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LABORATORY STUDIES OF THE LOAD ON TZ-38 TANGENTIAL PICKS

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ABSTRACT
The article summarizes the results of experimental studies related to determining the cutting forces of three types of TZ-38 picks. The test samples, test stand and operating conditions are described and the results obtained have been processed. Possibilities are presented for their practical use on the basis of the conclusions made.

The shearing drums of the Aykov continuous miners used at Babino Mine are equipped with tangential cutting tools of the TZ-38 type (Fig. 1). The loads these picks take up during operation have a considerable effect on the general technical condition of the miners. In order to determine the magnitude of this load under lab conditions, we carried out long-term studies. They aimed at determining the distribution of the resultant cutting force between the hard alloy plate (pin) and the head (holder) of the cutting tool. For the purpose, special picks with elongated heads were prepared (Fig. 1b), in which only the hard alloy plate participated in the cutting process as well as a pick without a hard alloy plate (Fig. 1b) where the cutting was performed only by the holder. Representative fragments from the Babino Mine were used in the experiment in the form of specially prepared rock samples. The tests were carried out on the test stand shown in Fig. 2.

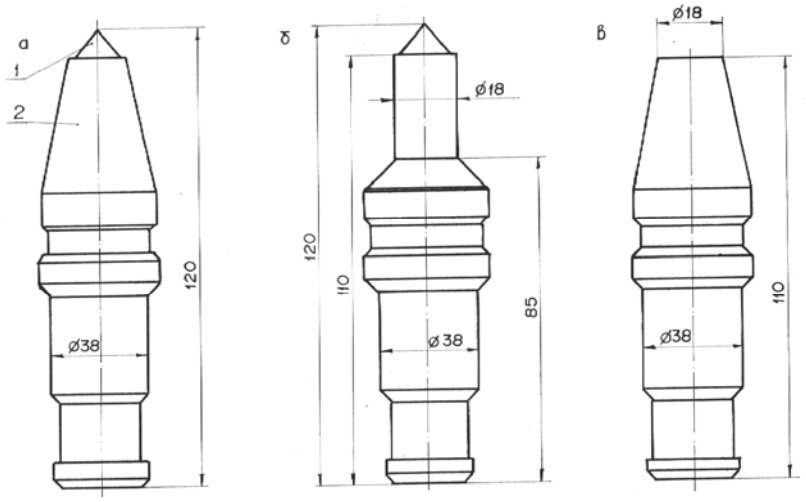

Figure 1. Experimental TZ-38 picks
a – original head; b – pick with elongated head;
c – pick from hard alloy plate

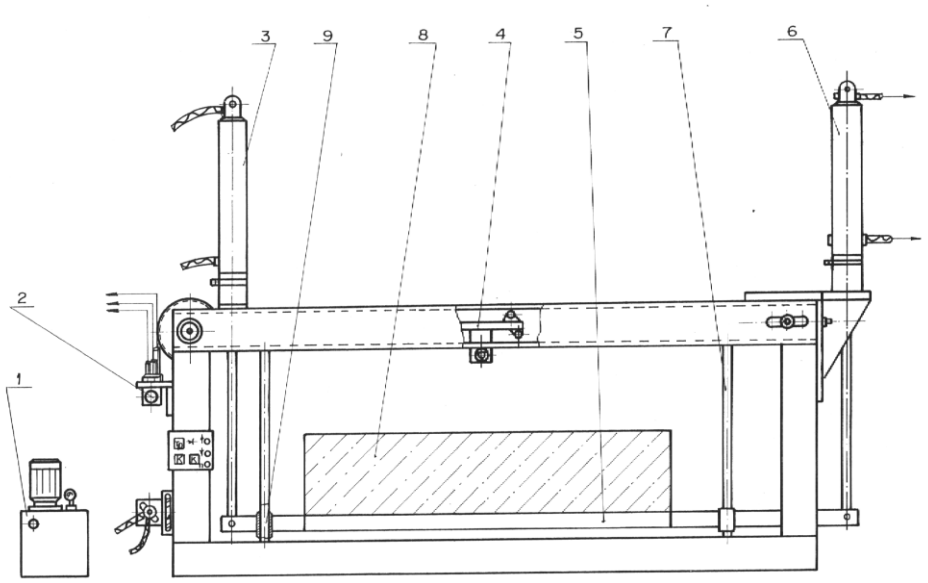

Figure 2.

