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ANALYSIS OF TRIBOLOGICAL WEAR IN BLOCK – ON RING CONTACT ON TRIBOLOGICAL TESTER T-05

Summary. Friction is one of the most common phenomena in this technique. The friction process in the tribography systems causes both energy losses and consumption process losses. The layer of the surface of a solid body differing from the material to the entire volume of the solid is a close participant in the tribological process. The effects of external influences during treatment of the material and in friction processes were established and modified. The well-shaped layer of the surface provided optimum tribological properties during operation.

This work provides an analysis of the use of a tribological pair working in a rotational movement, in different operating conditions. The tests carried out showed the impact of the selected exploitation factors, that is, the speed and load, the consumption and the friction coefficient of the saliva and the graphical interpretation of results from the results obtained from experimental and metallographical studies. The tests carried out in the block-on ring position of the T-05 tribology was the nature of preliminary tests. Preliminary tests enabled

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the effects of designated performance parameters to be determined on selected tribological properties. Low-carbon steel used for heat-chemical treatment and steel with DLC coating was used for the test. Metallographic studies enabled the dominant use mechanism to be determined, depending on external factors.

The application of the above-mentioned value for materials currently used in various types of constructions allows for extending the life of a given device without major financial and constructional costs. A wide range of applications can bring many benefits to the current design solutions, in which the efficiency of the entire device can be easily improved.

Keywords: friction, lubrication, DLC layer

1. INTRODUCTION

The wear of cooperating elements with each other has being a focal point of interest for a long time [1-3]. The following articles show the various approaches to engineering solutions for improvement of wear elements [4-10]. Machinery for using machinery components is the inseparable effect of the device. One of the main phenomena that happen during the cooperation of two elements is the friction phenomenon. The friction process entails both positive (for example, motor vehicle equipment) and negative effects (for example, aerodynamic resistance). The friction process in the tribography systems causes both energy losses and consumption process losses (Figure 1).

The surface layer of the solid differing in structure and properties from the material in the entire volume of the solid body is a strict participant entering the tribological process. It is created and modified under the influence of external influences during material processing and in the friction process. A properly shaped top layer ensures optimal tribological properties during operation [11].

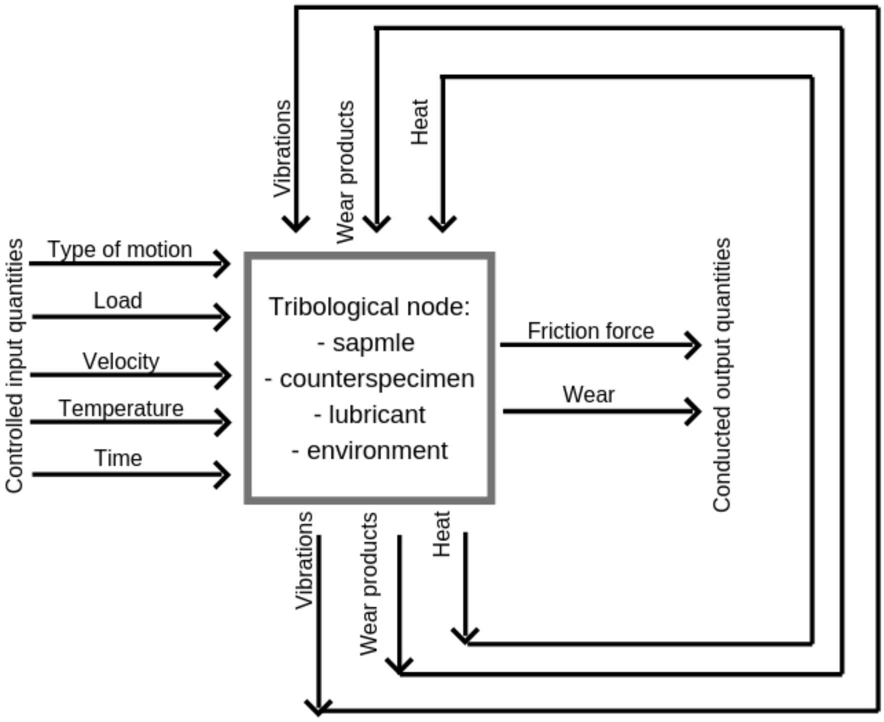

Fig. 1. Dependency: input-output in the tribological test [12]

