Surface Temperature Reduction Methods Brake Pair Friction

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Abstract
One of the promising industries is oil engineering, the main task of which is the creation of drilling equipment of increased reliability and durability. A band- block brake (LKT) is one of the main units of hoisting and transport machines and equipment widely used in the oil, gas, mining industry, construction and transport. LCT, which has a number of advantages, differs sharply from other types of brakes. Therefore, LCT is used as a mechanical brake on a draw works, which performs the most difficult and responsible work. For all types of brake units, the main requirements are: ensuring smoothness and stability of braking, creating the maximum value of the braking torque, minimal and uniform wear of brake pairs, compact design and reliability in operation. Braking, by its very nature, is one of the most complex "without lubrication" friction processes in the field of tribological engineering.

Keywords
eDemocracy, digitalization, eurointegration, information technologie, thermal spots, nozzles, friction, temperature, cooling, loading.

1. Introduction

The conducted experimental studies show that without forced cooling, high temperatures arise on the friction surface of brake pairs, which causes a sharp decrease in the quality of the friction surface and, in general, negatively affects the efficiency and reliability of the braking process. To reduce the temperature of the friction surface during braking and create a favorable working condition for the brake, researchers have proposed various methods and designs for forced cooling of the friction surface of brake pairs. In view of the imperfection and inefficiency of the proposed methods and structures for the full cooling of the friction surface of brake pairs, they have almost not found their application in a band- block brake to date. Therefore, it became necessary to develop a new method and design of a system for forced cooling of the friction surface of the brake pairs of a band-shoe brake, which, when used, would enable efficient cooling during braking. For this purpose, a new design of the forced cooling of the friction surface of the brake pairs of the band- block brake during braking, which was protected by a patent [4]. A technique has also been developed for testing a new design on an following test was carried out with the measurement of the temperature of the friction surface through the experimental installation of a band- block brake. The proposed design of the cooling system for a band-shoe brake has an air-cooling device and is designed for uniform cooling around the entire perimeter of the friction surface of the brake pulley after each shoe during the braking process. To do this, compressed air is supplied to the slots formed between the pulley, the brake band and the pads from 2 sides along the width of the brake pulley, in a checkerboard pattern so that after cooling it is possible for air to escape in front of the nozzles. The proposed design is shown in (Fig. 1). It contains a brake pulley 1, a brake band 2, brake pads 3, mounted on carriages 4, an air-cooling device with a main pipeline 5, fixed clamps 6 on the brake housing from the side of the tape, with distributing nozzles 7 placed on them on both sides. The design of the cooling system of the band-shoe brake works as follows. Compressed air is supplied to the main pipeline, from here to the friction surface of the pulley, through dispensing nozzles placed along the width of the tape on both sides between the shoes in the slot on the pipeline.

Bodies of the brake pairs in the following order: on both sides of the brake pulley and in the middle

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part of the block without and with the use of cooling from one and 2- x sides.

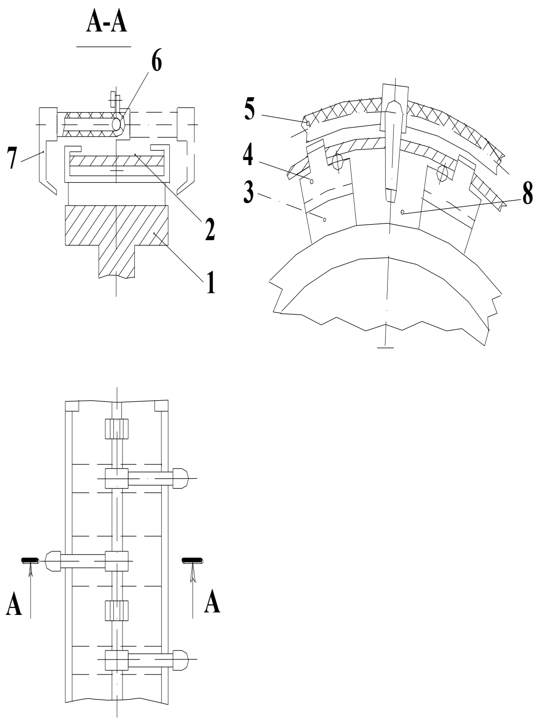

Figure 1: The device for cooling the friction surface is tape- block brake

When this compressed air is sent to the slot 8, with the possibility of exit after cooling in both ends of the tape 2 hot air. Slots for compressed air inlet and hot air outlet were formed between the pads around the brake pulley (1), created on both sides of the carriage (4) with pads (3), the surface of the pulley and the belt. In front of all nozzles, one side of the slots was left open.

