THE INFLUENCE OF THE THERMOMAGNETIC TREATMENTS ON THE HARDNESS NUMBER OF STEELS AND THE SUPERFICIAL LAYERS NITRIDED DURABILITY

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ABSTRACT

Two types of steels subjected to a nitriding thermo-chemical treatment after thermomagnetic treatments. The structural aspects into superficial layer of these steels are studied during friction process by using of an Amsler machine, taking two sliding degrees, different contact pressures and testing time. I tried to determine the durability of these materials, the surface structure evolution at different tests after thermomagnetic treatments.

KEYWORDS: thermomagnetic treatements, hardness number, wear process, durability

1. Introduction

The friction or wear processes are complex, being of physical, chemical, mechanical or metallurgical nature. These processes appear during dynamic or static contact between surfaces of two solid bodies where can be or not be a gaseous atmosphere, liquid (or solid) lubricant. The depth of the superficial layer varies between some atomic layers, in case of wear and chemical processes, and can attain up to 50-100 μm – in case of dry friction.

An important domain for laboratory researches and industry activity is the heat treatments domain. Here we can add the thermo-chemical treatments domain. Overlapping a magnetic field on Conventional heat treatments (the hardening and the recovery processes → the improvement process), the energy of magnetic field interferes in global energy balance of solid stage transformation. This magnetic field changes (thermodynamic change), the transformations mechanism and cinetics – obtaining the thermomagnetic treatment.

In the end, it can be obtained the change of the mechanical properties and the change of structure configuration for these materials. Interciding with a surface treatment (thermo-chemical treatment) like nitriding with plasma (ionic nitriding), the resistance to wear increase [8] and the resistance to corrosion too.

In this paper, it was made the balance- sheet looking at the advantages/disadvantages between: classic improvement and ionic nitriding and the improvement in different regimes of magnetic field (continuous or alternative current), different cooling regimes and ionic nitriding.

Until 1932, the martensitic structure of steels – after hardening process, it was considered the principal materials for the magnets [6]. Minkievici, Stark and Zaimovski, Erahtin, Komar and Tarasov studied roentgenographic, these alloys.

They demonstrated that, the optimal magnetic properties are a consequence of their variable structure-that appear in the initials processes stages by order.

Because variable structure, the materials has individuals micro-volumes of different phases. Each of these micro-volumes of ferromagnetic phase, has a spontaneous magnetization and a marked magnetic anisotropy (a single axes by light magnetization). These micro-volumes are isolated magnetic layers, un-magnetic layers or, easily magnetic layers. Result, a big coercitive force which depends by the grain size and the temperature.

For the stable magnetic texture making, are preferred two methods:

a). The cooling regime in outside magnetic field → thermo-magnetic treatment;

b). The cooling regime based on overlap to unilateral elastic tensions → Thermo-mechanic treatment.

2. Experimental tests

It was considered two few alloy steels, for improvement treatments, useful in metallurgical industry: 42MoCr11 (code V) and, 38MoCrAl09 (code R). These materials are presented in table 1.

***Table 1**: The chemical composition*

Steel grade	C(%)	Mn(%)	Si(%)	P(%)	S(%)	Cr(%)	Cu(%)	Mo(%)	Al(%)
42MoCr11 (code V)	0,38-0,45	0,60-0,90	0,17-0,37	Max. 0,03	0,02-0,04	0,90-1,20	Max 0,30	0,15-0,30	0,02
38MoCrAl09 (code R)	0,35-0,42	0,30-0,60	0,20-0,45	Max. 0,03	0,02-0,035	1,35-1,65	Max 0,30	0,15-0,25	0,70-1,10

The heat and thermo-chemical treatments applied are:

t_1= Martensitic hardening process (at 850 ˚C for code V and 920˚C – for code R) and high recovery (at 580˚C –for code V and 620˚C – for code R)), without magnetic field (classic treatment: H =0). T1= t_1 + ionic nitriding (at 530˚C);

t_2= Complete martensitic hardening process in weak alternative magnetic field (cooling in water) and high recovery process (just cooling in water, in strong alternative magnetic field –H=1300 A/m). T2 = t_2 and ionic nitriding;

t_3= hardening process (cooling in water, in strong alternative magnetic field) and high recovery process (cooling in water, in strong alternative magnetic field – more then 1300 A/m). T3 = t_3 and ionic nitriding;

t_4= hardening process (cooling in water in strong continuous magnetic field) and high recovery process (cooling in water in strong continuous magnetic field). T4 =t_4 and ionic nitriding.

T_5= t_1 + laser nitriding (t= 5 ms);
T_6= t_1 + laser nitriding (t = 5 ms);
T_7 = t_4 + laser nitriding (t = 5 ms);
T_8= t_3 + laser nitriding (t = 5 ms).