The sliding friction, classified as the sliding friction, occurs at the interface between two solid bodies, while the bodies slide against each other or remain at rest. In the case of external friction (for example, sliding), the force occurring causes the displacement of one of the bodies relative to the other. Sliding friction occurs when a pressure force is transferred at the contact point of the bodies. This is accompanied by many phenomena occurring on the friction surface and just below it. In the case of dry friction, where there is no lubricant and foreign matter between the cooperating elements, the intensity of friction increases with the increase of surface roughness, this is accompanied by the release of a large amount of heat, which results in loss of strength and increased wear of selected machine parts [11]. Exploitation under the conditions of changing tribological and corrosive excitations results in unfavourable changes in the structure of materials that may cause the loss of important functional properties or even the complete destruction of structural elements of machines and devices [14]. The functional properties of machine parts depend not only on the possibility of transferring mechanical loads but mainly on the structure and properties of surface layers [15-19]. Factors determining the tribological properties of the coating are shown in Figure 2.

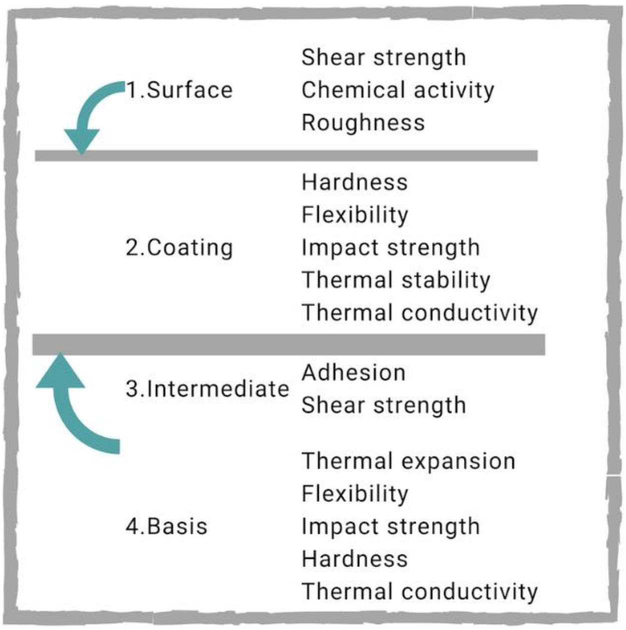

Fig. 2. Factors determining tribological properties of coatings [20]

2. TRIBOLOGICAL STUDIES - TEST FACILITY

The Common Rail injection system leads all other types of injection systems in diesel engines in the passenger and supply sectors. This system works in a pressure range of 30 to 220 MPa where the fuel pressure is produced continuously by a high-pressure pump. As a high-pressure pump, piston pumps driven by one to four piston pumps were used. The accuracy of the performance of the cooperating pair is up to 0,001 mm. This makes it impossible for any part of the various components to be included, which would result in a flawed injection and calibration [13].

The device for assessing the tribological properties of material combinations is a block-on ring-testing machine. Tribological tests using the T-05 tester were carried out with the following parameters:

- friction association: roll - made of 17 HNM material and block made of 17 HNM material with DLC coating, where the chemical composition of 17 HNM steel is:

Tab. 1

Chemical composition of 17HNM steel, %

C	Si	P	S	Cr	Ni	Mo	W	V	Cu
0,14-0,19	0,17-1,37	max 0,035	max 0,035	1,5-1,8	1,4-1,7	0,25-0,35	max 0,05	<=0,2	max 0,3

- load P = 10 N,
- sliding speed v = 0.18 m/s,
- road of friction s = 1950 m (for 0.18 m/s),
- test time t = 10800 s.

