

Characterization of wear of steels before and after nitriding

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Abstract—Wear is a complex set of phenomena, leading to debris emission with loss of mass, ribs, shape, and accompanied by physical and chemical surface transformations. Thermochemical treatments (nitriding) directly cause increased hardness of steel surfaces and contribute to strength and improvement against the effects of layer wear.

Keywords—nitriding, wear, loss mass, time, hardness.

I. INTRODUCTION (HEADING 1)

The tribology concerns the study of surfaces in contact and in relative motion; it thus includes the lubrication, the friction and the wear of the machine elements. The economic boom given in 1994 by Cetim confirms that the order of 26 billion euros per year in France, or 1% of GDP, if all the knowledge acquired in tribology were applied to the industry [1]. The good knowledge of the used material is essential for the realization of a satisfactory structure which gives, the production of the sacred pieces and the profiles with respected standards, and more and more apt to answer the dimensional intentions. The experimental determination of these mechanical characteristics of nitrided steel (the nitrided depth should not exceed 300 μm in order not to promote superficial cracking) [1-3].

The effect of the thermal gradient and nitriding before taking its final form, generate residual stresses and plastic deformations (hardening) in the part produced.

In our approach, we tried to measure; some properties of the steel considered (42CD4) and see the behavior before and after the nitriding operation. All these works are recorded in figures below, in a set, having an importance of their own and, subject to different demands, must be the subject of a special

study involving the determination of a quality class that is clean.

II. MATERIAL AND PROCEDURE

The material of our study is low alloy steel which a good oil hardenability, good overload resistance in the treated state. This steel is very used in mechanics, for parts of medium and strong sections: shafts, axles racks, crankshafts, connecting rods, gears ... This steel is sometimes used for parts hardened superficially. Its composition is record in TABLE I.

TABLE I. CHEMICAL COMPOSITION

Percent	Chemicals Elements					
	C	Si	Mn	Cr	Ni	P
value	0.42	0.25	0.79	0.93	0.13	0.015

The surface areas of the mechanically stressed parts have an important role because their properties condition friction, wear and fatigue resistance. It is therefore often sought to produce superficial layers of high hardness resting on a ductile core. Nitriding is a thermo chemical treatment intended to improve the mechanical properties (resistance to fatigue, hardness, and resistance to wear) or chemical properties (corrosion resistance) of the materials [5].

The nitriding gas treatment was carried out at a temperature of 531 ° C. for 19 h. An oil quench at 60 ° C. makes it possible to obtain a martensitic layer with a thickness of about 1.5 mm capable of withstanding the large bending forces, P = 0.5 mm

the white zone 30 μm . For tribological tests we used a pion-disk tribometer from the mechanical engineering laboratory of materials engineering at the University of Annaba. The pawn is a 100C6 steel ball.

Archard's equation [6] implies that if K_u is constant for a given slip system then the volume of material lost will be proportional to the slip distance. Equation (1) is relevant for plastic contacts it cannot be applied to cases where the contacts are elastic.

$$K = \frac{V}{F \cdot D} \quad (1)$$

K , Wear,
 V , Volume,
 F , Normal load,
 D , Sliding distance.

