THE EXPERIMENTAL RESEARCH ABOUT PHYSICO-MECHANICAL PROPERTIES OF FERROUS-NICKEL PLATING

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The Galvanic plating is widely used in the reestablishment and strengthening of the machine details; thanks to its high physico-mechanical properties. One of the most used is the wear – resistant galvanic alloy which in comparison with a single – component plating has a higher physico-mechanical property, due to the variation of the alloying elements content [1,6].

The self – lubrication of ferrous-nickel plating has been investigated and obtained from the electrolyte with the following composition:

* ferrous – chloride	400÷450
* nickel – sulphate	35÷ 45
* sodium - acidated	2 ÷ 3
* hydroxylamin	0,3 ÷ 0,5
* kaprolactam	3 ÷ 5.

In this research it has been investigated the optimal content of kaprolactam in the electrolyte and the necessary conditions, in order to obtain a qualitative electrolytic self-lubricant ferrous-nickel plating which work capacity is not lower than that of the new machine details.

The early researches showed [3, 4, 8] that in order to estimate the qualitative plating we should use their microhardness, in their optimal size within the limits of 4500-5500, and it answered to the requirements of the maximum wear-resistance.

It is well-known [3, 5, 6] that if we introduce nickel in the plating of electrolytic iron till 4%, this will increase the non-recoverable microhardness. The hardness in the micro volume and the modulus of elasticity diminishes to a great extent the sedimentary tendency of a large-scale destruction in comparison with the electrolytic iron.

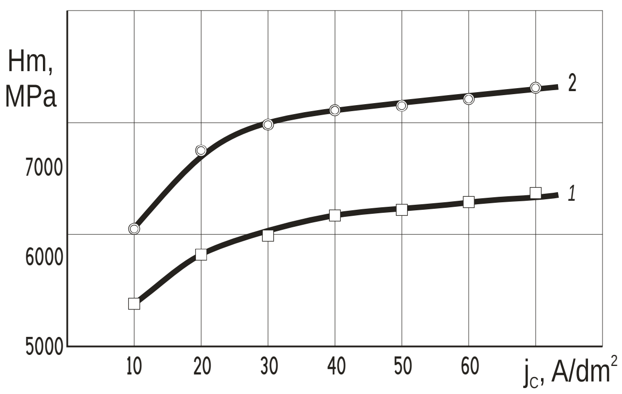

Figure 1. The current density influence on microhardness of ferrous (I), and ferrous-nickel plating; I – $FeCl_2 \cdot 4H_2O$ - 500 g/l, T =313 K, pH=0,8; 2 – $FeCl_2 \cdot 4H_2O$ - 500 g/l, $NiSO_4 \cdot 7H_2O$ - 40 g/l, $Na_2C_4H_4O_6 \cdot 2H_2O$ - 2 g/l, pH=0,8, T=313 K.

The study about regular influence of the current density on the microhardness of plating showed the dependence of **Hμ=*f* (jk)** is similar to the iron alloy and the electrolytic iron (figure 1)

It should be mentioned that with the similar current density the microhardness of ferrous – nickel alloy is higher than the electrolytic iron.

The addition of kaprolactam in ferrous – nickel electrolyte will not change this regularity (figure 2) from the current density.

The addition of 2 g/l of kaprolactam in electrolyte (figure 2, curve 2) lowered the microhardness of ferrous – nickel plating to 200-350 MPa.

If we increase the kaprolactam concentration in electrolyte till 6 (figure 2, curve 3, 4) the microhardness continues to lower.

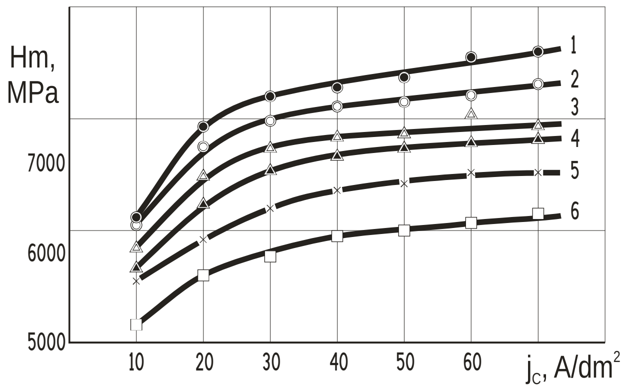

Figure 2. The influence on microhardness Fe-Ni alloy current density and kaprolactam concentration, g/l: I – 0 [6]; 2-2; 3-4; 4 – 6; 5 – 10; 6 – 20.

Then the further increase of kaprolactam concentration in electrolyte lower than 6 ***g/l*** leads to a considerable reduction of sediments microhardness (figure 2, curve 5, 6)

Within the limits of each current density, the dependence on microhardness of ferrous –nickel alloy from the kaprolactam concentration is similar (figure 3).

