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EXPERIMENTAL RESEARCH REGARDING THE INFLUENCE OF PROTECTION AT IONIC NITRIDING ON DIMENSIONAL PRECISION

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ABSTRACT

The thermo-chemical treatment which does not implies any deformations due to low temperatures during the process is called ionic nitriding. Among this process some dimensional changes appear as a result of the penetration of the nitrogen atoms due to the formation of nitridings, leading to modification in he network. An analysis upon the way in which special protecting paints used against ionic nitriding succeed to prevent the dimensional modifications of zones on which they are laid is described in this paper.

1. INTRODUCTION

Generally speaking, the engine parts which suffer a ionic nitriding treatment (the thermo-chemical treatment which doesn’t cause deformations due to the relatively low temperatures during the process), undergo dimensional modifications as a result of the phenomena which appear during the process. These modifications represent some consequences which usually does not affect the good working of the nitraded marks among the unit they belong to. From the phenomenologic point of view the changes mentioned above are sure and they need to be considered as far as the great precision parts are concerned.

Theoretically, the dimensional modifications (together with those ones regarding shape and position) of the parts subjects to ionic nitriding, are established by the penetration of the nitrogen atoms in layer, respectively the formation of nitrides which generate pressures and lead to ‘the disorder’ of the crystal lattice. At the same time they are established through internal pressures which are formed due to the cooling from the regime temperature to the ambiental one. These modifications also depend on the material, the shape and the dimensions of the parts.

Generally, it is very important to be acquainted with the influence of the thermo-temporal parameters of the ionic nitriding on dimensional variations of the parts to establish correctly the depth of the further working using superfinishing for the dimensions to fit within the tolerance field required by the functionality of the parts.
All these changes have a special significance for the precision pieces which also present another category of zones besides the surfaces that need ionic nitriding. The zones are of great functional importance, requiring both protection against superficial hardness and their dimensional and qualitative conservation, technologically speaking (e.g.crankshafts and cam axles which need protection at the threaded exterior and interior surfaces, ports, grooves etc.)

2. EXPERIMENTAL TESTS AND RESULTS

Further on, there is a presentation of the experiments and the results regarding the way in which the elaborated dyes for protection during the process of ionic nitriding (V-1 and V-2) influence or not the cause of possible modifications(mentioned above) on the metallic surfaces of the parts they are set on. These dyes are made of lamellar copper powder mixed with magnesium oxide dispersed in carbon tetrachloride and polystyrenic lacquer-polystyrene is distilled in carbon tetrachloride. [1]
The researches required the rolling up of eight cycles of ionic nitriding on INI-30 plant. These cycles were from EXP.1 to EXP.8, at two distinct levels of temperature (500 and 550 degrees Celsius) and in four temporal regimes (5h, 10hm 15h and 20h) under a pressure of 2,5 torrs and the work atmosphere 25%N2 / 75%H2. The samples prepared for experimenting were elaborated from 1 type of steel 39MoAlCr15, in two dimensional ranges: Φ60x10 mm and Φ90x10 mm disks. All the parts had a threaded punctured hole(M6) in the center, with a view to being assembled into the single fixing post charging device using a threaded rod(M6). Beforehand, the samples were improved at 28…30HRC and after mechanical working all their surfaces have been grinded. In the end the parts were ungreased and half of them were protected by a 0,45 mm pellicle of dye (V-1 and V-2), made through double brushing with intermediate drying time (cca.10min).
Table 1 shows the way in which the prescribed materials involved in ionic nitriding states using protected and unprotected samples (tests).
To emphasize the dimensional modifications generated by ionic nitriding, the effective dimensions of tolerated diameters (tolerance level IT 5) corresponding to the before and after treatment parts have been measured both for protected and unprotected tests. The pellicle of dye from the unprotected parts was completely and carefully removed, through energetic drying and ungreasing. These types of measurements were made with the help of a vertical device for controlling exterior dimensions and deviations of form and geometrical position ABBE-P01, using the absolute calculus method. [1]

TABLE 1. THE EXPERIMENTS MADE FOR ANALYZING HOW V-1 AND V-2 INFLUENCED THE DIMENSIONS OF METALLIC SURFACES THEY ARE SET ON, FOR PROTECTING THEM DURING THE PROCESS OF IONIC NITRIDING.

