Ключевые слова: ***ковшовой элеватор, динамическая модель, математическая модель, динамическая характеристика двигателя, режим пуска, динамическая нагрузка***

ANALYSIS OF MOVEMENT OF BUCKET ELEVATOR WITH DYNAMIC MECHANICAL CHARACTERISTIC OF ENGINE

V. S. Loveykin, L. B. Tkachuk

Abstract. *Built bucket elevator dynamic model with the dynamic mechanical properties of the drive motor. Constructed the mathematical model which based on the dynamic model with the d'Alamber's principle. For specific bucket elevator with a capacity of 60t/h has been performed dynamic analysis with static and dynamic characteristics of the drive mechanism. Constructed graphic changes depending on the angular velocity of moving parts elevator buckets, angular deviation of buckets, efforts in the traction body on the drive drum and driving torque of static and dynamic characteristics of the engine. Based on the schedules during the start-up bucket elevators the significant oscillating processes has been established, and they are more intensive in the use of dynamic characteristics of the engine. Discovered significant torsional vibrations of the buckets which are cause rashes and damage the grain. Therefore, recommended the dynamic characteristics of the engine for study transients of the bucket elevator in the future. To reduce dynamic loads and minimize torque of the buckets during start-up, it is advisable to implement process optimization mode of movement of the elevator.*

Keywords: ***bucket elevator, dynamic model, mathematical model, dynamic characteristics of engine, start-up mode, dynamic load***

УДК 631.2

CHANGES OF BLADE SHAPE OF AGRICULTURAL TOOLS DURING DETERIORATION

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Abstract. *The paper analyses the ways technical condition of working parts of agricultural tools can be improved. It focuses more* *precisely on cultivators for in-between row and all-over cultivation. The authors define several ways for the improvement of durability of cultivator foots by local reinforcement with rigid materials and also calculate possibilities of the formation of serrated shape of a razor over the course of usage. The paper presents results of testing proving that the usage of reinforcing material on surfaces of cultivator foots with a cord T598 is leading to the effect of a working parts' blade self-sharpening. Furthermore, it is demonstrated that the most intensive deterioration of a reinforced blade takes place at the beginning of usage with the subsequent slowing down of deterioration while on the cutting edge emerges a serrated profile with redistributed soil pressure on serrations and cavities. With a comparative testing of serial and experimental cultivator working parts good prospects of usage of the foots with curvilinear reinforced blade are proven.*

Keywords: ***agricultural tools, cultivator foot, soil, deterioration***

Introduction. The technical condition of agricultural machinery and tools considerably depends from reliability and durability of working parts. This is especially the case for cultivation parts of agricultural machinery that deteriorate over a short of time. That is why nowadays the technical condition of agricultural machines is defined by the overall condition of their working parts.

Formulation of problem. The most numerous group of agricultural machinery, in terms of variability in construction and design of working parts, is constituted by cultivators for in-between row and all-over cultivation. Considering differences in the conditions of use in abrasive environment the majority of working parts lose their initial shape as the result of deterioration. As such, these working parts are used for a considerable period of time with their initial characteristics worsened and more energy spent on the completion of technological process (bad soil penetration, unevenness of cultivation depth, increase of traction resistance). A high number of technological processes for the improvement of durability and reliability of working parts have been introduced in recent years. These new technological processes are based on different physical principles such as thermodynamic processing, plasma welding, thermal and alloy processing, etc.

Analysis of recent research results. The most common way to increase durability of agricultural working parts is the usage of fusing of rigid alloys on the working [1, 2, 3]. Considering that the majority of cutting surfaces of working parts are made rectilinear (ploughs, cultivator foots, etc.) this way of improvement of durability is effective and cheap as it does not require substantial changes of a working part. One of the most perspective directions for the research of the processes of deterioration of agricultural machinery is a possibility of control over characteristics of deterioration to make changed geometry of working parts to meet quality requirements over a given period of time. It is important to point out that deterioration of working parts for a large extend depends such factors as friction between soil and working surface. Therefore, changes of such friction are affecting the effectiveness of processing operation. One of such changes can be utilization of none-rectilinear surface. Such approach allows changing of a power interaction between a working tool and the soil environment during operation and to define required parameters of working parts of agricultural machines.

