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# TRIBOLOGICAL PROPERTIES TESTING OF ADI DISK AND BLOCKS MODIFIED BY DIFFERENT COATINGS

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## ABSTRACT

Tribology has the task not only to connect the knowledge about friction and wear resulting from the work of researchers and practitioners in different fields, but also to explain all activities aimed at improving friction and wear and reducing losses of tribological origin. Identification and measurement of tribological characteristics of materials, elements of the tribological system is reduced to the identification of the friction process in the contact zone and the wear process of each element separately. The parts that make up the tribological system are the pin and the disk. the pins are made of ductile iron and the disks of steel and gray cast iron. Equipment for conducting experiments with a measuring chain of triboelements with special emphasis on (Talisurf 6) on which the shape and depth of the contact surface of the pin are measured. This paper presents a small part of the research.

## INTRODUCTION

The tribological significance of the materials is the basis for the formation of numerous databases in the tribological information system (TiS), which is increasingly developing and expanding in highly developed countries. it is known that the safety of control in industrial and transport systems and their reliability are determined by combining all the characteristics.

Tribological characteristics are in their essence relative and depend on the place of contact between the elements of the tribological system. The tribological properties of the material of one of the elements of the tribological system are determined by the type and properties of other elements (different bodies as well as different materials).

Identification and measurement of tribological characteristics of materials, parts of tribosystems is reduced to the identification of the friction process in the contact zone and the wear process of each part separately.

In this study with the aim of forming a database of the tribological characteristics of the elements of the tribosystem, the friction force was measured as well as the wear parameters using a pin and a disk and a measuring system (Talisurf 6). The scientific and professional aspect of tribology is reflected in the application of knowledge gained through progress in fundamental knowledge of friction and wear in the development of new materials and new qualities of lubricants, and more recently the need to respect the economic aspect. One of the new materials is nodular cast iron NL500 ferrite-perlite base, which is in contact with steel and gray cast iron. A small part of the results of tribological research is presented in this paper.

## 2. ECONOMETRIC ASPECTS OF TRIBOLOGICAL CHARACTERISTICS OF MATERIALS AND TEST METHODOLOGY

Tribological characteristics from the energy aspect, tribomechanical systems and their elements are relative, because they depend on numerous factors that define the conditions under which the contact is made. In industrial and other practice, the answer to the question of how to reduce the cost of energy to overcome friction is constantly sought. In numerous tribological systems and how to design or select tribomechanical systems, ie their elements with favorable tribological characteristics determined from the energy aspect. In order to choose the solid elements of the tribomechanical system whose tribological characteristics are the best for the conditions under which the contact is made, it is necessary to have elementary data and even the influence of, for example, chemical composition, heat treatment of materials from which their production is possible. Experimental data of this type are usually obtained through the implementation of appropriate research programs on tribometers in laboratory conditions.

## MATERIAL AND METHOD

Mentioned materials are isothermally improved ductile iron EN-GJS-500-7 (NL500) ferritic perlite structural bases which are improved isothermally and classically. Austenitization temperature Ta = 900 C, heating time 90 min. Improvement temperature Tp = 390 C / 30 EN-GJS-500-7-30 and Tp = 520/60 EN-GJS-500-7-K. Everything is more visible on the isothermal improvement diagram and especially the improvement temperature and the different relaxation time.