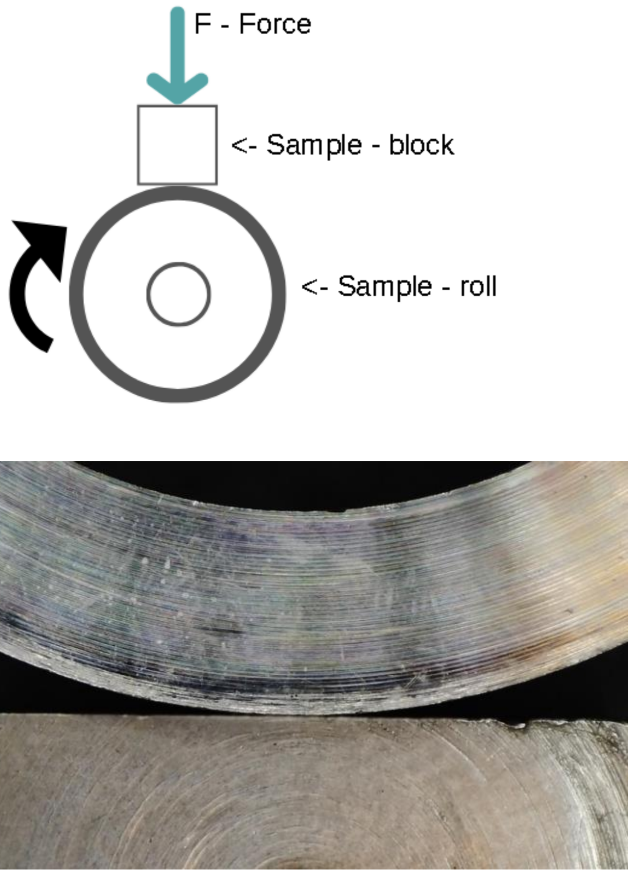

Fig. 3. Tribological knot block-on ring

Fig. 4. Tester used for tests - T-05

3. TRIBOLOGICAL STUDIES - TEST RESULTS

The tests used the T -05 type test equipment working in the cinematic pairs of the block-on ring. During the tests, the friction force was recorded for 10800 s. The tests were carried out for five samples from each type of material. Figures 5 and 6 show indicative graphical interpretation of the friction coefficient where the rotational bar and load were constant and 100 N. Figure 5 presented the values for the case tested - steel with the DLC layer. Figure 5 shows the values for steel-steel tested. The drawings indicate that the values of the different materials differ. The case shown in Figure 5 shows that for steel with a DLC layer the value of the coefficient is significantly lower. As the journey of friction grows, it increases. For the case of Figures 5 and 6, the friction coefficient after the test increased by about 0,08 [-]. Figure 7 shows the loss of mass of the samples tested. The primacy between materials showed that the material without the DLC layer recorded a loss of mass almost three times larger than material with a layer.

Figures 8 and 9 show examples of graphical frictional interpretation for parameters as in Figures 5 and 6, except for load. For the following examples, it is increased to 100 N. Figure 8 presented the values for the case tested - steel with the DLC layer. Figure 9 shows the values for steel-steel tested. As seen in the charts, the coefficient of friction in the DLC layer falls over time. The initial value of the coefficient increased rapidly due to the break of the layer from the surface of the sample.

Figures 11 and 12 show one of the samples surface cooperating with the counter sample. The migrating of the DLC layer between samples can be noticed, thus, the value of the coefficient of friction decreased during the test.