Previous scientific researches on the improvement of effectiveness of agricultural tools do point out good perspectives of managing the quality of processes and operations by changes in geometrical parameters. The finish of a working surface of cultivator foot that consist of two flat elements is proposed by [4, 5]. The changing geometry of the forefront of a working part is realized in the first case. Here the angle of the forefront is more important in comparison with the angle of wings' positioning. By several studies [4] it is proven that such constructive decision serves the purpose of slowing down deterioration of a cultivator foot. At the same time the increase of the forefront's angle of positioning also increases chances of blockage and overall traction resistance. Such problems are solved by [5] making a cutting edge with a changing angle of positioning that increases over the length of the blade. Such approach allows increasing of a tangential inflow of soil over the working surface and to prevent a blockage by weeds. The aforementioned researches do not contain a comparative analysis with serial working parts of cultivators. This fact does not allow us to make conclusions about durability of these working parts.

The decrease in the pace of deterioration is secured by the curvilinear finish with increased streamlining [6] that has a conic surface the directive of which is a logarithmic spiral. By [7, 8] it is proposed the improvement of the profile of the working part cultivator blade that has a minimal power consumption. This provides a decrease by 1,25… 1,32 times in the traction resistance by the change of power interaction with soil environment. These studies do not provide results on the measurement of durability of working parts during their interaction with the soil environment.

A substantial increase of effectiveness of the working part of agricultural tools can be achieved by a serrated shape of a working surface. The proposed [9] serrated working parts due to the change of a power burden have a lesser traction resistance when moved in an abrasive environment and do increase qualitative indicators of the process. Serrated blade surface can also be created over the course of a tool deterioration [10, 11, 12, 13]. It is proved by research outcomes that a serrated surface is created by the difference in deterioration of the main and fused over materials. Such specification of deterioration of a blade is explained by the theory of cutting anisotropic materials that are being ruined not exactly in the dimension of the blade movement and due to not colliding but streamlining by a soil environment of a cutting edge of the working part. At the same time localized amount of soil is moved to the zones of comparatively low pressure that is caused by the reinforcement of some and increased deterioration of other parts of carrier metal [10]. Moreover, serrated blade decreases specific pressure on parts of a blade and decreases linear deterioration that facilities an overall increase of durability of working parts.

The contemporary literature on the issue points out that there are advantages of the making of working parts of agricultural tools that acquire a serrated shape over the course of deterioration.

Purpose of research. The research objective of the proposed paper is the investigation of deterioration dynamics of working parts of agricultural tools using the case of cultivator foots with a curvilinear shape and evaluation of the impact of geometric parameters of blade's local reinforcement during interaction with abrasive environment.

Results of research. Diameter and positioning of elements within all length of a blade are very important characteristics of local reinforcement of cultivation tool's blade and cultivator's foots [14]. Over the course of abrasive deterioration the blade acquires plain serrated shape without sharp ledges that increases overall effectiveness of the working parts.

The working parts of the cultivator are accepted as the main object of this research. This is made in accordance [15] with characteristics of the local reinforcement which is l=d=10мм or, in other words, the step between reinforcing elements is equals to their diameter over the lengths of the blade. The experimental working parts are made from ST 65G and these are reinforced locally according to the following variants: 1 – electroerosive alloying (EEA); 2 – fusing with a wire T 598. A local reinforcement with the EEA method was made at the Sumy National Agrarian University using portable installation "Elitron 22A" that allows reinforcing of details' up to 0.12mm. Spreading of material was made on the places that were marked in advance with precise (picture 1a) and in accordance with the existing methodology [16]. Rigid alloys BK8 and T16K6 were used as reinforcing materials. According to the first variant, a plain surface with the noticeable circles of reinforcement was achieved (Fig. 1,a). In the second variant a working surface was made with ledges above it that vary from 1.5 to 2.5 mm. The fusing over the blade with a wire T598 provided a coefficient between material rigidness of 1.5:1 that makes rational durability and self-sharpening of the working pats possible. The experimental working parts were installed on a cultivator for all-over soil cultivation KPS-4 paired with MTZ-82 tractor. Tests were made under the following conditions: soil – common black soil; humidity – 22–24%; depth of cultivation 0.12m; working speed – 2–2.2 m/s.

a)

b)

Fig. 1. The general view of locally-reinforced cultivator working parts: a) electroerosive alloying; б) cultivator foot reinforced with T598 wire.

The outcomes of testing proved the usage EEA for the purposes of reinforcement as not justified and effective due to small thickness of the rigid material cover. The deterioration of this cover was noticeable up to first five hectares cultivated with the working part.

The analysis of the working parts of cultivator according to the second variant has demonstrated difference in a deterioration speed and fast creation of serrated profile over the length of the blade (pic. 2). Picture 2 illustrates that upper positioning of reinforcing elements with a bottom cutting of the cultivation foot provides the emergence of serrated surface with smooth transitions between serrations and also the effect of self-sharpening of a working surface is noticeable.