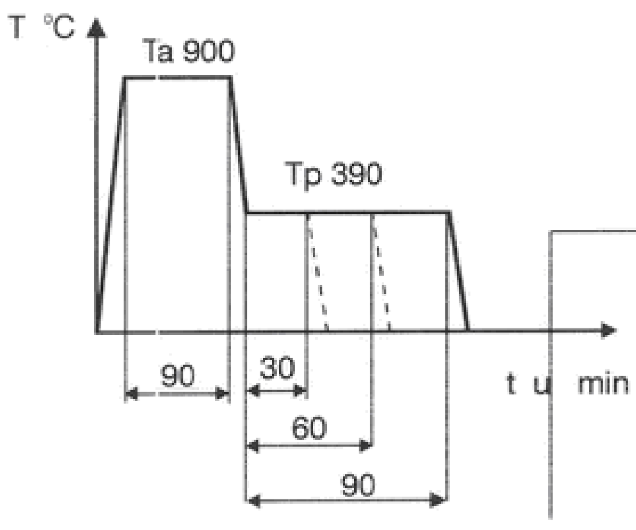
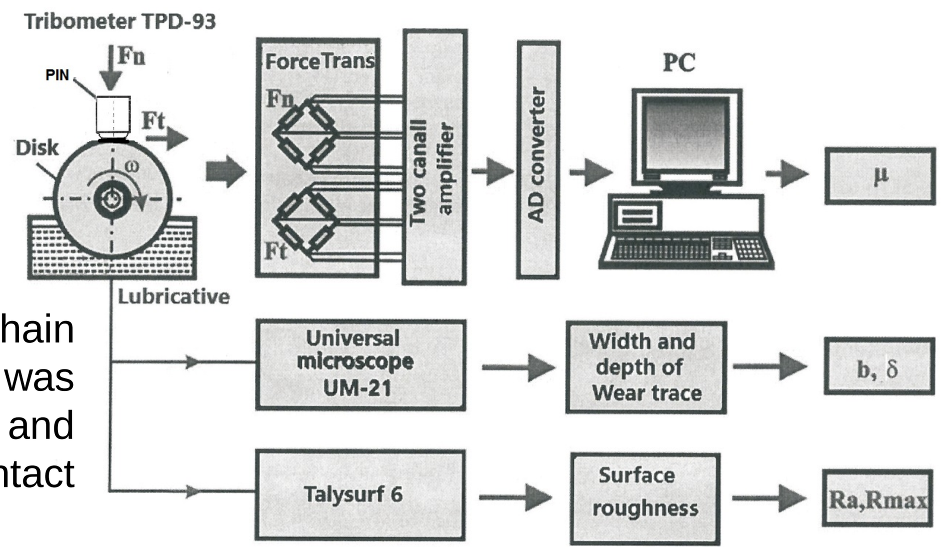


*Diagram of the isothermally improved EN-GJS-500-7*

A special place in the menu chain belongs to Talysurf 6, which was used to determine the shape and depth of the crater on the contact surfaces of the pins.

