ANALYSIS OF PIN'S SURFACE LAYER STRUCTURE INFLUENCE ON INTERACTION WITH SLIDING COUPLE ELEMENTS USING GRP

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Abstract

Earlier researches have proven that sliding bearings cooperating with different surface layers of s have shown different wear. There is also a difference between cooperation characteristics, which can be measured with help of different electric potential (GRP) in sliding couple. Analyzing changes in characteristics of generated potential difference effective value $U_{S\text{-}GRP}$ during operation allows to estimate time Tg since the beginning until to forming of oil wedge shows up and estimate time Ts – says about stabilization tribological processes in frictional contact (running-in process was finished).

This work will present the investigations results of s surface layer structure influence on the size of wearing of cooperating bearing and the characteristics of this cooperation. It has been proven, that there is a definite impact of a phase structure; with a good probability it became clear that grain size and placement and size of different phases also provided some impact on cooperation of pivots and bearings. Considering pivots covered with clear metallic coating, there have been proven impact of the type of metallic coating, macrostructure (density of crack mesh) have also been proven to be very influential.

Keywords: *tribology, indexes of tribological process course, generated potential difference, wear, structure of superface layer*

1. Introduction

Researches [1, 2] have proven that sliding bearings cooperating with different surface layers of pivots have shown different wear. There is also a difference between cooperation characteristics, which can be measured with help of different electric potential (GRP) in frictional contact.

Analyzing changes in characteristics of generated potential difference effective value $U_{S\text{-}GRP}$ during operation allows to estimate time *Tg* since the beginning until to forming of oil wedge shows up and estimate time *Ts* – says about stabilization tribological processes in frictional contact (running-in process was finished) [3 - 7].

2. Purpose and research range

In order to tell which measurable properties of surface layer of a pin have the biggest impact on a bearing wear and operation characteristics, model and structural research were performed.

Tribological researches were performed on KRWAT-1 stand in unchanged, in comparison to [2], conditions considering inputs (unit pressure, relative motion speed). One probe last 360 min. During this time, with a proper force being applied, guaranteed stabilized interaction in frictional contact was achieved (stable of friction coefficient, temperature in frictional contact and effective value $\boldsymbol{U_{S\text{-}GRP}}$), model tribological couple have shown full running-in [1, 2].

Two groups of surface layers have been chosen: surfacing by welding and electrolytic coating. These groups have been chosen mainly because of different grain grade.

Coatings achieved by surfacing by arc welding of materials: GRIDUR S-600, FILARC PZ-6054 and FILARC PZ-6154. Most important property of such structure is equal number, type and placement of each phase.

Electrolytic coatings were represented by two types of metal: hard iron and hard engineering chrome. Despite that, chromium coatings were used in three different configurations with different oil capacity of surface: chrome with dense and sparse crack mesh and chrome no crack mesh.

Model s was made of 40H and 45 hardened steel. As an anti-test piece was a multilayer bearing with sliding layer PbIn5.

3. Results of tribological investigations

Mean value of slide bearings wear *Zg* after finish interaction with model and surfaced by welding s are shown of Fig. 1.

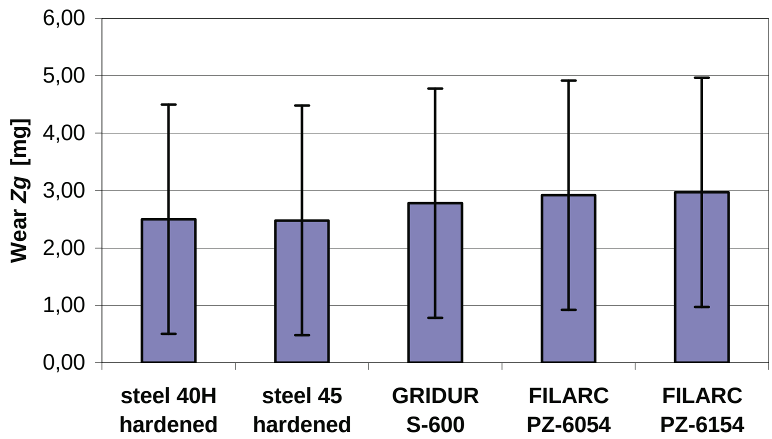


Fig. 1. Mean value of slide bearings wear Zg after finish interaction with model and surfaced by weldings

