Researches on obtaining composite materials to be used in manufacturing brake pads

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Abstract. The paper presents the laboratory experiments and results meant for obtaining composite materials to be used in manufacturing brake pads for the drive and driven rolling stock. Six samples of composite material have been designed and obtained; each of them has been assessed in terms of tribological behavior using a tribotester and using the friction and wear parameters. Also, determinations have been made on the influence of the material factors and of the main parameters of the work conditions upon the tribological characteristics of the samples under tests and upon the processes that are going on in the superficial strata.

1. Introduction
The noise pollution generated by Rail traffic can be reduced by the application of passive and active measures at the source of disturbance noise. Applying passive methods to reduce rail traffic noise impact on the environment (protection walls and insulation windows) having effect only locally and require major investments [1]. The oriented measures reduce noise source for the entire railway system, if widespread are introduced. This is possible if the cast iron brake blocks will be replaced with composite brake blocks. This issue is examined in the rail industry and currently affects about 370,000 old freight cars and can be used the composite brake blocks K or LL.

K-blocks have higher coefficient of friction than cast iron brake blocks of about 2.5 times their installation on existing wagons requiring changes to the braking system, which is recommended for use in new vehicles. LL-blocks have coefficient of friction similar to cast iron brake blocks, their attachment to the existing wagons do not require major changes to the braking system, which is recommended for use in older vehicles in operation. Currently, there are a variety of composite blocks in operation [2].

European Commission recommends obtaining composite materials for brake shoes with superior characteristics to significantly reduce costs and noise [5].

2. Experimental research
The paper presents the laboratory experiments made to obtain composite materials meant for the brake pads to be used by train engines or carriages.
For the preliminary tests of the composite materials the following have been established: the composition of the experimental recipes, the technology of sample manufacturing, the assessment of the tribological behavior of the samples, the analysis of the results [6-8].

For the composite material, 6 experimental test rods were made, using the following components (Figure 1): 19-40% novolac; 3-5% hexamethylenetetramine; 0-7,5% sulphur; 0-10% carbon fiber; 9-15% graphite; 0-20% aluminum; 0-15% brass; 0-30% rubber.

The experimental samples made of composite material have been subjected to tribological tests. The evolution of the friction coefficient has been analyzed by means of a universal UMT-2 tribometer (CETR®, SUA), which allows rod-to-disc tests and also the visualization of the control parameters (the normal force, FN), as well as of the gauged parameters that can be chosen according to the needs (the friction force, the friction coefficient, the acoustic emission, the distance between the two friction elements, marked Z).

Figure 2 shows the device used in the tribological tests, and further on, the shape and dimensions of the steel rod (Figure 3) and of the composite material samples used in the experiment (Figure 4).

![Figure 1. Sample](image1.png)

![Figure 2. Universal UMT-2 tribometer](image2.png)
Figure 5 shows one example of visualization of the parameters on the tribometer monitor.

![Figure 5](image)

**Figure 3.** The shape and dimensions of the steel rod

**Figure 4.** The shape and dimensions of composite samples

**Figure 5.** One example of visualization of the parameters on the tribometer monitor

### 3. Result

The time taken for covering a distance of 1500 m is calculated for each level of sliding rate, under laboratory conditions. Each test is carried out on a radius of 25 mm from the disc center to the rod axis, a single wear trace resulting on each disc. The wear has been measured for each disc separately, as mass loss between the value initially measured and the value measured at the end of the test. Two successive weightings have been done and their average has been used in calculations.

The experimental materials have been tested under dry sliding conditions, for the normal mean pressure of 0.17 MPa and 0.34 MPa and a sliding rate of $v = 0.4$ m/s, 0.6 m/s and 0.8 m/s using discs made of the pad material (composite material) and rods made of steel for roll bearings.
The results of the tests have been given in text files for the trial data, as well as the graphs of the parameters recorded by the software of the computer the tribometer is endowed with.

Figures 6-11 show the variation of the friction coefficient for a force of 5N and 10N, three different sliding rates.

**Figure 6.** The variation of the friction coefficient for a force of 5 N and a sliding rate of \( v = 0.4 \) m/s

**Figure 7.** The variation of the friction coefficient for a force of 5 N and a sliding rate of \( v = 0.6 \) m/s
Figure 8. The variation of the friction coefficient for a force of 5 N and a sliding rate of $v = 0.8 \text{ m/s}$

Figure 9. The variation of the friction coefficient for a force of 10 N and a sliding rate of $v = 0.4 \text{ m/s}$

Figure 10. The variation of the friction coefficient for a force of 10 N and a sliding rate of $v = 0.6 \text{ m/s}$
4. Conclusions
The analysis of the research results leads to the following conclusions:
- When the sliding rate goes up, for the same load, $F = 5\, \text{N}$, one can notice an increase of the friction coefficient as the distance grows, for most samples;
- The evolution of the friction coefficient depending on the work distance is approximately constant;
- When the work load grows, for the same sliding rate, the friction coefficients decrease, but in time, they become stable;
- The friction coefficients obtained by tribological tests on the composite material samples are generally inversely proportional to the increase of the load and of the sliding rate, but they stay above 0.4.

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