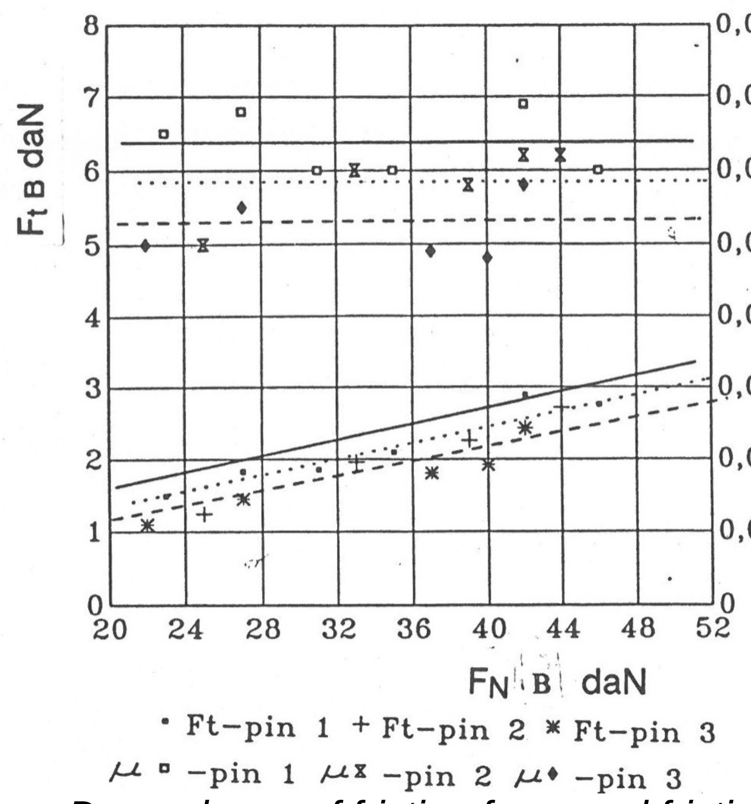


*Tribometer with measuring chain*

## RESULTS AND ANALYSES

**Friction coefficient research results**

The results of measuring the friction force that develops in the zone of contact of the pin and the disk at the relative sliding speed V and different external loads are shown:



*Dependence of friction force and friction coefficient on load and type of heat treatment*

Ductile iron pins EN-GJS-500-7 (with three heat treatment modes) and gray cast iron discs SL 250 and carbon steel Č1531 (C40E) were used in the test.

If the tribological characteristic of nodular cast iron NL500 improved by the classical method (pin1), which is determined by the friction force, is marked with 100% then the logical conclusion of the same material determined by other (2) forms of isothermal processing (pins 2 and 3) can be determined by the following equation:

$$I_{Ft}^{i} = \frac{F_t^1}{F_t^i} \times 100$$

$F_t^1$ - the value of the friction force obtained by changing the pin from ductile iron whose tribological characteristic is taken as 100%.

$F_t^i$ - the magnitude of the friction force obtained when applying pins from other materials or from all materials processed in other conditions.

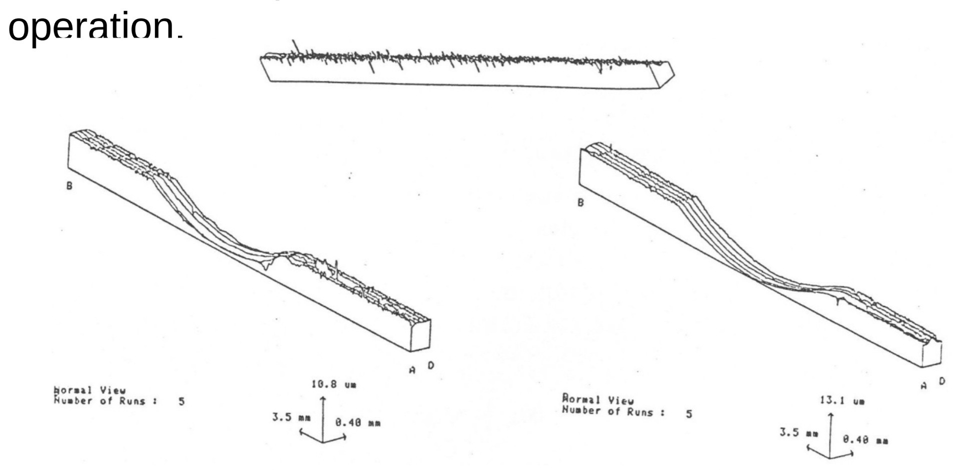
*Tribological characteristics of ductile iron EN-GJS-500-7 with shown sizes*

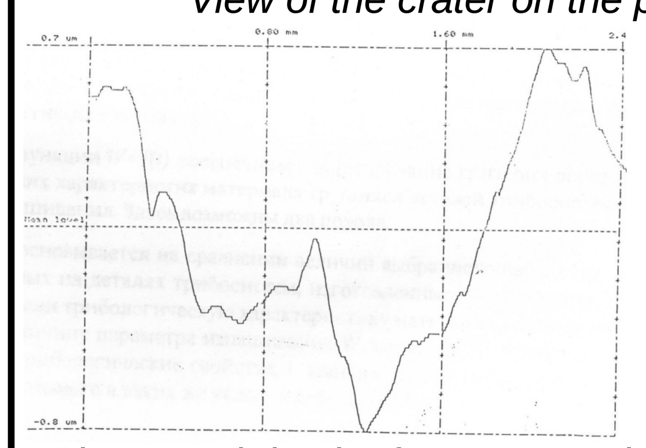
| Test tube | Hardnes - HRC | $F_{tb}$ - daN | $I_s$ - % | Note |
|---|---|---|---|---|
| Pin 3 | 52 | 1,25 - 2,25 | 130 | Fn= 25 - 45 daN |
| Pin 2 | 51 | 1,375 - 2,475 | 108,1 | V= 1,45 m/a |
| Pin 1 | 48,5 | 1,625 - 2,925 | 100 | T = 24 h |