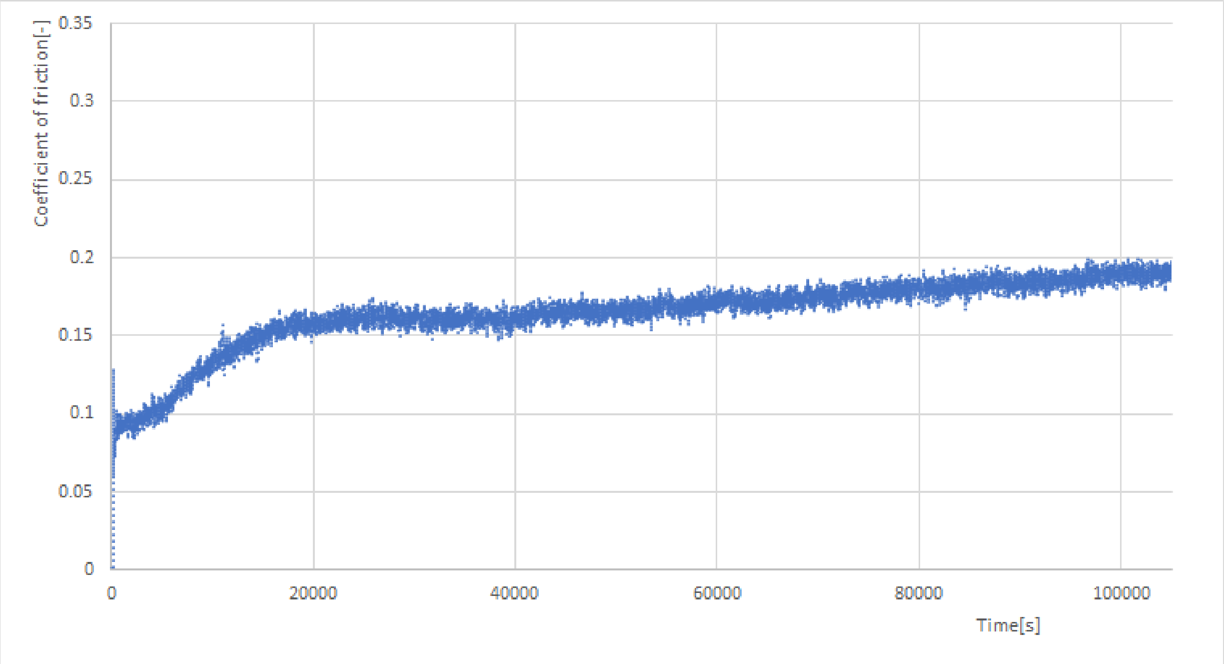

Fig. 5. Cofficient of friction steel - steel with DLC layer - load 10 N

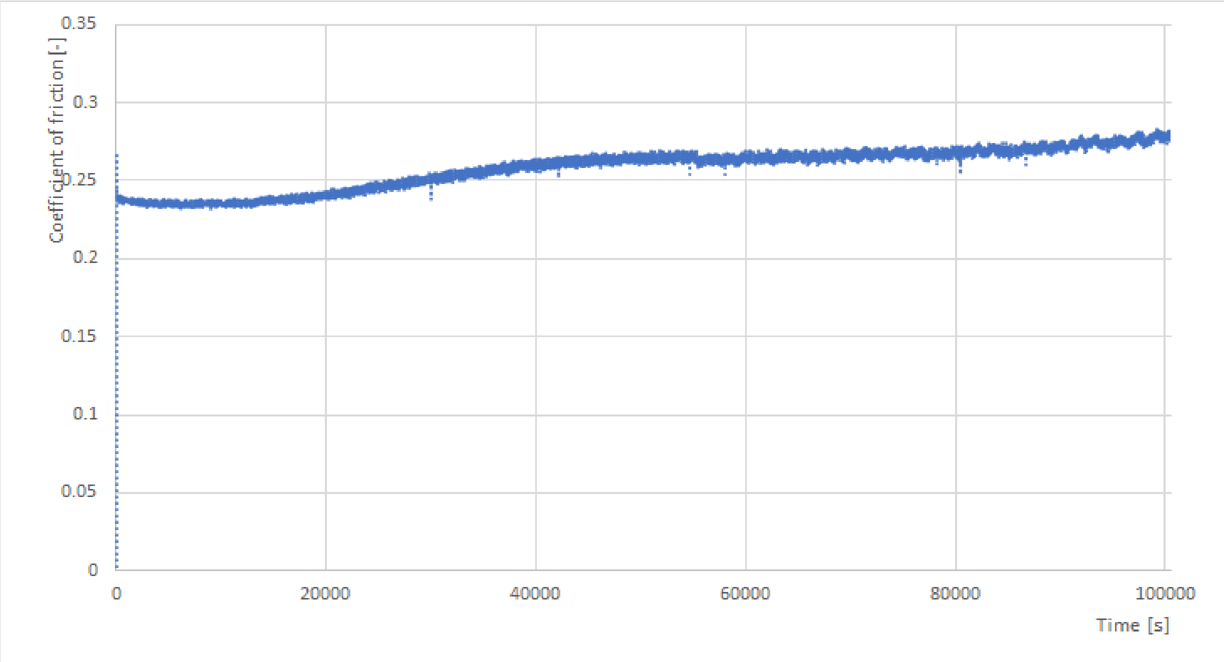

