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CONTRIBUTION OF HEAT AND THERMOCHEMICAL TREATMENTS TO THE IMPROVEMENT OF THE PERFORMANCES OF HIGH-SPEED STEEL TOOLS

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ABSTRACT

The In this paper the influence of non-conventional heat and thermo chemical treatments upon the structure of tool steels and implicitly, upon the performances that are derived from applying such treatments, is presented. Reference is made to the conditions in which the heat and thermo chemical treatments in vacuum and in electrolyte baths are carried out. The advantages of these procedures are evidenced both from a technical as well as an economic standpoint.

The experiments have been carried out on Rp3 and Rp5 steels, with application of vacuum at the final heat treatments.

KEYWORDS: cyanurated layer, electrically activated salts

1. Introduction

In the modern industry which uses more and more materials with superior quality properties, the usual thermal treatments start to be replaced with new technology.

The most important reason for the introduction of new technologies is the necessity to comply with the requirements of the quality standard ISO 9000.

The important steps of this standard are connected to the flow of raw materials, as well statistic control and TQM-receptions services.

An essential step was the appearance of the concept of a “clean product” that has determined direct actions of modification of high technologies, that are friendly to the environment.

The introduction on a large scale of the automation of technological processes for metalworking, of the use of high speed turning is accompanied by the increase of demands on the metalworking tools.

The characterization of the diverse types of tool steels can be effected on the basis of the newest technologies and from the experience of the tool producing factories.

Thermal treatments in vacuum

The principal purpose of thermal treatments in vacuum is to protect products surface against physico-chemical actions of environments of usual heating.

This way thermal treatments in vacuum can be a good solution from many points of view, in comparison with usual thermal treatments in protective atmospheres or salt baths. Because the heating ovens in the vacuum heat treatment procedure can function over a wide interval of temperature, but in special at high temperature (over 700°C), this procedure allows treatment of almost all metallic materials used now in industry. The first types of ovens for vacuum heat treatment consisted of a room that could be voided, mounted in an oven heatable with electrical resistances, with walls consisting of refractory bricks kept warm. With time these ovens have been optimized regarding heat utilization yields.

The construction of new types of vacuum ovens has increased the use of vacuum heat treatments. A new type of heat treatment oven has been designed that is used at temperatures of 1300 °C, at an advanced vacuum, at high thermal yield. Heat treatments in vacuum can be of the type: degassing, annealing, quenching and thermo chemical treatments.

In ***table 1*** the main parameters of heat treatment for the Rp5 high-speed steel samples are indicated.

Table 1. *The main parameters of heat treatment for the Rp5 high-speed steel samples*

N^o.	Type of heat treatment	Heating parameters			Cooling conditions			Hardness
		Pressure	Temperature	Time	Parameters		Medium	
					v	T_{final}		
		[torr]	[°C]	[min]	[°C/h]	[°C]		[HRC]
1.	Annealing for globulizing	10^{-3}	760	120	35	590	N_2 recycled	32-34
2.	Quenching	10^{-2}	870	40	30	65	N_2 purified	60-61
		0.2-0.3	1220	7-10				
3.	Tempering	400	560-570	2x 90		65	N_2 purified	62-63

3. Thermo chemical treatment in electrically activated salt baths

The favorable effect of electrolysis being known upon the diffusion processes at low temperature thermo chemical treatments, the stimulation of this process at the cyanuration of high-speed steels has been undertaken.

Samples of Rp5 high speed steel, after oil quenching from 1290 °C and a tempering of 1.5 hours at 560°C, have been cyanurated at the same temperature in a salt bath containing 23% sodium cyanate. Also, an electrical tension has been applied between the interior wall of the vessel and the device containing the samples.

At the electrolysis in stationary electric current, the anodic dissolving process takes place; this process has been evidenced also at lower temperatures (180-200°C) at anodic sulphurization.

The increase of the bath temperature has as an effect the increase of the metal losses from the work pieces. In order to avoid this process, alternative electrical current has been used, at the industrial frequency of 50 Hz.

