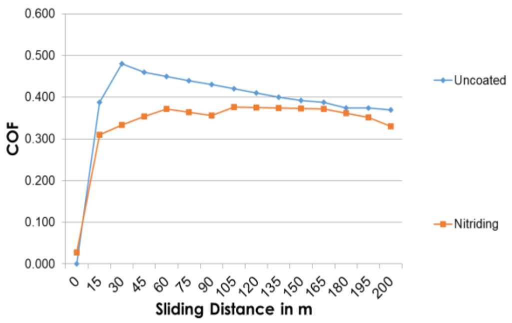


Pin on Disc Apparatus

IV. RESULT AND DISCUSSION

A .Coefficient of Friction

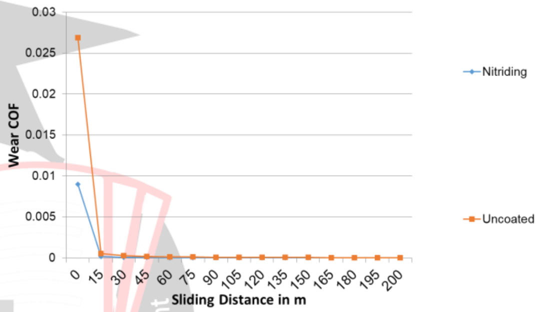
Test procedures were employed with the pin on disc tests at 0.3m/s. The wear, Frictional Force and time were obtained at a load of 10 N for every 15min sliding. The Plot of friction coefficient versus Sliding distance for the uncoated, Nitrided This shows the Characteristic feature of the diagrams is that the friction coefficient values decreases as the Sliding distance increases. The result obtained confirms that Nitrided treatment of metals decreases the coefficient of friction. In clean metals, the friction coefficient is independent of the load while on Nitrided metal surface the rupture of the Nitrided layer can change the friction coefficient. The dry friction of uncoated steel is around 0.37, and Nitride coating can decrease the friction coefficient by 0.33..



A . Coefficient of Friction Vs Sliding Distance

B .Wear Coefficient

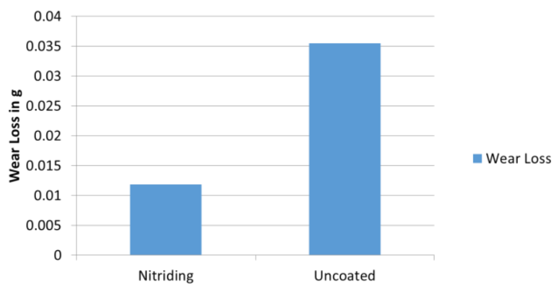
Steady-state wear was proposed by Archard V=KsPL/3H where V is the volumetric loss of material after sliding for a distance L and load P normal to the wear surface. H is the Brinell hardness number of the pin while Ks a dimensionless standard wear coefficient. For known values of V, P, L, and H the standard wear coefficient can be calculated from the equation Ks=3HV/PL. Volumetric wear loss can be calculated from the weight loss W and the density. L. J. Yang [12] expressed that the higher initial running – in wear rate, has a higher value initially in the transient wear regime and will reach a steady – state value when the wear rate becomes constant. Figure 6 shows the variation of wear coefficient with sliding distance. It is observed that wear coefficient decreased due to increase sliding distance. However, under the same conditions, nitrided coated shows lowest wear coefficient. The major reason is the lowest volumetric loss is recorded. P. H. Hivart et al [13] also expressed *that the* dehydrated and transformed new coating surface has a better reactivity towards lubrication than the initial Huralite.



B . Wear COF VS Sliding Distance

C. Wear Rate

The wear rate is calculated from the equation: Wear Rate = Volumetric Wear Loss / Sliding Distance. Wear rate of nitrided coated with oil is lesser than nitrided coated pins because of Very less Wear loss. Nitrided coated gives less wear rate of 6.418E-6. Due to the porous nature of nitride pins and it exhibits the less Wear rate.



C . Wear rate

V. CONCLUSIONS

- The Wear coefficient of uncoated, nitrided coated pins were examined under 10 N loads at sliding velocity of

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0.3 m/s using a pin on disc apparatus and the results are summarized as follows:

- Nitrided coating pin shows the very low coefficient of friction compared with uncoating. The coefficient of friction is around 0.33 under 10 N loads with sliding velocity of 0.3 m/s. The reason is Nitriding has improved its properties in terms of both frictions and wear.

- Nitrided coating shows very low Wear coefficient compared with uncoating. The Wear coefficient of friction is around 4.8*10^-5 under 10 N loads with sliding velocity of 0.3 m/s.

Wear rate of nitrided coated is lesser than only uncoated pins because of Very less Wear loss.

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