2. Tools to reduce friction surface temperature at local levels

To install thermal sensors that determine the temperature of the friction surface of the band-shoe brake, on the brake pulley at the ends on both sides, at a distance of 0.5 mm from the friction surface, pre-drill o determine the effectiveness of the proposed cooling system on the installation of a band.

The measurement of the temperature of the friction surface during braking is carried out using temperature sensors that were prepared in advance. Then, using the calibration graph (Fig. 2), the value of the temperature of the friction surface of the rim of the brake pulley is determined along the width. For this, a certain cycle of operation was first chosen and its mode was worked out, which consists of the time spent on the braking process and the time between braking processes.

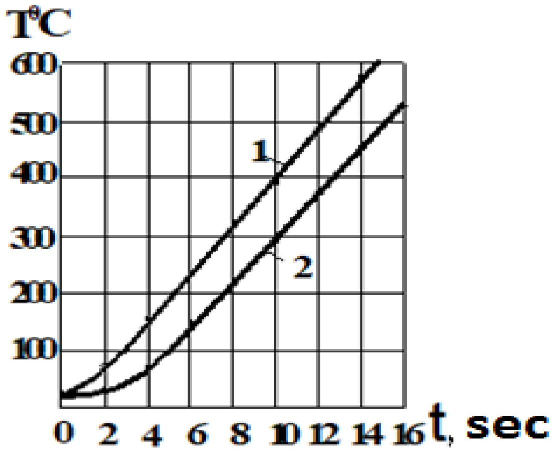

Figure 2: Calibration schedule brake pulley temperature depending on process time braking (1-on friction surface; 2-in depth)

The worked cycle of work was achieved by repeated repetition of braking and its values for all cases were taken to be the same. Measurement of the temperature of the friction surface is carried out according to the developed method, in the following three directions. 1. Measuring the friction surface temperature of the brake pulley without forced cooling. 2. Measurement of the temperature of the friction surface of the pulley with forced cooling on one side. 3. Measurement of the temperature of the friction surface of the pulley with forced cooling on both sides. During the experiment, the ambient temperature was 8-10° C. At the beginning, the friction surface temperature of the brake pulley in the selected mode was measured without cooling. Then, without changing the mode of operation of the brake, the temperature of the friction surface of the brake pulley was measured from both sides with cooling after each pad from one and both sides.

To do this, compressed air is supplied to the pipeline, from there compressed air is directed to the dispensing nozzles placed on the pipeline and through them in a checkerboard pattern along the width of the tape, from one and both sides between the pads in the slot on the surface of the brake pulley after each pad. The slots are formed between the pulley, the belt and the blocks fixed on the carriages, and one side of the slot in front of each nozzles with the possibility of hot air outlet was left open.

The results of the experiment, cooling the friction surface of brake pairs, are shown in (Fig.

3.). The nature of the temperature change during the braking process, depending on the time of increase, and cooling relative to the previous positions is shown by thin lines in (Fig. 3.).