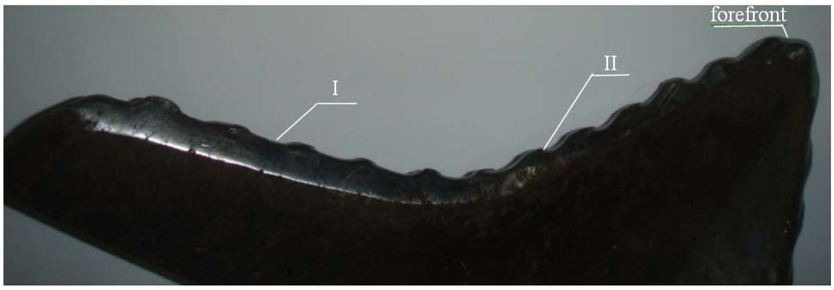

Fig. 2. General view of deterioration of the experimental cultivator foot (a view from below).

The result of comparative tests of a serial arrow-shaped cultivator foots with the ploughing width of 0.33 m and experimental foots with curvilinear shape and locally reinforced blade points out a significant difference in their dynamics of deterioration (Fig. 3).

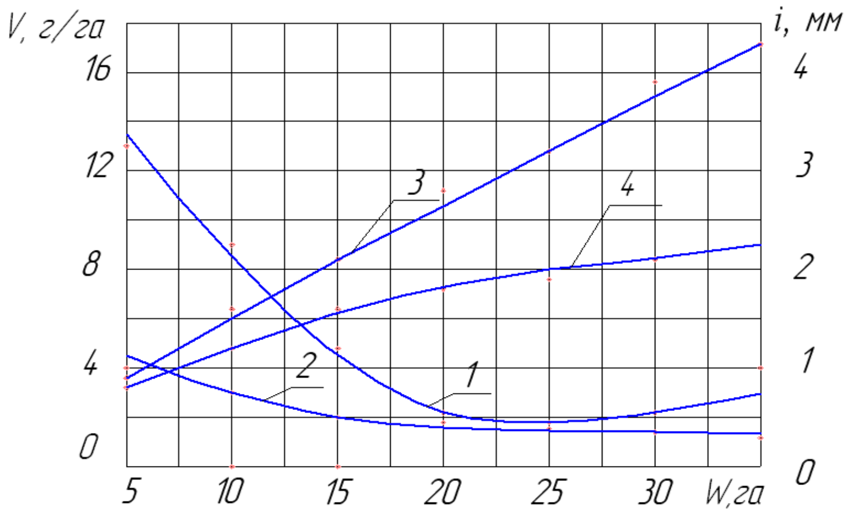

Fig. 3. Dependence of deterioration of cultivator foots according to the usage: 1, 2 – weight deterioration to the serial arrow-shaped and experimental foots, respectively; 3, 4 – median linear deterioration over the length of blade of serial and experimental foots, respectively.

In both cases the most intensive period of deterioration was observed at the beginning of usage within the interval from 0 to 15 hectares (dependent variables 1and 2). After 20 hectares this indicator stabilized at the level of 3.0 grams per hectare. Such dynamics of the weight change of the working parts that were tested can be explained first of all by a higher streamlining of the experimental cultivation foot. Another substantial difference that was observed has taken place during the moderate linear deterioration of the length of the blade (dependent variables 3 and 4). A slowing down of deterioration speed of the experimental working part (dependent variable 4) after some usage is distinctive and can be explained by the formation of a serrated profile of the blade and by the redistribution of pressure on serrations and cavities.

A distinctive particularity of the experimental foot [18, 19] is that every of its wings is made from two related parts with different angles within all length. This suggests seeing particularities in dynamics of which of them separately to further explanatory parameters of working parts. On picture 4 are presented the depending variables of deterioration of elements (forefront, first and second parts of the blade) of the experimental foot. The analysis of the experimental data suggests specific intensive deterioration of the forefront of the cultivation foot and the fastest phase of deterioration at the beginning of usage and up to 10ha (dependent variable 1).

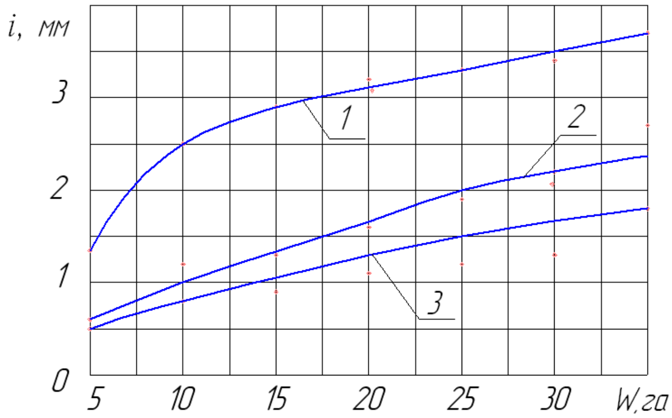

Fig. 4. Dependence between deterioration of the elements of experimental cultivation foot according to usage: 1 – forefront; 2 – first part; 3 – second part.