The usual methodology for the machinery parts study (roller wheel) useful in the metallurgical industry, presents the theoretic contact like a point (point contact) or, a line (linear contact).

On Amsler machines [7], I tried to determine the durability of rolls, the surface structure evolution at differents tests. Not must be neglect the other factories which influence the wear process: the geometric forms at contact machinery parts (roll on roll, roll on ring), the technological parameters (the surface quality, the heat treatments,) or, the exploitation conditions (the solicitation temperature – for example).

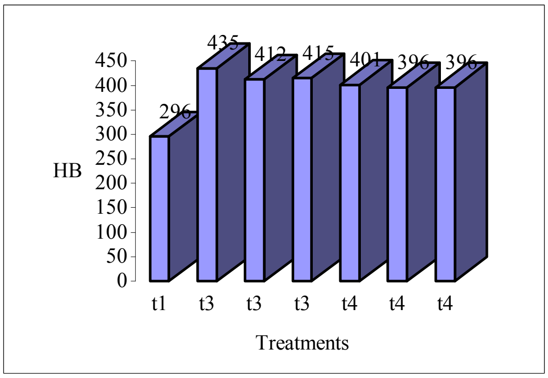

***Figure 1**: The influence of the magnetic field applied on the hardness number, for code V (42MoCr11)*

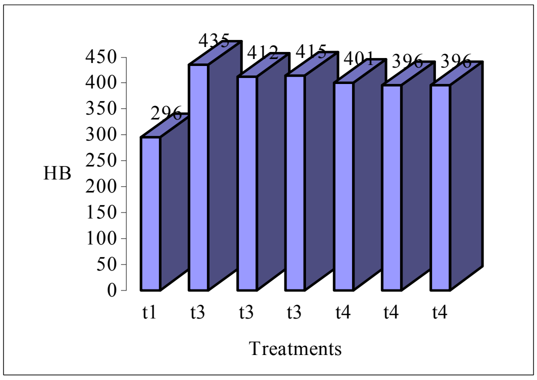

***Figure 2**: The influence of the magnetic field applied on the hardness number, for code R (38MoCrAl09)*

It were submissive at wear process on Amsler machine from University "Dunarea de Jos" of Galati –Romania, rolls with different diameters and, different materials (code V, code R) which suffered differents regimes like: T_1, T_2, T_3, T_4, T_5, T_6, T_7, T_8. The forces Q_i are variable from a roller to another one, and the wear process period, is variable too.

The partial results are presented in table 2

Table 2

Code material	Code treatment	Sliding degree (%)	Q_i [daN]	Initial size D_0’ [mm]	Uh_f Wear depth [mm]	T[h] Total Wear time	Δt [h] Wear time
42MoCr11	T_1	10	-	40	-	0	0
“	T_1	10	75	40	-	1	1
“	T_1	10	75	40	-	2	1
“	T_1	10	75	40	0.10	3	1
“	T_1	10	-	40	-	0	0
“	T_1	10	150	40	-	1	1
“	T_1	10	150	40	-	2	1
“	T_1	10	150	40	0.12	3	1
“	T_1	20	-	44	-	0	0
“	T_1	20	150	44	-	1	1
“	T_1	20	150	44	-	2	1
“	T_1	20	150	44	0.13	3	1
“	T_1	20	-	44	-	0	0
“	T_1	20	190	44	-	1	1
“	T_1	20	190	44	-	2	1
“	T_1	20	190	44	0.3	3	1
“	T_2	10	-	40	-	0	0
“	T_2	10	75	40	-	1	1
“	T_2	10	75	40	-	2	1
“	T_2	10	75	40	0.07	3	1
“	T_2	10	-	40	-	0	0
“	T_2	10	150	40	-	1	1
“	T_2	10	150	40	-	2	1
“	T_2	10	150	40	0.09	3	1
“	T_4	20	-	48	-	0	0
“	T_4	20	150	48	-	1	1
“	T_4	20	150	48	-	2	1
“	T_4	20	150	48	0.11	3	1
38MoCrAl09	T_1	10	-	40	-	0	0
“	T_1	10	75	40	-	1	1
“	T_1	10	75	40	-	2	1
“	T_1	10	75	40	0.09	3	1
“	T_1	10	-	40	-	0	0
“	T_1	10	150	40	-	1	1
“	T_1	10	150	40	-	2	1
“	T_1	10	150	40	0.14	3	1
“	T_1	20	-	44	-	0	0
“	T_1	20	190	44	-	1	1
“	T_1	20	190	44	-	2	1
“	T_1	20	190	44	0.18	3	1
“	T_1	20	-	44	-	0	0
“	T_1	20	150	44	-	1	1
“	T_1	20	150	44	-	2	1
“	T_1	20	150	44	0.13	3	1
“	T_3	20	-	44	-	0	0
“	T_3	20	150	44	-	1	1
“	T_3	20	150	44	-	2	1
“	T_3	20	150	44	0.065	3	1
“	T_3	20	-	44	-	0	0
“	T_3	20	190	44	-	1	1
“	T_3	20	190	44	-	2	1