The smallest wear was shown by bearings operating with model s made of 40H and 45 hardened steel. The wear of a bearing operating with coated with GRIDUR S-600 was about 1.11 times more intense than the one working with s surfaced by welding with FILARC PZ-6054 (1.17 times more intense) and FILARC PZ-6154 (1.19 times more intense).

Registered times *Tg* since the start of generated potential difference effective value $U_{S\text{-}GRP}$ (Fig. 2) were almost exactly the same for all tribological couples.

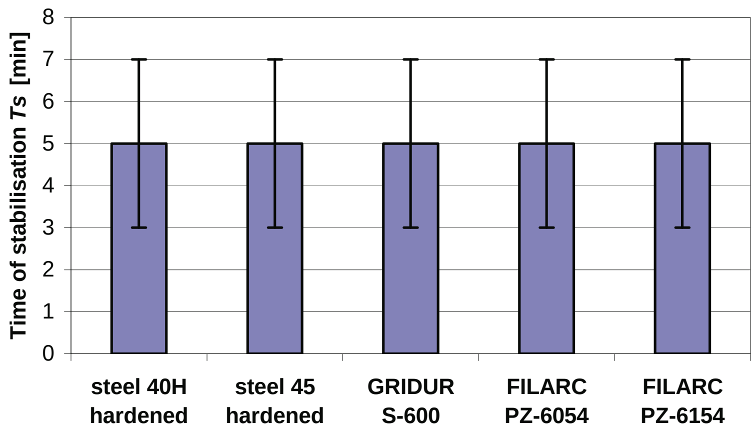


Fig. 2. Time of generated Tg since the start of generated potential difference effective value $U_{S\text{-}GRP}$ for frictional contact with model and surfaced by weldings

T_S times measured since the beginning of interaction until stabilization of potential difference $U_{S\text{-}GRP}$ (Fig. 3) show much more intense difference. The pivot made of 40H and 45 steel happened to have had the shortest time. Slightly longer (about 1.15 times) it took for pivot coated with FILARC PZ-6054 (about 1.5 times longer) and FILARC PZ-6154 (about 1.6 times longer).

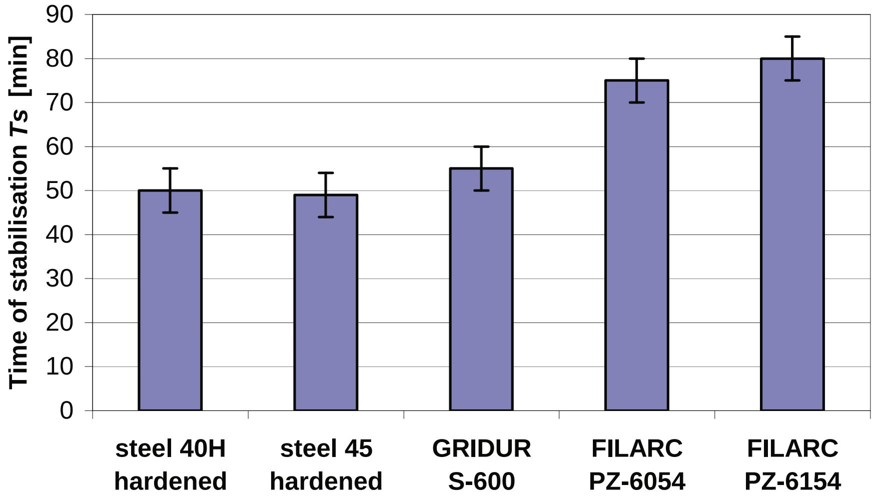


Fig. 3. Time of stabilization Ts since the beginning of interaction until stabilization of potential difference effective value $U_{S\text{-}GRP}$ for frictional contact with model and surfaced by weldings

Mean value of slide bearings wear *Zg* after finish interaction with model and electrolytic coated s ones is shown on Fig. 4.