Fig. 6. Cofficient of friction steel - steel - load 10 N

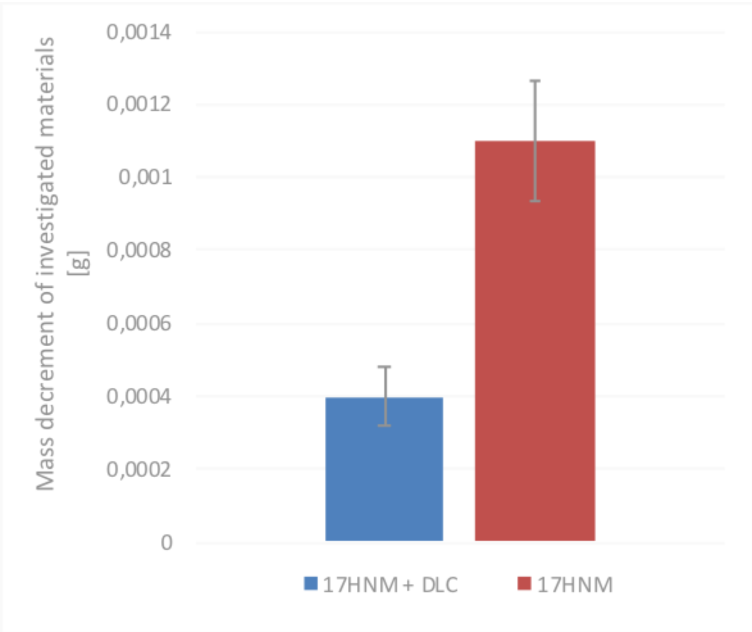

Fig. 7. Mass decrement of investigated materials (load 10 N)