Experiment no.	No.of sample/material		The state of sample's surface	Ionic nitriding regime
	Steel			
	39MoAlCr15	42MoCr11		
Exp.1.	P39 ml	P42 ml	unprotected	T=500 t=5h p=2,5torr 25%N2/75%H2
	P39 pl	P42 pl	protected- 0,45mm	

Exp.2.	P30 m2	P42 m2	unprotected	T=500 t=10h p=2,5torr 25%N2/75%H2
	P39 p2	P42 p2	protected-0,45mm	
Exp.3.	P39 m3	P42 m3	unprotected	T=500 t=15h p=2,5torr 25%N2/75%H2
	P39 p3	P42 p3	protected-0,45mm	
Exp.4.	P39 m4	P42 m4	unprotected	T=500 t=20h p=2,5torr
	P39 p4	P42 p4	protected-0,54mm	
Exp.5.	P39 m5	P42 m5	unprotected	T=500 t=5h p=2,5torr 25%N2/75%H2
	P39 p5	P42 p5	protected-0,45mm	
Exp.6.	P39 m6	P42 m6	unprotected	T=500 t=10h p=2,5torr 25%N2/75%H2
	P39 p6	P42 p6	protected-0,45mm	
Exp.7.	P39 m7	P42 m7	unprotected	T=500 t=15h p=2,5torr 25%N2/75%H2
	P39 p7	P42 p7	protected-0,45mm	
Exp.8.	P39 m8	P42 m8	unprotected	T=500 t=20h p=2,5torr 25%N2/75%H2
	P39 p8	P42 p8	protected-0,45mm	

It should be mentioned that only the corresponding increments of the diameter for Φ90x10mm samples were mentioned. They lead to the following records: [1]

- An increment of the diameter of the unprotected samples of 4…47 μm, while the protected parts almost kept the before treatments dimensions, no matter how much they lasted.
- The extremely low increment (1…4 μm) that was noticed on cleaned samples (which were protected) , could proceed either from some possible traces of copper booklets that remained accidentally on the metallic surface or internal tensions due to the cooling from the regime temperature to the ambient one.
- The intervals among which the dimensional modifications of metallic unprotected samples are placed, differ one from another both as far as the nitriding regimes is concerned and the steel's mark, and also the size of the samples.

3. CONCLUSIONS

To conclude, we can declare that the parts made of 39MoAlCr15 steel, protected by special dyes V-1 or V-2 and ionic nitrided at technological parameters considered by experimental research, annihilate the possibilities of dimensional modification of the zones they are applied on. Thus, the pellicles keep the values of the functional levels on surfaces they protect against ionic nitriding. [1]

The experiment is planned according to a certain plan, previously established, which is optimal from the viewpoint of the factor alteration algorithm, its completion ensuring a complex influence on the variable conditions of the researched object. [2]

The diversity of aims in research generates a multitude of experimental programmes, the mathematical experiment theory providing a number of concepts, which are necessary for the attainment of the research aims.

In general, experimental research is not dependent on a well-defined logic, on laboratory-experimentation planning and on previously establishing of what needs to be done and, in fact, of the final objective. In most of the cases, those who conduct a new experiment do all their best to reach the conclusion they want and not the one that would naturally result from the experiment. [2]

A fundamental condition to ensure a correct processing of a data sequence is the expert's (who process the data) acquaintance with the experiment that provided the data, and as well with all the details on the way and conditions in which the measurements have been performed, with the goal of the experiment, with the physical nature of the measured or neglected parameters, with the destination of the data, etc. These requirements are naturally met if the data processing and interpretation are performed by one of the persons who have actually played an active role in the experiment and measurements.

Suggestive graphical representations of the factorial experimental programme of the Di objective function are presented in figure 1,2 and 3. [2]

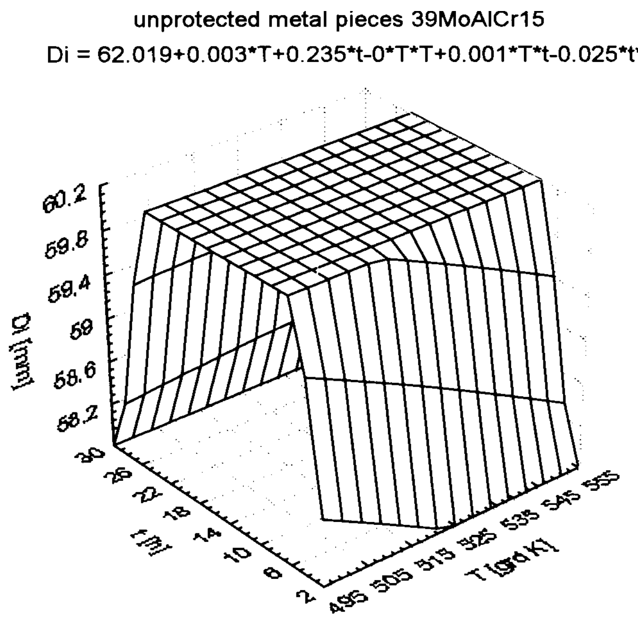

FIGURE 1.
THE EVOLUTION OF THE MAXIMUM D_i PARAMETER
FOR UNPROTECTED METAL PIECES.

