WAYS TO INCREASE THE DURABILITY OF THE TEETH OF THE WORKING BODY OF ENGINEERING MACHINES

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Abstract: *this article examines the results of a study on the intensity of wear of the teeth of the working body of engineering machines, in particular excavators, operated at the Muruntau quarry, which is part of the Navoi Mining and Metallurgical Combine.*
A requirement is proposed for the bucket teeth to change them in configuration and size. The results on the influence of the abrasiveness of the developed medium on the wear rate are presented. Specific recommendations for reducing the wear of excavator bucket teeth are given.
Keywords: *cutting part of teeth, excavator bucket, abrasiveness, intense wear, quarry, shape of teeth, durability.*

ПУТИ ПОВЫШЕНИЯ ДОЛГОВЕЧНОСТИ ЗУБЬЕВ РАБОЧЕГО ОРГАНА ИНЖЕНЕРНЫХ МАШИН

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Аннотация: *в данной статье рассматриваются результаты исследования по интенсивности износа зубьев рабочего органа инженерных машин, в частности экскаваторов, эксплуатирующихся на карьере Мурунтау, входящем в состав Навоийского горно-металлургического комбината.*
Предлагается требование к зубьям ковшей, их изменение по конфигурации и размерам. Приведены результаты по влиянию абразивности разрабатываемой среды на интенсивность изнашивания. Даны конкретные рекомендации по снижению износа зубьев ковшей экскаваторов.
Ключевые слова: *режущая часть зубьев, ковш экскаватора, абразивность, интенсивный износ, карьер, форма зубьев, долговечность.*

The efficiency of the functioning of the cutting bodies of earth-moving machines, in particular, excavators, is an urgent task, which is operated especially in the Muruntau quarry, which is part of the Navoi Mining and Metallurgical Combine (NMMC) [1].

Due to the intensive wear of excavator bucket teeth, hundreds of thousands of tons of high-quality steel grade 110G13L are annually consumed for their manufacture. In just one year, NMMC spent up to eight thousand pieces of teeth, the production of which consumed thousands of tons of high-manganese steel 110G13L worth more than 10 million soums. The cost of teeth at the NGMK was about one third of the total annual cost of spare parts for the entire excavator fleet.

The quarry produces rocks that are characterized by a high degree of development difficulty. The main mining method is the extraction of rock mass and its further development with single-bucket excavators.

Excavators operating in the quarry carry out loading of the blasted rock mass and transport vehicles for delivery for further processing.

The study of changes in the configuration and dimensions of the teeth was carried out by measuring them

using a special template. The contours of the teeth were traced on a tablet and measured every 12 hours of operation of the excavator in the excavator face.

Experiments have shown that the main type of tooth wear is abrasive wear. On the working edges of the teeth, scratches, dents, grooves and craters are clearly visible, the depth of which reaches 5-12 mm, i.e. wear occurs due to cutting, crushing and chipping of microvolumes of metal by hard abrasive particles of rocks.

It has been established that the intensity of tooth wear depends primarily on the degree of abrasiveness of the developed rock. The abrasiveness of rocks is understood as the ability of a rock to wear out a solid in contact with it in the process of interaction.

The studies carried out have established that in the process of wear, the cutting part of the teeth undergoes large geometric changes. The main ones are shortening of the teeth, the formation of wear areas on the front and rear edges of the cutting edge of the teeth, a change in the thickness of the cutting edge, and an increase in the taper angles.

It was found that at first, when the teeth are sharp enough, the wear occurs quite intensively, and later, with the teeth blunting, the amount of wear remains almost constant. In this case, the tooth acquires a certain shape that changes little, i.e. the stabilization of the tooth profile occurs.

The process of loading ore when operating an excavator with worn teeth changes dramatically. Since the profile of the worn flank surface of the teeth does not coincide with the trajectory of the bucket, in the process of digging, the wear pads are pressed into the rocky soil, which leads to the manifestation of large additional resistance forces, bucket pushing teeth are introduced into the bottomhole along a horizontal trajectory [2].