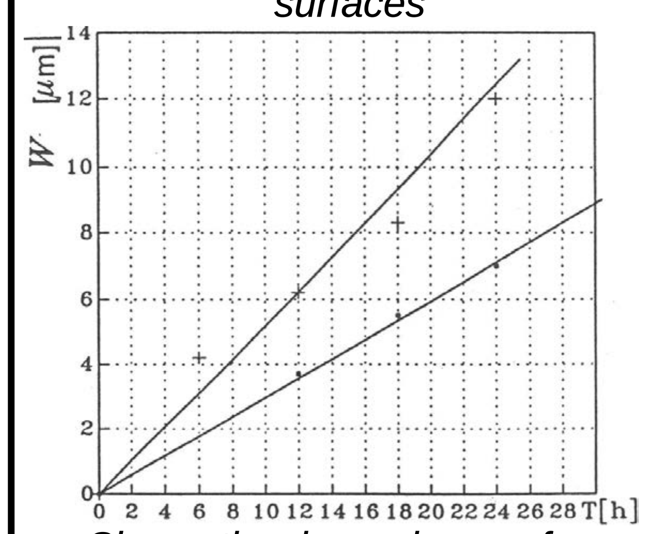
## TRIBOLOGICAL CHARACTERISTICS OF THE TESTED MATERIALS FROM THE ASPECT OF WEAR

Elements of the tribomechanical system made of ductile iron EN-GJS-500-7 isothermally treated to create a structure corresponding to beinitic structures (pin 3) have tribological characteristics 30% better than elements made of the same material and heat treated only by the classical method (pin 1) .

Determining the tribological characteristics of the materials of the elements of the tribomechanical system is based on measuring the changes in the selected wear parameters, which are in contact during operation.


*View of the crater on the pin surface*


*Shape and depth of craters on pin surfaces*



*Shows the dependence of shape and the depth of the crater versus time*

The obtained results visible in Figure show that between the tribological characteristics of EN-GJS-500-7 ductile iron pins improved by different methods, there is a difference of X% if the measurement characteristics are based on wear measurements after 24 hours.

## CONCLUSION

The identification of the tribological characteristics of the material of the elements of the tribosystem in terms of wear can be determined by measuring one part or several wear parameters. Modern tribometers and measuring systems are equipped with computers that have built-in programs for data processing and graphical display, the obtained results, allow the measurement of friction force with satisfactory accuracy in different friction conditions.

Having in mind all the existing possibilities of preventing the process of wear of tribosystem elements of different types, the problems of determining tribological characteristics are still great. Using the measuring system Tarysurf 6 can be very efficient with the change of the tribometer made according to the construction of the pin-disk, because it gives the possibility of measuring not only line but also surface parameters. Databases for tribological characteristics of materials, which are the basis of the tribological system, can be formed and constantly updated relatively quickly at low cost, if you have several different dynamometers and measuring systems using tribometers designed to make line contact (pin-disk). Identification of changes in the condition of contact surfaces (surface topography parameters) is performed by measuring surface roughness parameters. In this case, this was realized on Talysurf 6. Figure 7 shows the monitoring of the depth and the formed crater in the contact of the pins with the mentioned disks. It is important to note that the pins and disk are made of multiphase materials. Ductile iron pins and steel and gray cast iron discs.

The conducted tests show that the ratio of tribological characteristics of the presented materials depends on what is determined: whether the friction force or wear parameters are measured.

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