It should be mentioned that with every current density the increase of kaprolactam concentration in electrolyte reduced the microhardness of ferrous – nickel alloy to the most intensive 6 ***g/l***. It can be explained by the growth of pH in the cathode layer of electrolyte.

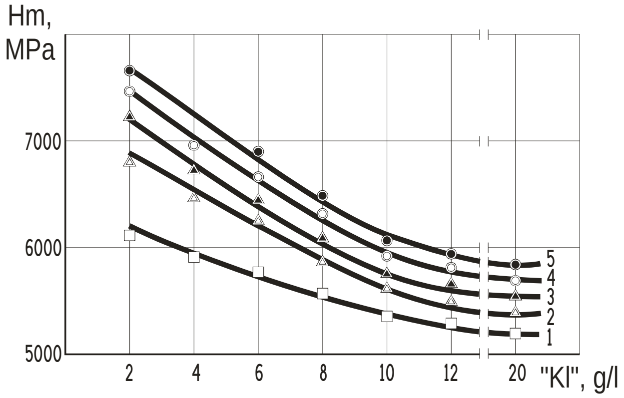

Figure 3 The character of influence of kaprolactam concentration in electrolyte on microhardness of Fe-Ni plating with different current densities, A/dm^2: I-10; 2-20; 3-30; 4-40; 5-50

Despite the fact that the microhardness is one of the most important characteristics of the plating, still it does not entirely characterize all the peculiarities of the ferrous – nickel plating.

Thus, it may be the hardness of the plating [5,6] by which means the selection of electrolyte conditions is possible and with their presence sediments have the optimal elasto-plastic properties from the point of view of wear-resistance.

The electrolyte plating tendency towards large scale destruction represents one of the most important parameters for every material and it could be studied with the similar method amount.

In this connection, it represents a great practical interest to study the influence of electrolyte condition and kaprolactam concentration in electrolyte with its physico-mechanical properties in the macro volume of self-lubrication of ferrous-nickel plating.

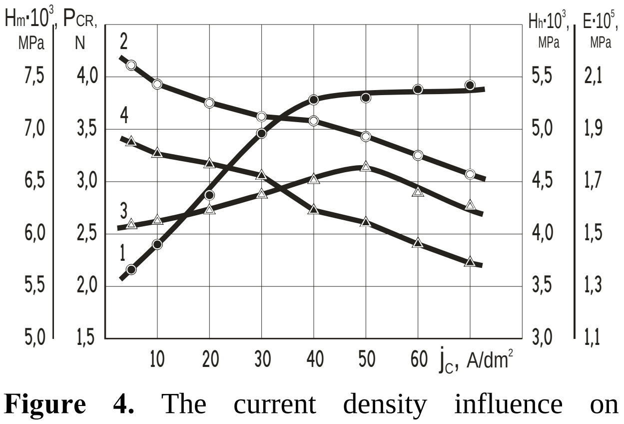

Figure 4. The current density influence on microhardness (1), modulus of elasticity, (2) hardness (3) and critical loading (4) of ferrous – nickel plating.

Our investigations showed, that the alloy which contains 1,7 – 3,9 % of nickel, the largest part of hardness was displaced towards the biggest amount of current density (50 A/dm^2) in comparison with the sediments of the electrolytic iron (20 A/dm^2). And this, in its turn permitted to increase in 2 – 2,5 times the work capacity process and the sedimentation of ferrous-nickel plating (figure 4).

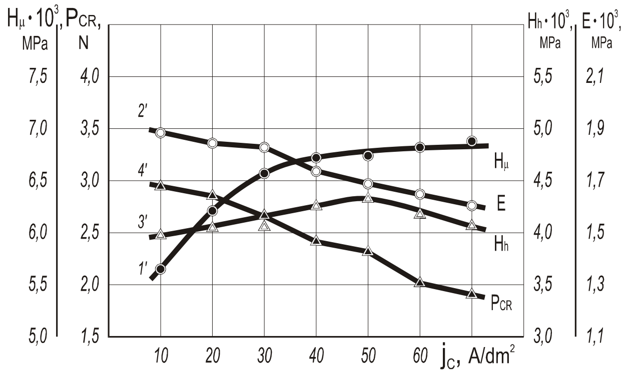

Figure 5. The influence of current density on microhardness (1'), modulus of elasticity (2'), hardness (3') and critical loading (4') of ferrous-nickel plating with the addition of kaprolactam

The addition in ferrous-nickel electrolyte with an optimal kaprolactam concentration (5 g/l) [7] did not bring any changes in the type of the hardness distribution (curve 3), of elastic modulus (curve 2) and microhardness of sediments (figure 5, curve 1). The investigations showed that the microhardness (curve 1), the elastic modulus (curve 2), the hardness in macro volume (curve 3), and critical loading (curve 4) represented the beginning of destruction of ferrous-nickel sediments with the kaprolactam content (figure 5) were on average 7-12 % lower than the corresponding physico-mechanical properties of ferrous-nickel plating without kaprolactam content (figure 4).