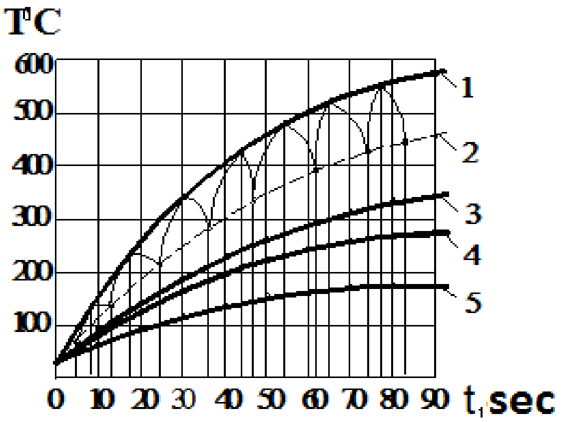

Figure 3: Graph of the dependence of the temperature of the friction surface of the pulley on time: 1 - during braking, without cooling of the friction surface; 2 - during cooling, without cooling the friction surface; 3 - at the outlet, with one side of the friction surface cooling; 4 - at the inlet, with one side of the friction surface cooling; 5 - with bilateral cooling of the friction surface

From these graphs it can be seen that with one-sided cooling of the friction surface of the brake pulley, the width at the inlet and outlet of the compressed air has a different temperature, and compared to without cooling, it turns out to be significantly lower. This is explained by the fact that with one-sided cooling of the friction surface of the brake pulley, compressed air removes heat from one side of the friction surface at the inlet, increases its value and displaces it in a warm form to the outlet in the other direction. With double-sided cooling, the friction surface of the brake pulley heats up much less than in previous cases and does not have a temperature gradient across the width, since the friction surface of the brake pulley is uniformly cooled around the entire perimeter after each pad in a checkerboard pattern. It should be noted that with this method of cooling, the friction surfaces of the brake pairs are simultaneously also cleaned of wear product.

The table shows that as the speed of the brake shaft and the load of the pulley increase, the temperature of the friction surface increases and reaches 630°C. Subsequently, with an increase in temperature, when it reaches the limit of 800-900*C, there is a significant change in the quality of the friction surface and, subsequently, the braking efficiency decreases sharply.

Table 1
The results of measurements of the temperature of the friction surface through brake pulley body

Flywheel load N, H	Brake shaft speed min.$^{-1}$				
	20	40	63	80	100
	Brake pulley friction surface temperature, T°C				
20	52	110	170	190	210
30	70	130	210	270	370
40	85	165	270	350	450
50	95	190	350	480	530
60	105	215	380	520	630

Table 2
The results of measurements of the temperature of the friction surface through brake pad bodies

Flywheel load N, H	Brake shaft speed min.$^{-1}$				
	20	40	63	80	100
	Friction surface temperature of brake pads, T°C				
200	40	100	155	175	195
300	60	122	195	245	335
400	75	155	255	325	415
500	88	175	330	455	495
600	95	200	360	490	600

At the same time, it was found that the number of microcracks on the friction surface of the brake pulley increases, and the first signs of thermal spots appear. And on the surface of the block, cracks also increase and there are places where particles of retenax material are pulled out. On the friction surface of the brake pulley along the entire perimeter, especially in the middle part, the cracks were *1000-3000 µm in length and *20 µm in width (Fig. 3.4). On the surface of the pads, the sizes of cracks were large compared to the brake pulley and amounted to *3000-5000 microns in length and *2000-3000 microns in width. At high loads that occur in heavily loaded friction units, such as a draw works band-shoe brake, from the braking process, the temperature on the friction surface rises sharply, which leads to strong heating of the elements of the friction pair. And this affects the change in frictional properties, the quality of the friction surface: the geometric and physical-mechanical properties of the surface layer, and also creates the necessary conditions for the formation of micro and macrocracks, thermal spots on the working friction surface of the brake pulley. The presence of thermal spots on the friction surface of the brake pulley, due to their deepening, further increases the discreteness of the process of contacting the surfaces of brake pairs, which leads to a direct change in the actual contact area and the pressure of the pads on the brake pulley rim. As can be seen, at high speeds of the brake shaft and the presence of a large load, a high temperature can occur on the friction surface of the band-shoe brake, which, of course, has a significant impact on the parameters characterizing the quality of the friction surface: geometric and physical-mechanical properties of the surface layer. This creates conditions for changing the hardness of the surface layer of the brake pulley, which causes the formation of thermal spots and adversely affects the magnitude and stability of the coefficient of friction.