With the appearance of wear areas with a negative clearance angle, the taper angle increases from 30° to 54°. This in turn leads to an increase in drag on digging.

Formation of a rounded cutting edge, the shape of which is maintained until the wear limit is reached.

The front face wears out less intensely, since the friction force that occurs when the rock moves along the front face of the tooth is much less than the friction force that occurs when the rock moves on the back face. The change in the profile of the front face occurs in the direction of an increase in the taper angle.

The clearance angle has a great influence on the wear rate of the teeth. With an increase in the back angle, the contact surface of the cutting part of the tooth with the rock mass decreases, and the linear wear along the back edge of the tooth decreases. However, it should be borne in mind that an excessive increase in clearance angle leads to an increase in the cutting angle, as a result of which drag is significantly increased. Increasing the cutting angle from 40° to 60° doubles the frontal resistance of the tooth [3].

The correct choice of the value of the clearance angle of the teeth is an important condition for increasing the durability of the cutting tool of mining excavators. Typically, the clearance angle is taken in the range of 5°-12°.

The teeth were made of high-manganese steel 110G13L in the foundry of NGMK. Their hardness after quenching was 195-210 HB.

The size of the ECG bucket teeth is usually determined by its strength, rigidity and stability. The measurement results were entered into the cards.

The bucket teeth work in EKG excavators, which works in specific conditions: harsh climatic conditions, dustiness in mine workings, work in horizontal and inclined seams. In this regard, high requirements are imposed on it in terms of productivity, safety, control reliability, technical and economic indicators. And high rates can be obtained if the equipment of the complex is of high-quality workmanship.

This part belongs to particularly critical high-loaded parts. The steel from which it is made must have improved plastic and strength characteristics, high crack resistance and low sensitivity to stress concentration, must have increased strength and reliability.

This bucket tooth must be improved to a hardness of 269 ... 302 HB. The developed technology for manufacturing a bucket tooth should provide strength, wear resistance, corrosion resistance and reliability of the part in operation.

Steel 110G13L is subjected to improvement, that is, multiple quenching and high tempering. Steel is quenched at a temperature of 800 - 880 °C with cooling in water and immediately quenched a second time at a temperature of 800 °C with water cooling. After such heat treatment, the structure of the steel is an austenite structure. Steel has a high yield point, low sensitivity to stress concentrators, high fatigue strength and a sufficient toughness margin. With full hardenability, the steel has good mechanical properties, and the resistance to the growth of existing cracks increases.

For steel 110G13L, preliminary heat treatment (PHT) is used - multiple hardening. Such PHT is carried out in order to achieve the hardness of the workpiece material 230-280 HB in order to improve the hardness, elasticity, toughness, ductility, fatigue strength and wear resistance.

The available data of visual inspection of worn teeth and laboratory studies allow us to draw the following conclusions: the leading type in this case is abrasive wear, accompanied by plastic displacement of the metal; the reason for the change in the original shape of the tooth is microcutting of the metal with abrasive particles; The loads acting during the operation of the tooth do not cause deep work-hardening of austenite, and the resulting

thin hardened layer cannot withstand the destructive effect of abrasive particles.

In conclusion, it should also be noted that the formation of the wear area and its angular position relative to the longitudinal axis of the tooth is a key point in choosing the most effective methods for increasing the durability of the teeth. The constant angular position of the wear area does not depend on the properties of the material of the teeth and the wear medium, but is determined by the kinematic features of the working equipment of the EKG-8I and EKG-10 excavators [4].

The wear area is a convex surface and the tangent to it, apparently, coincides with the tangent to the trajectory of the tooth, the longitudinal axis of the tooth and the tangent to the wear area form the actual cutting angle. It is not possible to change the angular position of the wear area, and therefore the proposed method for increasing the durability should provide for strengthening not only the front and rear surfaces of the tooth, but also the entire material of the cutting part.

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