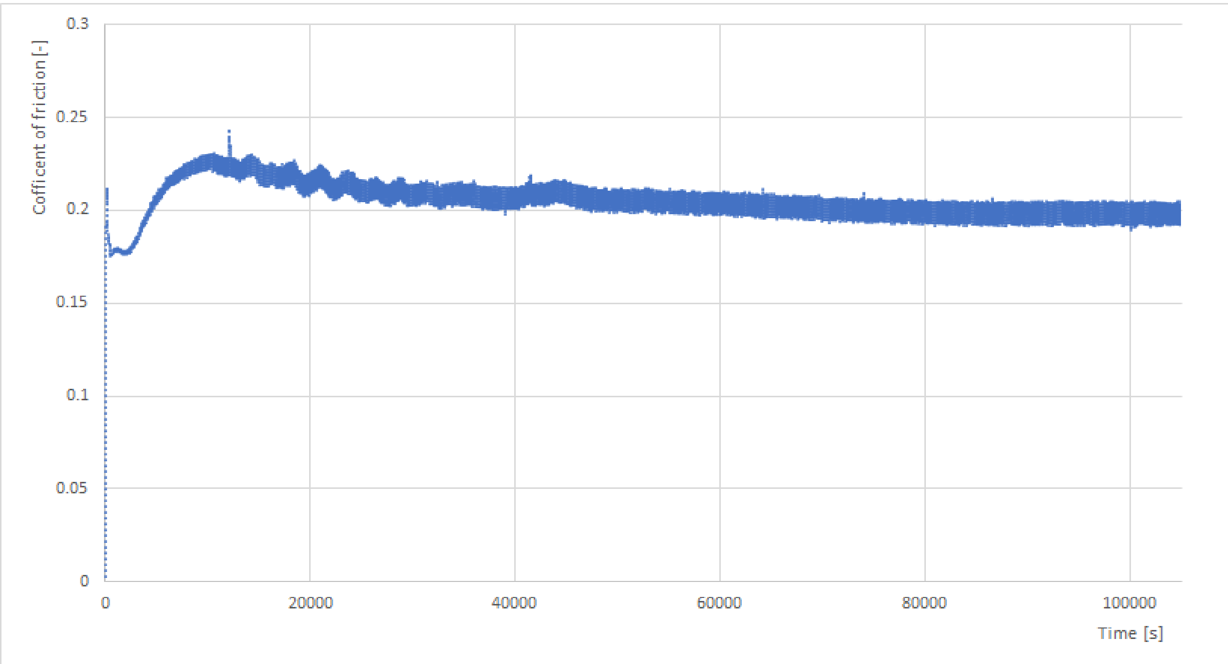

Fig. 8. Cofficient of friction steel - steel with DLC layer - load 100 N

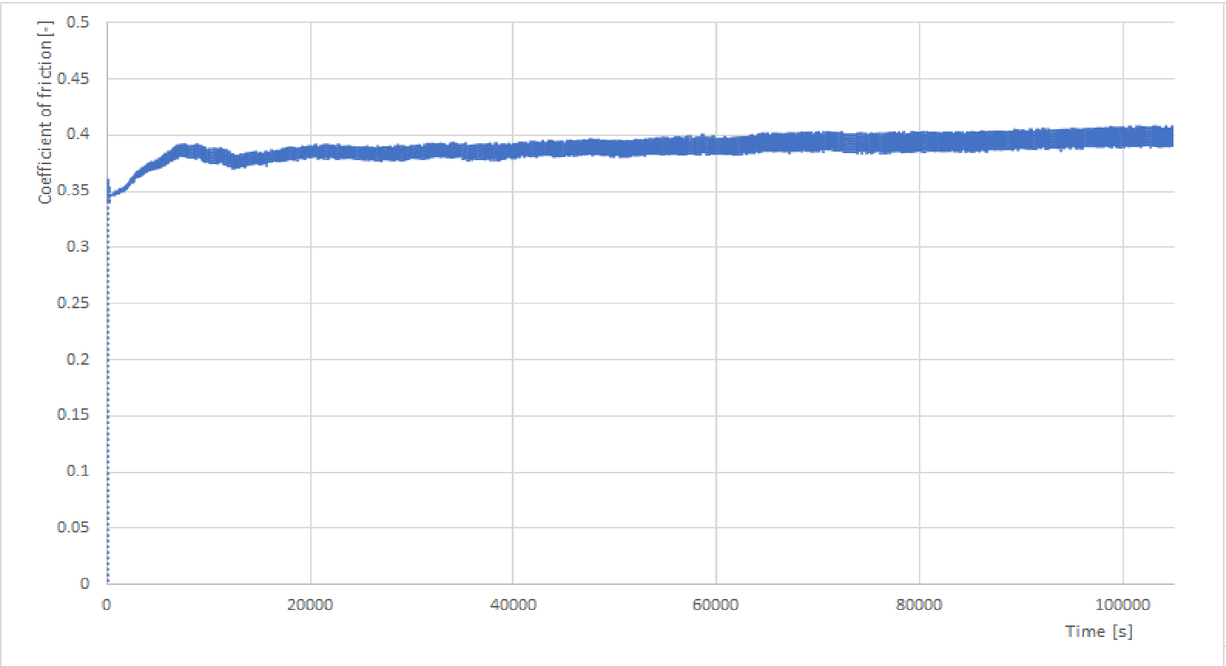

Fig. 9. Cofficient of friction steel - steel - load 100 N

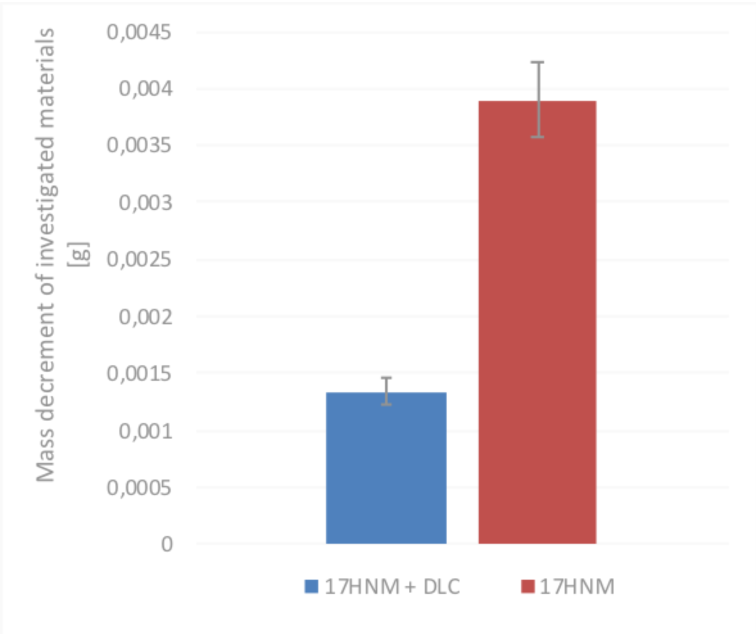

Fig. 10. Mass decrement of investigated materials (load 100 N)

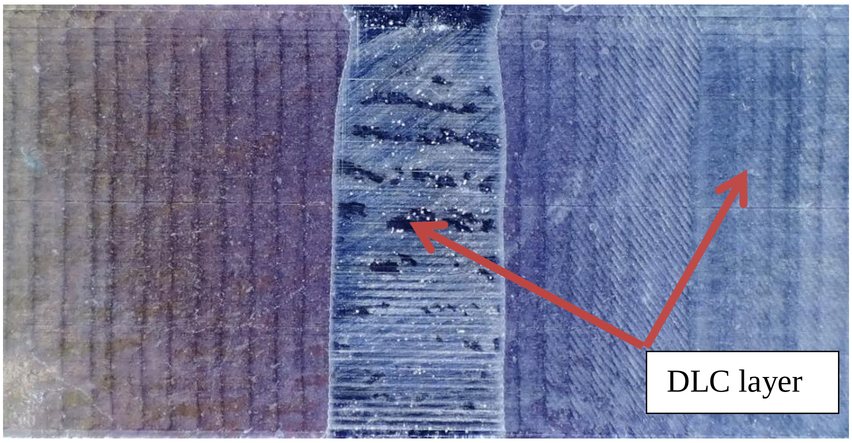

Fig. 11. Example sample with DLC layer (load 100 N)

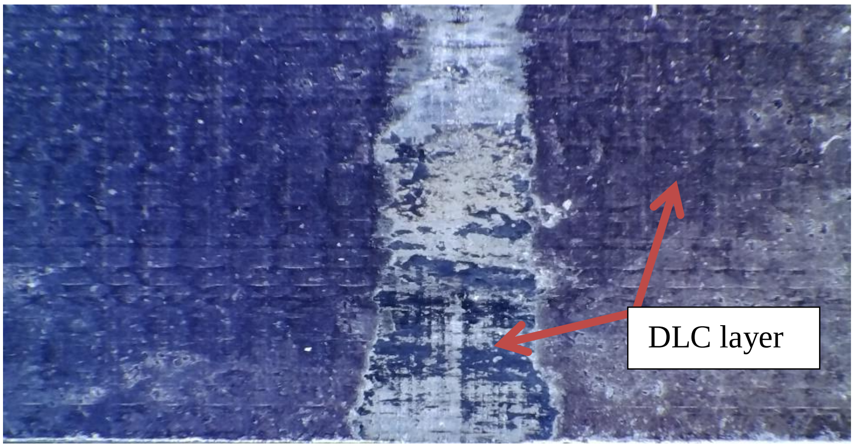

Fig. 12. Example sample with DLC layer (load 100 N).

4. SUMMARY

The tribological tests carried out using the T-05 tribotester were preliminary tests that were introduction to the main studies. Microscopic examination allowed observation of the sliding association in a swinging motion whose lubricating medium was diesel oil. Magnification of the drawings revealed various types of grooves, and discontinuities caused by the interaction of friction elements.

The following conclusions were formulated on the basis of the conducted research:

- carrying out research in a block-on ring system at T-05 in single-sided traffic, a significant impact of the load on the value and type of wear was found,
- wear in the sliding combination is of the abrasive and adhesive nature, and its intensity depends on the operating parameters (for example, load),
- in view of the nature of the tests leading to comparison of the coefficient of friction of the two samples, the mass loss was measured, and rightness correctness of the applied DLC layer,

- the application of the above-mentioned value for materials currently used in various types of constructions allows for extending the life of a given device without major financial and constructional costs.

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