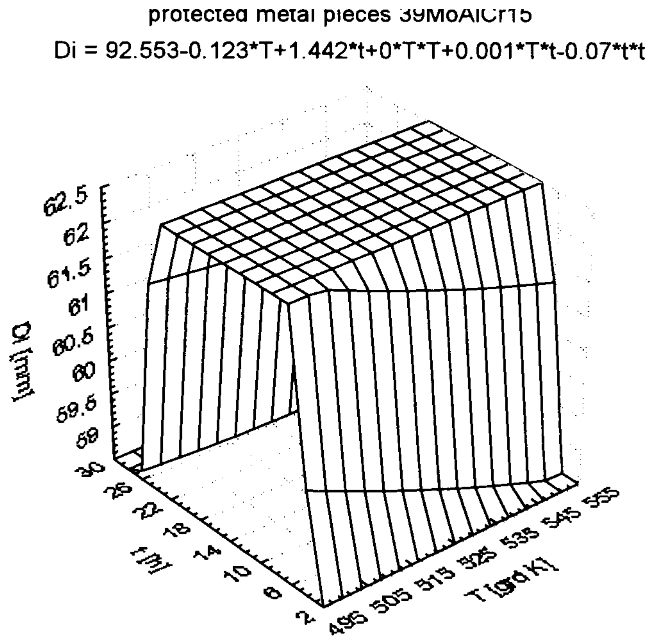

FIGURE 2.
THE EVOLUTION OF THE MAXIMUM D_i PARAMETER
FOR PROTECTED METAL PIECES.

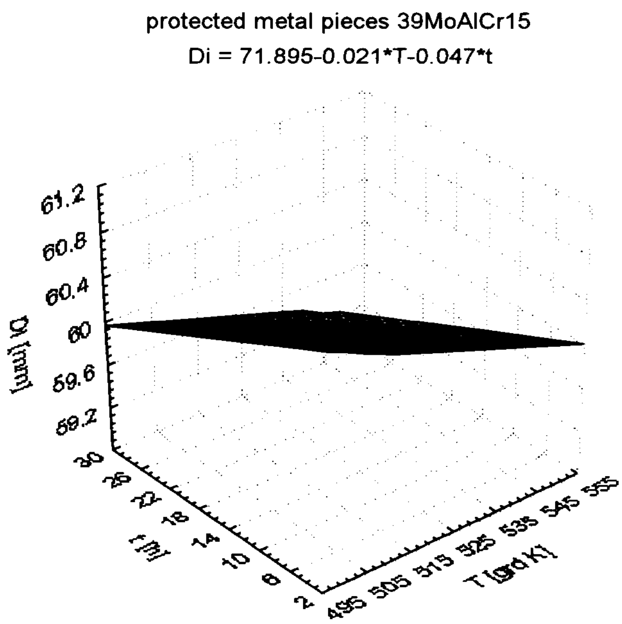

FIGURE 3.
THE EVOLUTION OF THE MINIMUM AND MAXIMUM D_i PARAMETER
FOR PROTECTED METAL PIECES.

A crucial element in approaching any experimental research, completed by the modelling and/or optimisation of an objective function, is the adequate planning of the experiments, and subsequently, the processing of the experimental data.

The presented statistic processing techniques and methods can be used for establishing the statistic significance of the influence factors on certain objective functions, virtually, in any scientific field; they can also be used to construct and analyse experimental models, obtained

as a result of applying the factorial strategy, in various fields, the only condition being the possibility of measuring the values of the investigated objective functions.[2]
One of the most frequent ideas (confirmed by the practical application of the factorial experiment method) in the reference material dealing with this issue is that the factorial experiment is so powerful that, even if inefficiently used, provides better results than the majority of all the other existing experimental data processing methods.[2]

4. REFERENCES

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