Figure 4: Brake pulley friction surface with microcracks and partial thermal spots

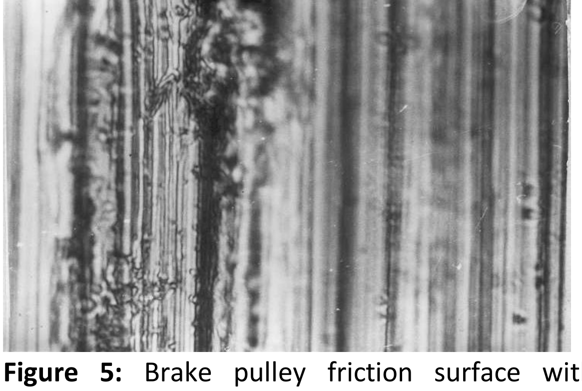

Figure 5: Brake pulley friction surface with adhering particles from the pad material Retenaks FK-24A

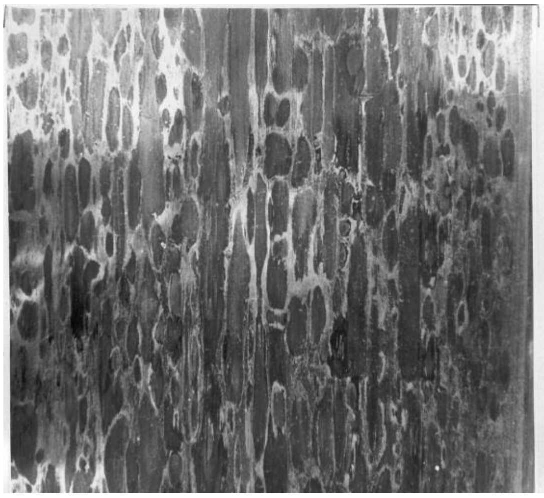

Figure 6. The surface of the brake pulley of the band-shoe brake of the draw works, worked out in severe conditions

3. Conclusions

1. The review of the work shows that with the advent of the band-shoe brake in various industries, for a long time the main problem was to ensure the rational distribution of pad pressure on the pulley rim, to find ways to improve the efficiency and reliability of the braking process. One of the disadvantages of this design is the instability of existing and emerging parameters and changes in their values.

2. Direct fastening of the pads to the brake band leads to an uneven distribution of pad pressure on the pulley rim and creates additional problematic tasks. These important problems are solved with the use of forced cooling of the friction surface on the new design of the band-shoe brake, where the pressure of the shoes on the pulley rim is evenly distributed.

3. Comprehensive experimental studies carried out with different modes on a new constructions, under the action of interrelated basic parameters, show that this the design provides not only uniform distribution of temperature, pad pressure on the pulley rim, uniform wear of all pads; efficient and rational cooling friction surfaces, but also stripping

4. Guided by the results of the conducted research and the position of the theory of "dry" friction, theoretical foundations have been established on the mechanism of formation of thermal spots and cracks on friction surfaces of the brake pulley and pads. Consistently and in detail formation of thermal spots, the process of adhesion and setting of friction surfaces brake pairs. Their physical structure is explained.

4. Acknowledgements

When performing the work, the main provisions of the modern molecular-mechanical theory of friction, proposed by Doctor of Technical Sciences, prof. I.V.Kragelsky and the theory of friction "without lubrication", proposed by Doctor of Technical Sciences, prof. A.V. Chichinadze. The main provisions of the work were reported at scientific and technical conferences and seminars. At the 43rd, 44th, 45th, 48th scientific and technical and methodological conferences of AzTU in Baku, 1995-2001. For graduate students, young scientists, undergraduates and students of scientific and technical conferences of AzTU in Baku, 1999 At the VI-VII Republican scientific and technical conference of graduate students and young scientists, AzTU Baku, 2000, 2001 At the 1st International Conference on "Technical and Physical Problems of Energy" (TRE-2002). Baku, 23.06 .2002 Heydar Aliyev and scientific and technical progress in Azerbaijan. Second International Scientific-Practical Conference:

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