III. RESULTS AND ANALYSIS

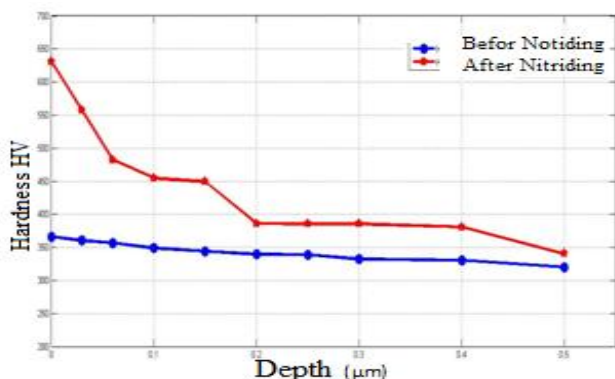


Fig. 1. Hardness function of Depth of steel

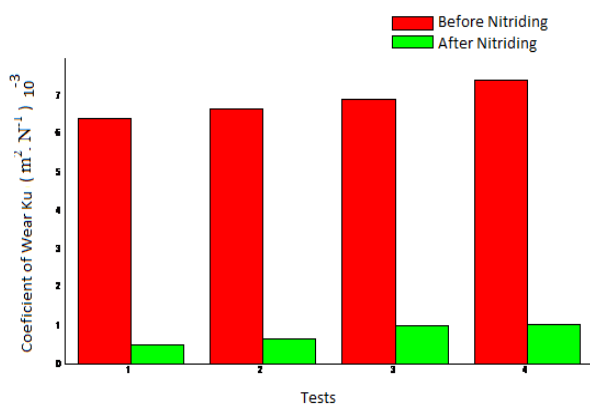


Fig. 2. Comparison wear coefficient before and after Nitriding.

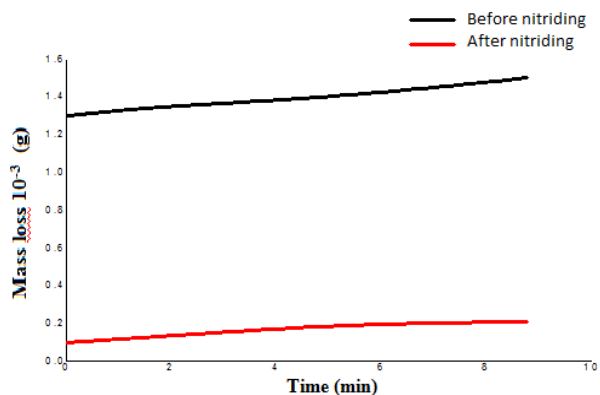


Fig. 3. wear before and after nitriding as a function of time.

From the results shown in the curves of the Fig. 1, the nitriding treatment resulted in a considerable increase in surface hardness. There is a medium superficial hardness (after nitriding) of the order of 341.7 MPa. This growth in values is mainly due to treatments (nitriding) followed by heat treatments.

On the other hand, the untreated surfaces have smaller micro-hardnesses, with an average of 180 MPa. This homogeneous decrease from the surface to the core of the metal is explained by the basic hardness of the steel in question.

Wear is a complex set of phenomena, leading to debris emission with loss of mass, ribs, shape, and accompanied by physical and chemical surface transformations. It does not generally vary in a progressive manner depending on parameters such as speed, temperature or time. Wear is generally combated because of its negative effects, but it also has favorable aspects.

Most of the time, the global wear of a mechanism is due to several processes that act simultaneously, more rarely to a well-defined and identifiable process. In the first moments of friction, it is the superficial screens that undergo all the mechanisms inherent to friction (thermal, mechanical or chemical effects). Then, these mechanisms take turns or interpenetrate according to the multiple conditions present.

In general, a part suffers throughout its life 3 stages of wear:

- Lapping: fast wear with a decreasing wear rate.
- Normal operation: service life (low and constant wear).
- Aging and death: increasing wear rate.

It can be seen that the sample before nitriding exhibits a significant loss in mass as a function of the wear course, compared with the sample after nitriding (see Fig. 3).

From the presented profiles, the nitriding treatment (AFTER NITRIDING) caused a considerable increase in surface hardness. This consolidation properties improved wear resistance with

low mass losses, which resulted in minimal wear coefficients (see Fig. 3).

It can be seen that the raw sample, that is to say without any treatment, has a significant loss in mass as a function of the wear course, if one compares with the heat-treated sample where a resistance of the material expressed by the loss in low mass after the first 100 meters of course. This is due in our opinion to the phenomenon of hardening which leads to a consolidation of the material. The ridges corresponding to the wear of the heat-treated material after 500 m of course are fine evidence of low wrenching of the material (see Fig. 2). The curves have a close appearance, that is to say, for a nitriding treatment, behavior and almost identical in the case of prolonged treatments (4h and 6h), the corresponding curves (4h and 6h) are below the curve corresponding to 2h.

ACKNOWLEDGMENT

I dedicate this modest work to all science and technology researchers around the world.

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