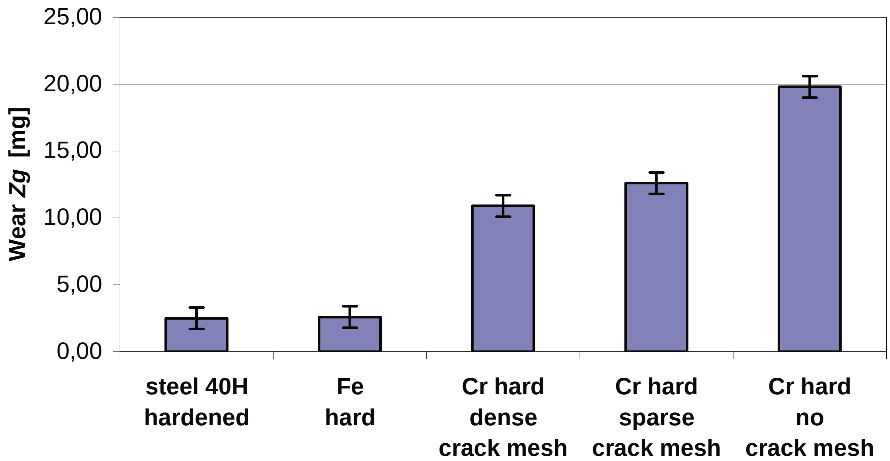


*Fig. 4. Mean value of slide bearings wear **Zg** after finish interaction with model and electrolytic coatingss*

Smallest wear *Zg* (comparable to template one) have been shown by a bearing cooperationing wit s coated with hard electrolytic iron. Much more intense wear have been observed on bearings cooperating with chromium coatings (about 4.5 times larger for dense crack mesh, and about 5 times for sparse crack mesh). The most intensive wear (about 8 times more) have been observed on a bearing operating with pivot coated with chrome no crack mesh.

Mean times value *Tg* of $U_{S\text{-}GRP}$ generating are shown on Fig. 5. The shortest time (similar to the one with model) has been shown for a couple with pivot coated with hard iron. For couple with pivots coated with crack mesh chrome it has been proven much longer times (about 7 times for coating with dense crack mesh and 9 times for coating with sparse crack mesh). The longest time (about 30 times longer) was noted for a pair with pivot coated with chrome no crack mesh.

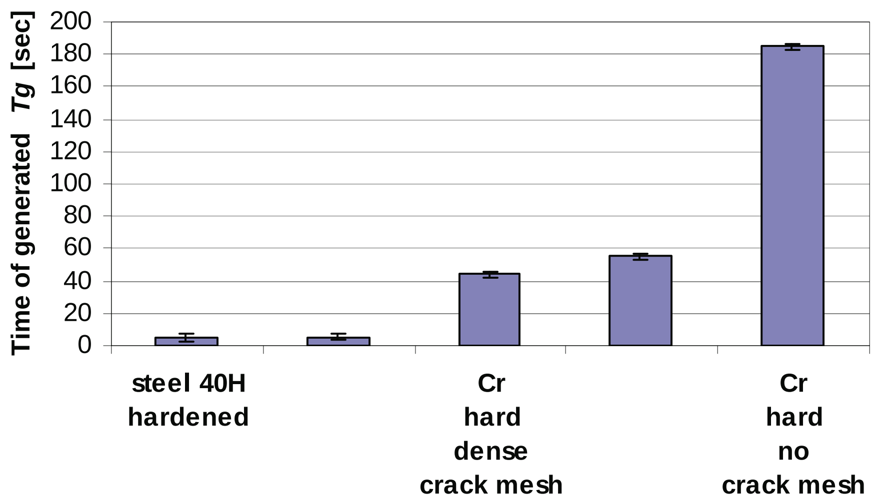


Fig. 5. Time of generated Tg since the start of generated potential difference effective value $U_{S\text{-}GRP}$ for frictional contact with model and electrolytic coatings