The measurements carried out in this case revealed that under such conditions the losses by dissolving are negligible. In table 2 and fig 1 the results obtained in these experiments are presented.

***Table 2**. Results obtained at thermo chemical treatment for Rp5 steel*

N^o	Current density	Layer thickness		
		10 min	15 min	20 min
	[A/dm^2]	[mm]		
1.	0	0.008	0.137	0.0160
2.	1.02	0.0173	0.0195	0.0250
3.	2.05	0.0180	0.0233	0.0273
4.	3.5	0.0187	0.0296	0.031

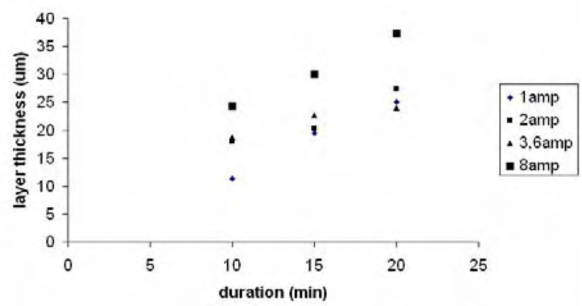

Fig. 1. *Influence of current intensity and duration upon the cyanurated layer thicknesses*

In fig. 2 the variation of the current density on the thickness of the cyanurated layer is shown.

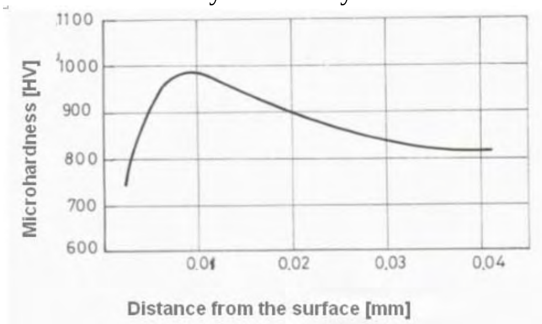

Fig. 2. *Variation of the microhardness of the cyanurated layer t=20 min at d=3,5A/dm^2*

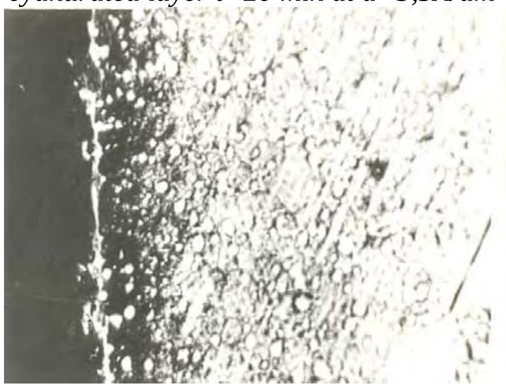

Fig 3. *Rp5 steel cyanurated 20 min at d=0 A/m^2. Nital attack, magnify: 750:1.*

A positive influence of electrical stimulation has been noticed, at applying electric current the increase of diffusion speed is significant. The stepwise increase of current density has a favorable effect, but not directly proportional. The explanation can be the increase (sometimes minor) of the rate of the dissolving process, that is manifesting in some measure under these conditions.

Fig. 4. *Rp5 steel cyanurated 20 min at d=3,5A/m^2, Nital attack, magnify: 700:1.*

The structure of the basis material is composed from martensite of tempering origin, carbides and residual austenite. The superficial diffusion layer, of white color, contains nitrous martensite, carbides and nitrides. In the superficial layer of white color, in larger amounts, nitrides and special carbides are present.

4. Conclusions

The modern heat treatment and thermo chemical treatment procedures have an increasing spread in the industry due to the advantages which these have, such as:

For heat treatments in vacuum:

- higher values of the hardness
- work conditions that are more hygienically, more advanced protection of the environment
- the elimination of supplementary operations

For thermo chemical treatment under electrical stimulation:

- the significant increase of the diffusion rate
- the realization of diffusion layers with high performance properties
- the possibility of remaking the thermo chemically treated layer, after wear of the active part of the cutting tool etc.

Even if one works with salt mixtures that contain toxic components, the procedure can be successfully used with special tools and high-precision tools, that need special qualities.

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