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THE EXPERIMENTAL RESEARCH OF THE FRICTION CHARACTERISTICS OF THE FRICTION MATERIAL

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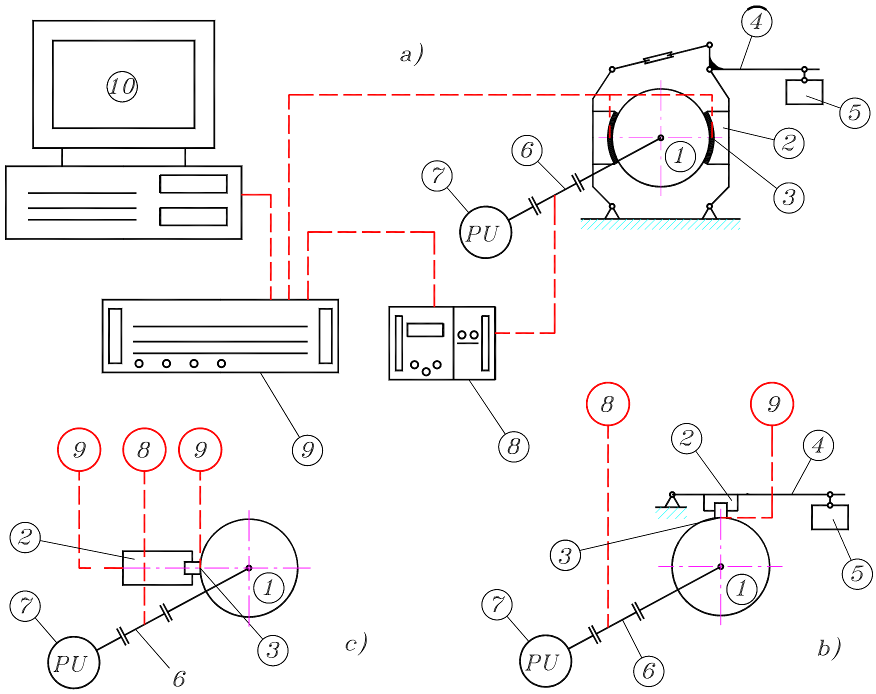
ABSTRACT
The brakes on crane are, depending of purpose and their build in mechanism, exposed to different working conditions. Their work characterize the transform of mechanical energy into heat which has warming up and temperature increasement of rubbing surfaces as result. If we take into consideration materials from wich these parts are made of, specific pressure on surfaces and sliding velocity, we see that there are many factors which can influence on reliability and lifetime of brakes.
More realistic description of braking process gives the opportunity for more correct selection of the braking drum and friction material, which provides in the first place reliability of the brakes and gives the possibility to predict their lifetime. To attain all this it is necessary to know friction characteristics of the friction material, which must be determined by the experimental way.
This paper shows results from the research of the friction characteristics of non-asbestos friction material.
Keywords: brakes, friction material, friction coefficient

1. INTRODUCTION
The brakes are devices that consider close contact of the lining made of friction material and braking drum and during this process friction material slide across the edge of the drum. Contact of these two elements, together with the environment, makes tribology system whose inner (tribological) process includes friction and wearing out. Analysis of such occurrences show that friction has its effect on relation between entrance and resulting values (for example, relation between quantity of energy at the resulting point and entry point, because part of the energy is spent to overcome friction). Considering the loss of energy in case it is not compensated, we notice relative movement velocity decrease of the braking drum until complete stop of the mechanism (machine), which is in most of the cases the assignment of such devices. For prediction of available brake momentum and temperatures of sliding surfaces, it is necessary to know friction coefficient of the friction material which needs to be high and stable at different velocities of sliding, charge, temperatures, environment, and wear out level so we could be able to name these materials as quality materials. Influence of some of factors listed above will be analyzed in this paper.