The shortest time *Ts* to stabilized generated potential difference effective value $U_{S\text{-}GRP}$ (Fig. 6) have been achieved by a pair with a pivot coated with a hard iron (similar to model couple). Much longer times were noted for pairs witch pivots coated with dense crack mesh chrome (about 1.7 times longer), and with a sparse crack mesh (about 2.2 times longer). The longest time was noted for a pair with a pivot coated with chrome no crack mesh.

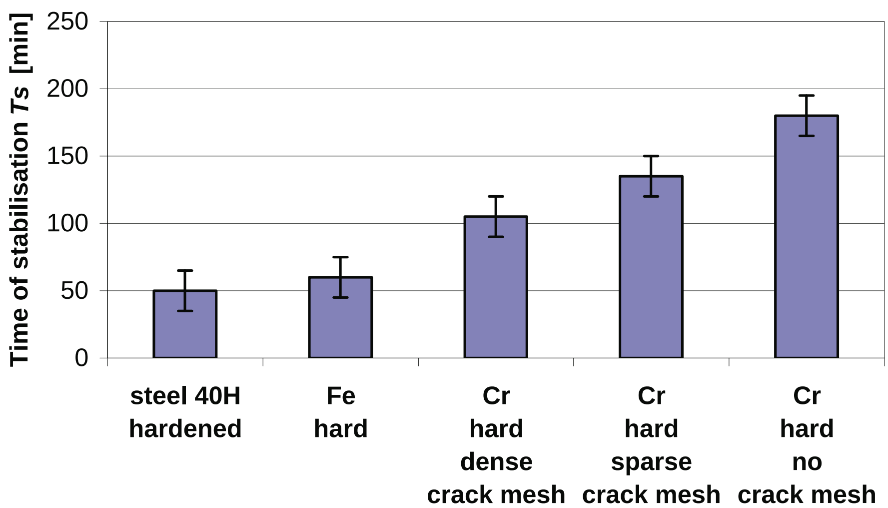


Fig. 6. Time of stabilization Ts since the beginning of interaction until stabilization of potential difference effective value $U_{S\text{-}GRP}$ for frictional contact with model and electrolytic coatings

4. Results of structure investigations

Model s made of 40H and 45 hardened steel (Fig. 7) show comparable, common tiny-acicular martensite structure.

Structure of surfaced by welding layers (Fig. 8) show some commonalities considering equal number, type and placement of different phases - visible tiny-acicular martensite structure with light carbide precipitation on the grain boundaries of primary austenite. Differences can also be observed in area of different phases, and the size of primary austenite grain and width of carbides precipitation on the grain boundaries.