"	T_3	20	190	44	0.1	3	1
"	T_6	20	150	40		0	0
"	T_6	20	150	40		1	1
"	T_6	20	150	40		2	1
"	T_6	20	150	40	0,16	3	1
"	T_7	20	150	40		0	0
"	T_7	20	150	40		1	1
"	T_7	20	150	40		2	1
"	T_7	20	150	40	0,125	3	1
"	T_8	20	150	40		0	0
"	T_8	20	150	40		1	1
"	T_8	20	150	40		2	1
"	T_8	20	150	40	0,105	3	1

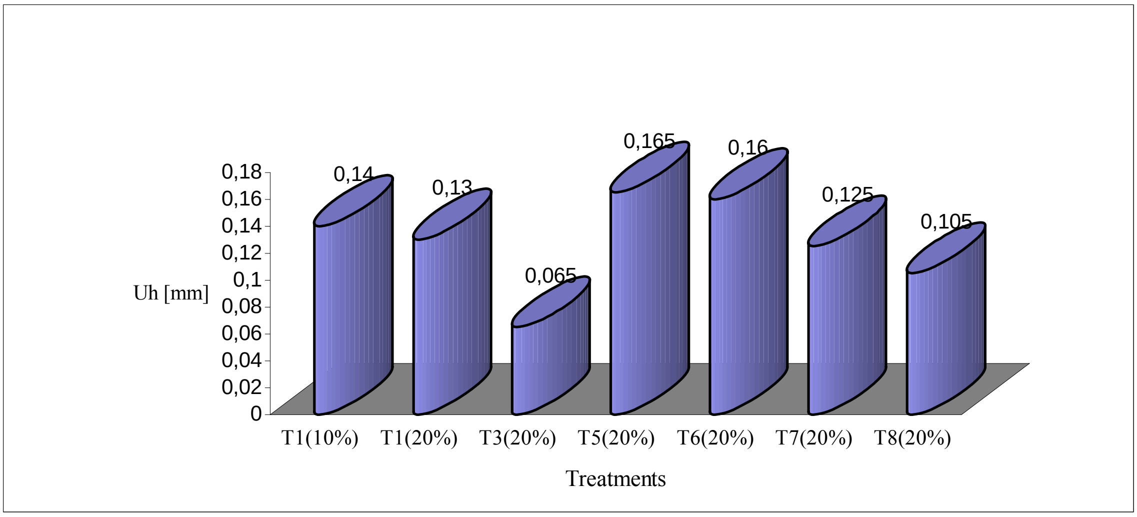

Figura 3:*The worn-out layer depth evolution as a function by the treatments applied for 38MoCrAl09 (code R) steel grade.*

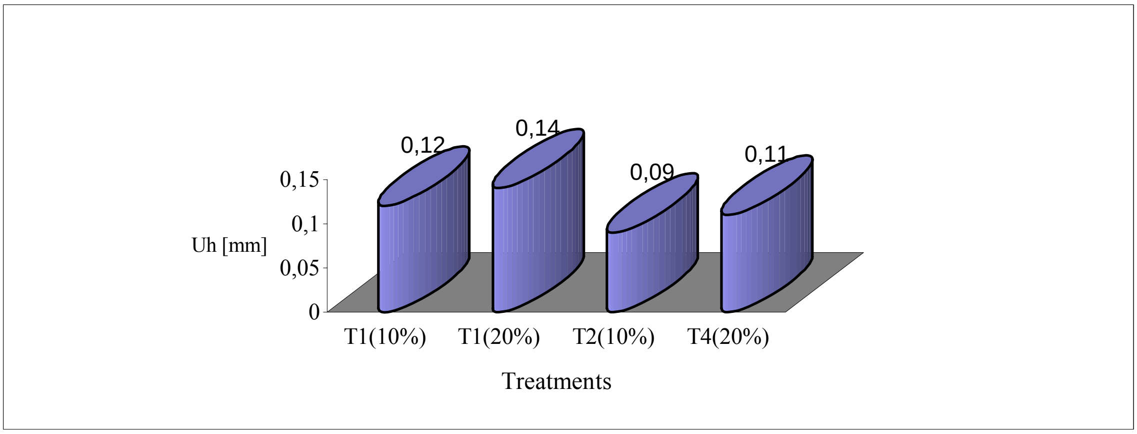

Figure 4: *The worn-out layer depth evolution as a function by the treatments applied for 42MoCr11 (code V) steel grade.*

3.Conclusions

The worn-out layer depth decrease and the hardness number of steels increase for the thermomagnetic treatments case.

This study may be considered like a fundamental research as it shows the necessity to perform typical studies for each kind of material and thermal or thermo chemical treatment applied.

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