It was established that the addition of kaprolactam in electrolyte changed the polarization of cathode and the sediments structure contributed to the growth of plasticity ant fragility of the plating.

As in other works it was found the correlation between the microhardness and hardness in macro volume (figure 5, curve 1, 3) with the growth of the current density till 50 A/dm^2, the hardness in macro volume (curve 3) increased till 4250 MPa.

The further growth of current density led to its insignificant fall and expression of $\mathbf{j_k}$ = 70 the hardness in macro volume was equal with 400 MPa (figure 5, curve 3). Experimentally it has been proved that with the current density 50 A/dm^2, the self – lubrication of ferrous-nickel plating contains the strongest wear – résistance.

Within the changes of kaprolactam concentration in electrolyte the hardness of ferrous-nickel plating also changed extremely and it was maximum between 4-6 g/l of kaprolactam content (figure 6).

It is important to mention that a good correlation instead of physico-mechanical properties of ferrous-nickel sediments can be obtained with and without addition in the electrolyte the kaprolactam (figure 1, 2, 3, 4, 5) composition and they correspond with other sources.

This obviously explains the increase of current density, which augments the number of microcracks in sediments, and in this way it lowers their density and includes a bigger amount of foreign matter.

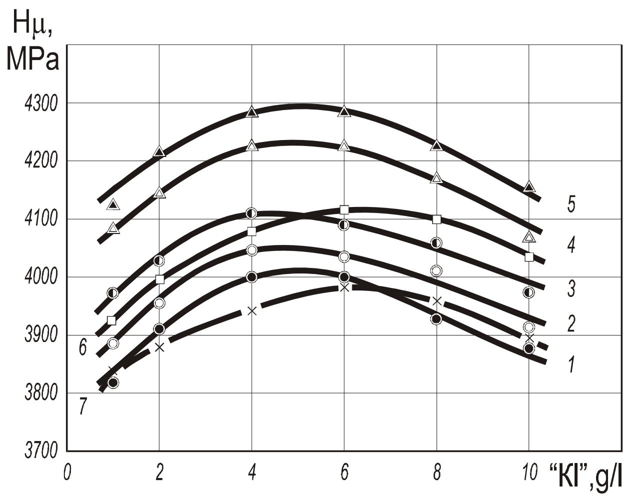

Figure 6. The influence of kaprolactam concentration in electrolyte on macro hardness of ferrous-nickel plating with different current densities, A/dm^2: I-10; 2-20; 3-30; 5-50; 6-60; 7-70;

While introducing the kaprolactam in the electrolytic content we can observe a similar situation.

Thus, we have established the electrolysis conditions and a quantitative content of kaprolactam in the electrolytic compositions by its means we can obtain a qualitative self-lubricant ferrous-nickel plating, that contains a high physico-mechanical properties and a smaller tendency towards a fragile destruction of sediments.

References:

1. ***Gologan, V. F., Javgureanu, V. N., Stoicev, P. N., Bulalonîi S. I.*** *Electrolit dlâ osajdenia splava jelezo-nicheli USSR, nr. 863724, 1981*
2. *.**Calmuțchii, V. S., Roşcovan, G. V., Stoicev, P. N., Javgureanu, V. N.,** Electrolit dlâ osajdenia splava jelezo-nicheli. Patent USSR, nr.1790635, 1991.*
3. ***Melcov, M. P. Şvețov, A. N., Melcova I. M****. Vostanovlenie avtomobilinyh detalei tverdym ostalivaniem. 2-e izdanie.M. Transport, s..165 1982.*
4. ***Şaidulin, A. M.,*** *Povyşenie pročnosti sceplenia electroliticeskogo jeleza s legirovannoi stal'û pri vosstonavlenii detalei sel'skohozâistvennoi tehniki. Dissertacia kandidata tehničeskih nauk. Chişinau, 1990.*
5. ***Gologan, V. N. Ajder, V. V., Javgureanu,V. N.*** *Povyšenie dolgoveč'nosti detalei mašin iznosostoikimi pocrytiâmi, Chişinau, Ştiinca, s. 110, 1979*
6. ***Javgureanu, .V. N.*** *Issledovanie vliâniâ fiziko-mehaničeskih svoistv iznosostoikih gal'vanopokrytii na rabotosposobnosti vostanovlennyh avtotractornyh detalei. Dissertacia candidata nauk. Chişinău, s.168, 1979*
7. ***Roşcovan, G. V., Stoicev,P. N. Javgureanu,V. N., Frunza,V. D.*** *Issledovanie zakonomernostei uprugo-plastičeskogo deformirovaniâ samosmazyvaûŝihsâ jelezo-nichelevyh pokrytii., Chişinău, s.17.,1989*
8. ***Petrov, Iu. N.*** *Galivaničeskie pocrytiâ pri vosstanovlenii detalei. Moscva, Colos, s.135,1965,*