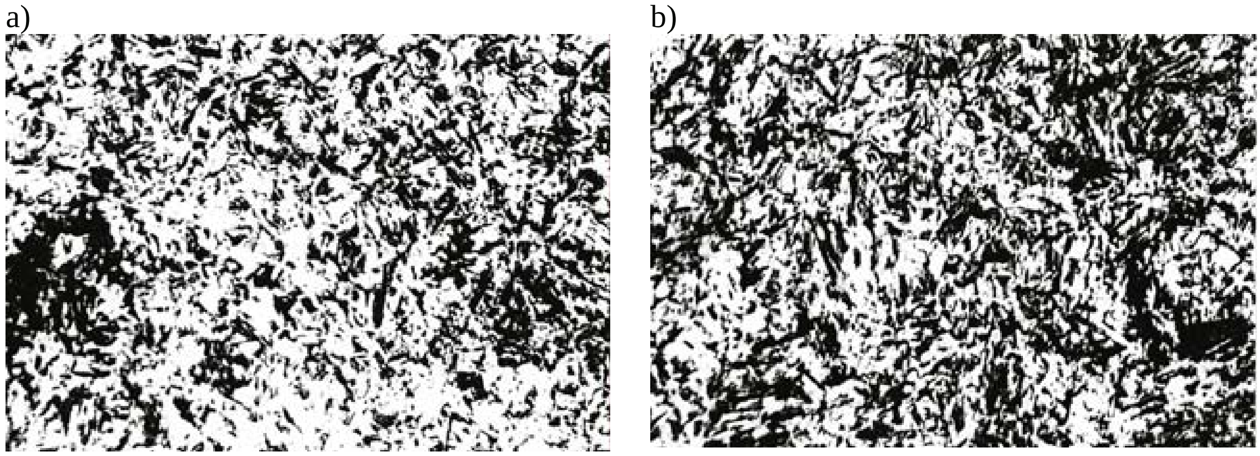


Fig. 7. Structure of model (enlarge 500x: a) – 40H hardened