It enables us to determine the resultant cutting force P_{res} and its three components oriented along the main axes X, Y and Z of the spatial coordinate system, P_x, P_y and P_z, respectively. The stand (Fig. 2) is equipped with a special strain-measuring head 4, driven by the hydraulic motor 2 and the hydraulic oil station 1. The rock sample 1 is moved vertically by the hydraulic cylinders 3 and 6, the platform 5 and the guides 7 and 9. Distributors with regulators were connected to the hydraulic system thus achieving automation of the full-load and no-load run as well as infinitely variable regulation of their rate. The new pick brands enable us to determine the loads taken up by the holder and the cutting part.

The tests were performed under the following operating conditions: blocked longitudinal scraping cutting along smooth surfaces; thickness of sickles – h = 10mm, angle of cutting tool β = 70°-110° changing through 10°; hardness of broken material f = 2.5-3 (according to Protodyakov) and feed rate of shearing drum V_p = 20mm/s.

The system for recording the test results enables us to control and record simultaneously the resultant cutting force and its components. The data obtained from the measuring head are stored in the primary memory of the computer every 0.02 s and during the reverse run are sent to the magnetic memory. The information, presented in a binary code, is processed by programs and the data are retrieved by files and fed to the printer for recording. Along with the printing, the results obtained can be observed on the computer screen. The analog-digital converter, which is used, enhances the metrological qualities of the system, increases its dynamic range and the error is determined by the computer digit capacity being 1/1256 for a 16-bit CPU.

The results of the summarized values of the controlled variables obtained during the experiments are shown in Table 1. In the same table, in percentages, are determined the ratios between the resultant cutting forces for the original and separate types of tested picks.

Table 1

Cutting angle β	Cutting forces, N												Ratio between resultant cutting forces, %	
	Original pick				Pick without head				Pick with elongated head					
	P_x	P_y	P_z	p_{res}	P_x	P_y	P_z	p_{res}	P_x	P_y	P_z	p_{res}	P^{wh}/P^{or}	P^{eh}/P^{or}
70	0.29	1.37	1.67	2.18	0.18	1.02	1.47	1.8	0.11	0.66	0.69	0.96	0.82	0.53
80	0.31	1.39	1.7	2.21	0.21	1.05	1.5	1.84	0.13	0.68	0.73	1.01	0.83	0.54
90	0.32	1.42	1.73	2.26	0.23	1.08	1.52	1.88	0.17	0.71	0.75	1.05	0.83	0.55
100	0.34	1.44	1.76	2.29	0.26	1.11	1.56	1.93	0.19	0.74	0.78	1.09	0.84	0.56
110	0.36	1.47	1.79	2.34	0.28	1.14	1.61	2.04	0.21	0.77	0.81	1.12	0.87	0.55

From the experimental studies carried out it was found that the cutting force is distributed between the hard alloy plate and the pick head. The experiment was necessitated by the processes occurring in the cutting tools used under the conditions of the Babino Mine, where the plate is broken and the entire cutting force is taken up by the pick head.

On the basis of the data obtained we can draw the following conclusions:

1. The resultant cutting force for the original picks is determined by the forces acting on the hard alloy plate and the body.
2. The hard alloy pin takes up approx. 80% of the cutting force and the remaining part (approx. 20%) is taken up by the pick body.
3. The vertical and side forces have a considerably weaker effect on the two pick elements since their participation in the formation of the resultant cutting force is insignificant.
4. The change in the angle of cutting from 70° to 110° has a weak effect on the ratio between the individual components.

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