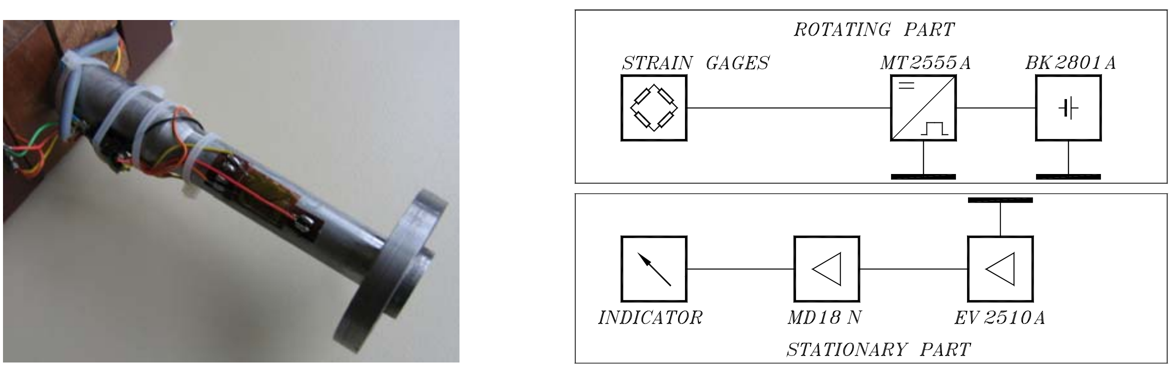
2. EXPERIMENTAL RESEARCH FOR FRICTION COEFFICIENT
During this research under the brakes it has been developed examination base where it is possible to check calculation results for temperature prediction on friction surface of the braking drum and stability of friction while brake is in state of activity. Making replacement of some parts and devices, examination base has been used to research friction coefficient of friction material.

2.1. Work method and examination base components
A systematic design for examination base is given on the Picture 1. Rotation of the drum 1 is giving relative sliding velocity forward stable test tube 2.



Picture 1. Systematic design (scheme) for examination base (work method): 1- breaking drum, 2-carrier and the test tube (brake shoe with lining), 3-thermoelastic cell couple, 4-a bar, 5-weight, 6-measurement shaft, 7-suurce of mechanical power, 8-digital indicator DA 24 and measuring amplifier MD 18 N, 9-multichannel measuring amplifier DMC 9012 A, 10-a personal computer

System of bars with non-equal tentacles 4 (a bar 4, picture 1b) and weight 5 or spring 2 (picture 1c) gives us normal force at the contact place. Run of the drum is happening by use of shaft 6 which is also used for measurement of friction momentum. Two shafts are used for measurements: Φ 20 (picture 1c) connected with drum whose diameter is 200 mm and Φ 16/ Φ 12 (pictures 1b and 2a) connected with drum whose diameter is 100 mm. Measurement chain is consisted of converter- elastic element with measurement strips pasted on itself and BLM system whose scheme is given below, on picture 2. Elastic elements have 1-XY21-6/120 and 1-XK210-3/350 strips pasted. Specific strip 1-XY11-3/120 is also pasted inside of the test tubes carrier where normal force originates with help of the spring (picture 1 c). All cases show strips connected into the configuration alike full bridge. Measurement of temperatures on sliding surfaces is being done with conductors and thermoelectric cell couples K: conductor 1 NiCr and conductor 2 Ni.

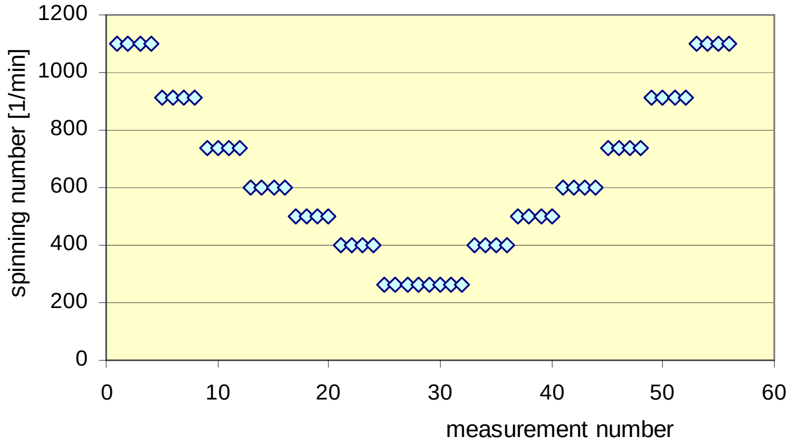


Picture 2. Signal flow using the recever preamplifier- battery operation

Test tubes used for examination are made of friction material with quality Co-666 and braking drum is made of steel X38CrMoV5-1. These test tubes have relatively small width (6-12 mm) comparing to the diameter of the drum, so we can consider this case as sliding straight surfaces with evenly allocated pressure.
Before the measurement started, first the calibration of measurement chain for reading friction momentum and normal force values is made.