steel, b) – 45 hardened steel

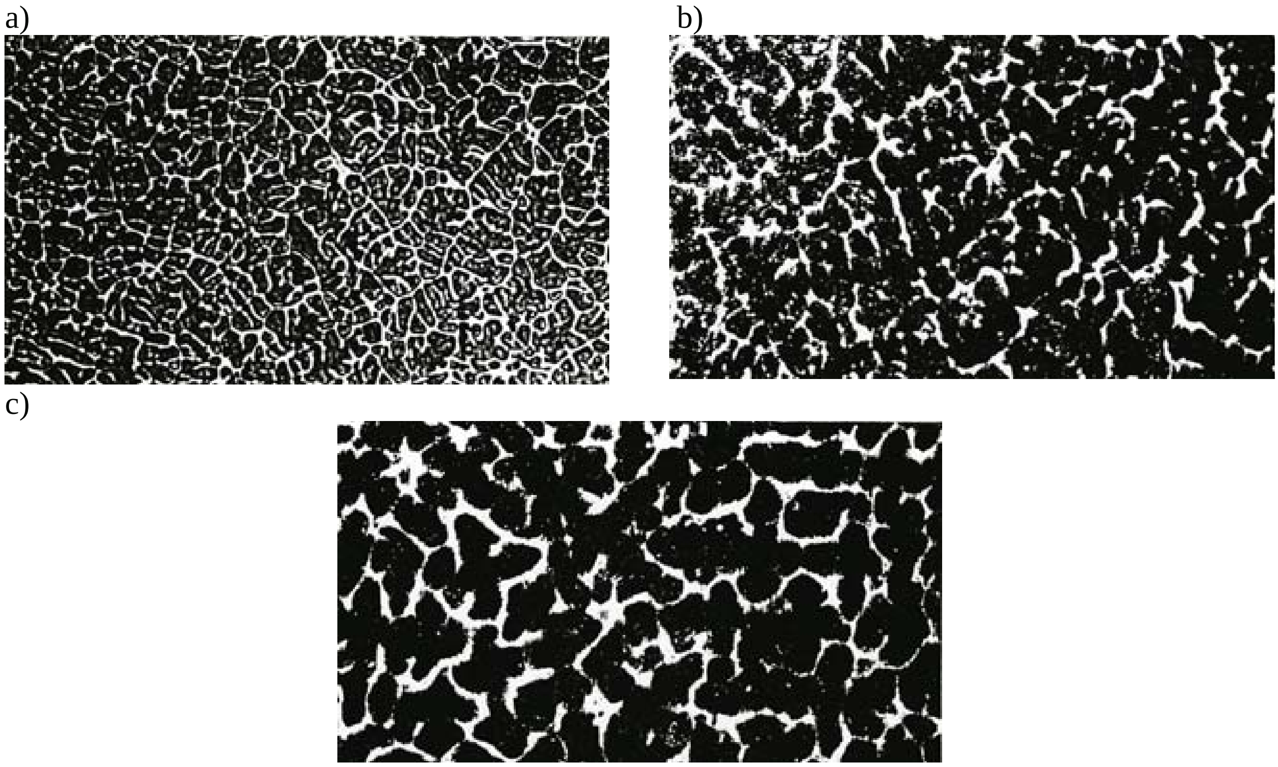
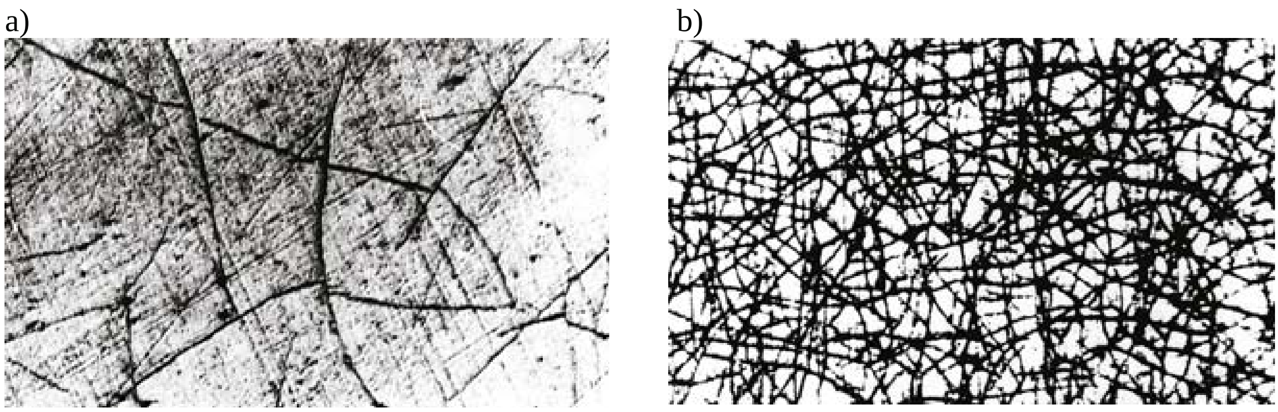