This can be explained by the maximal pressure of soil on the forefront of the working part. Also there is a noticeable difference between the first and second parts deterioration speed that can be explained by the change of dynamics of soil flow at the cutting edge with different angle [17].

The obtained results of our research point out the effectiveness of the experimental cultivator foot and expediency of the further search ways and methods to increase sustainability and predictability of deterioration of the cultivator working parts. One of the option to achieve this is by optimizing of the parameters of local reinforcement and geometric parameters that was previously realized in [18]. Furthermore, it is necessary to underline that the maintenance of a particular geometry of created serrated blade is possible when the shape of a serration secures equal pressure distribution at the contact zone and causes not only good disruption of cultivated soil, but also the decrease of the traction resistance.

Conclusions

1. Our research of the working parts of cultivators with different ways of reinforcement points out the expediency of usage of serrated cutting surfaces that can be created over the course exploitation.

2. For the purposes of increase in sustainable durability of cultivator foots with a curvilinear shape of the blade further experiments with the geometric parameters of blades and elements of the local reinforcement that secure equal distribution of pressure within the zone of contact with soil are justified and needed.

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ЗМІНА ФОРМИ ЛЕЗА ГРУНТООБРОБНИХ ЗНАРЯДЬ при зносі

Олексій Козаченко, Олександр Шкрегаль, Володимир Каденко, Олег Блезнюк

Анотація. *У статті розглянуто напрямки підвищення технічного рівня робочих органів грунтообробних знарядь, зокрема культиваторів для міжрядної і суцільного обробітку. Визначено напрямки вдосконалення і підвищення довговічності культиваторних лап при застосуванні локального зміцнення твердосплавними матеріалами, встановлена можливість формоутворення зубчастого леза при експлуатації. За результатами експлуатаційних випробувань доведено доцільність використання в якості зміцнюючого матеріалу робочої поверхні культиваторних лап дроту Т598, що забезпечує отримання ефекту самозатачіванія леза робочих органів культиваторів. Визначено, що найбільш інтенсивний знос зміцненого леза відбувається в початковий період експлуатації з подальшим уповільненням процесу зношування робочих органів при утворенні на поверхні леза зубчастого профілю і перерозподілом тиску грунту в зонах освічених зубами і западинами. Порівняльними випробуваннями серійних і експериментальних робочих органів культиваторів визначена перспективність застосування лап з криволінійним локально зміцненим лезом.*

Ключові слова: ***ґрунтообробні знаряддя, лапа культиватора, грунт, знос***

ИЗМЕНЕНИЕ ФОРМЫ ЛЕЗВИЯ ПОЧВООБРАБАТЫВАЮЩИХ ОРУДИЙ ПРИ ИЗНОСЕ

Алексей Козаченко, Александр Шкрегаль, Владимир Каденко, Олег Блезнюк

Аннотация. *В статье рассмотрены направления повышения технического уровня рабочих органов почвообрабатывающих орудий, в частности культиваторов для междурядной и сплошной обработки. Определены направления совершенствования и повышения долговечности культиваторных лап при применении локального упрочнения твердосплавными материалами, установлена возможность формообразования зубчатого лезвия при эксплуатации. По результатам эксплуатационных испытаний доказана целесообразность использования в качестве упрочняющего материала рабочей поверхности культиваторных лап проволоки Т598, что обеспечивает получение эффекта самозатачивания лезвия рабочих органов культиваторов. Определено, что наиболее интенсивный износ упрочненного лезвия происходит в начальный период эксплуатации с последующим замедлением процесса изнашивания рабочих органов при образовании на поверхности лезвия зубчатого профиля и перераспределением давления почвы в зонах образованных зубьями и впадинами. Сравнительными испытаниями серийных и экспериментальных рабочих органов культиваторов определена перспективность применения лап с криволинейным локально упрочненным лезвием.*

Ключевые слова: ***почвообрабатывающие орудия, лапа культиватора, почва, износ***

УДК 631.2.001

ЕКСПЕРИМЕНТАЛЬНІ ПОКАЗНИКИ ВІДНОВЛЕННЯ ПРАЦЕЗДАТНОСТІ ЗЕРНОЗБИРАЛЬНИХ КОМБАЙНІВ

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Анотація. *Однією із актуальних задач сучасного сільськогосподарського машинобудування поряд із підвищенням*

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