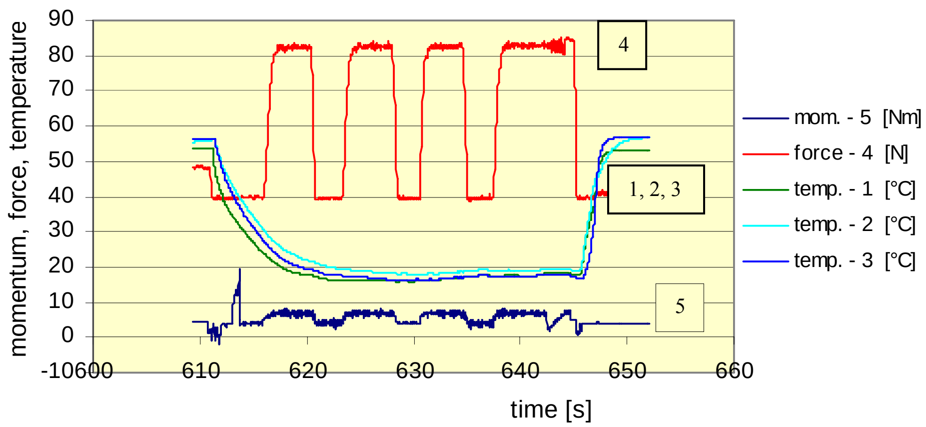
2.2. Measurement results

After the process of adaptation test tube sliding surfaces with drum sliding surface finished, the analyzing phase started and its measurement sequence throughout one cycle is given on picture 3. Measurement cycle is repeated few times leaving the same value for normal force. Also, individual measurements are repeated more than once under the same working conditions. An example of the results obtained by one of those measurements, where three repetition are done under the same conditions (normal force and sliding velocity are equal) is given on the diagram on picture 4.



Picture 3. Analyzing sequence throughout one measurement

We notice from the picture that temperature on the sliding surfaces of drum and test tube was monitored before and after measurement of friction momentum and normal force, because this temperature is one of the factors which effect friction coefficient value.



Picture 4. One measurement results (three repetition under the same conditions)

Based on measurements results (we read the momentum and normal force value), it was possible to calculate friction coefficient value of friction material for given measurements conditions. Friction momentum value was determined on the basis of mean values for momentum

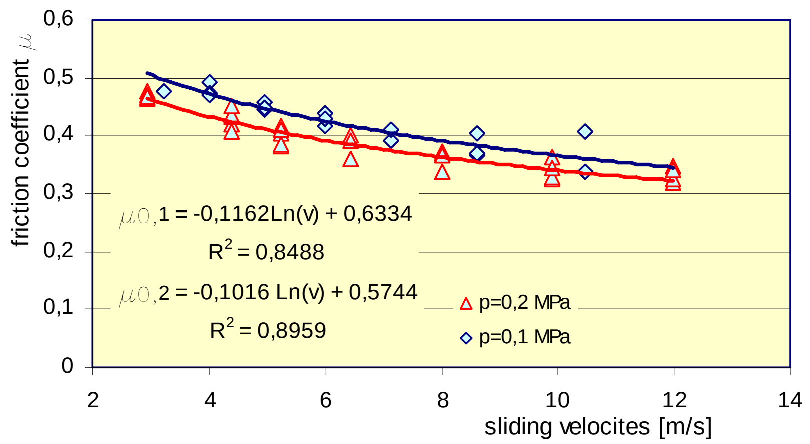
$$M_t^{\ i} = \overline{M}_a^{\ i} - \frac{\overline{M}_a^{\ i-1} + \overline{M}_a^{\ i+1}}{2} \qquad \ldots (1)$$

notation: $\overline{M}_a^{\ i}$ - mean value for momentum during the contact of the test tube and the drum,
$\overline{M}_a^{\ i-1}$ - men value for momentum of free shaft before the contact of the test tube and the drum,
$\overline{M}_a^{\ i+1}$ - mean value for momentum of free shaft after disconnection test tube from the drum surface.

Using equation (1) and already calculated values for friction momentum, mean values for normal force ($\overline{F}_N^{\ i}$) and for diameter of braking drum (D_b), we can calculate the friction coefficient

$$\mu = \frac{2 M_t^{\ i}}{D_b \overline{F}_N^{\ i}} \qquad \ldots (2)$$

Calculated values are used to define dependence of friction coefficient value from velocity of sliding surfaces, specific pressure at those surfaces and their temperatures. Picture 5 represents the diagram of dependence of friction coefficient value from sliding velocity for specific values of pressure 0,2 MPa and 0,1 MPa. The measurements are performed at ≅ 60 °C of the sliding surfaces, and dependence of friction coefficient value from sliding surfaces velocity while in contact is determined.



Picture 5. Dependence of friction coefficient value from sliding velocity for two values of pressure on the sliding surfaces

3. CONCLUSION

After all planed experimental research has been finished, dependence of friction coefficient from sliding velocity was found for specific friction material Co-666 across steel X38CrMoV5-1. From the diagram, we can conclude that friction coefficient decreases by increase of sliding velocity and by increase of specific pressure on contact surfaces. This dependence can be used for solving problems of predicting temperatures on sliding surface of friction drum, but also we can use it with problems of heating brakes in crane system.

4. REFERENCES

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