Fig. 8. Structure of surfaced by welding layer (enlarge 250x): a) – material GRIDUR S-600, b) – material FILARC PZ-6054, c) - material FILARC PZ-6154



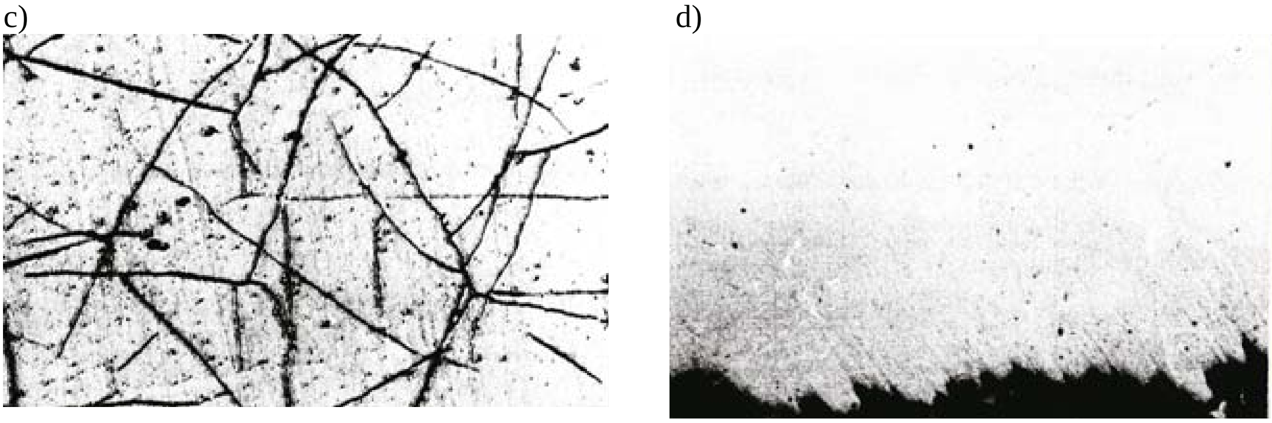


Fig. 9. Structure of electrolytic coating (enlarge. 250x): a) – hard iron, b) – hard chrome – dense crack mesh, c) – hard chrome – sparse crack mesh, d) – hard chrome – no crack mesh

The structure of investigated coating shown on Fig. 9. As You can see different grains are invisible, which mean that these structures are probably cryptocrystalline. Only except coat of no crack mesh chrome coat, as well as coat of hard iron and coat of crack mesh chrome show characteristic blocks cut of crack mesh. In turn structure of crack mesh chrome show diversification with density of crack mesh and largeness of blocks.

5. Analysis of investigations results

Tribological investigations of model s made of 40H and 45 hardened steel haven't shown any major differences considering wear and operation. It is so probably because of their structure and physical-chemical similarities.

Tribological and structural investigation results, when compared, show some difference between wear and interaction character and their structure.

These differences show up even though some commonalities like equal number, type and placement of different phases. You can also notice, that despite larger area of crypto-acicular martensite precipitations, bearing ware operating with s surfaced by welding with FILARC PZ-6054 and FILARC PZ-6154 was bigger. Smaller ware have been shown by a bearing operating with a surfaced by welding with GRIDUR S-600 with bigger ratio of reduce size of primary austenite grains, in spite of smaller surface fraction of tiny-acicular martensite.

Explicitly disadvantageous is influence bigger width of hard and fragile carbides on grain boundary, in spite of their smaller surface fraction for layers surfaced by welding with FILARC PZ-6054 and FILARC PZ-6154.

Comparing tribological test and structural tests You can see that, among all of tested coatings, the least wear, the shortest time of interaction interaction in conditions of mitigated solid friction and the shortest time of stabilization tribological processes have been provided by couple with hard iron coat.

Comparing hard chrome electrolytic coats you may notice how influential density of crack mesh has become on wear of bearings and their operation characteristic. The lest worn bearings Zg, the shortest operation time *Tg* in mitigated solid friction conditions and the shortest time *Ts* until stabilization of tribological processes have been shown by pair with chrome coating with dense crack mesh. Most intensive wear *Zg* and the longest time *Tg* and *Ts* have been noted for a couple coated with no crack mesh chrome.

Although positive impact of a dense crack mesh have been proven, you must note that wear *Zg* of a bearing operating with this kind of surface was much more intense than wear of bearing operating with a coating of hard electrolytic iron. It was also noticed, that, despite similarities in density of crack mesh and width of channels for iron and chrome coating, wear of bearings were significantly different from one another. Probably it was due to significant differences in chemical and physical properties of both metals.

5. Conclusion

Analyzing results of tribological investigations, you can notice that not all couples have shown visible differences in the size of bearing wear in depending on kind of operating with surface layer of.

Probably it follows from the fact that it has some reached sensivity border of wear estimate method by measurement of decrease of slide bearings weight. In such case it is possible to estimate of interaction course with analyzing GRP tribological factors of running process.

However for some couples it was state also decrease of measurable differences of registered GRP signal. It confirm undoubtedly about big similarity of physical and chemical properties between compared layers.

For couples of bearings with s surfaced by welding with iron-carbon alloys, You can note significant influence of structure phases, and with some probability You can tell the influence of a grain size, volume and placement of different phases.

As for pairs with pivots covered with clean metals (electrolytic coats), You can clearly notice how influential kind of coated metal and density of crack mesh have become,

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