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Theoretical background to the self-discharge ability of the milling drum for tillage

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ABSTRACT: The article discusses the theoretical issues of unloading cut soil from a milling drum; according to the calculations of the derived formulas, the dependence of the change in the volume of the internal space of the milling drum and the cut soil is constructed depending on the peripheral speed and radius of the blade end

KEYWORDS: Volume, soil milling, active knives, passive knives, soil lumps and lumps, milling drum radius, loosening coefficient, unloading, peripheral speed

I. INTRODUCATION

Rotary machines, equipped with a milling drum, tillage produces a cutting edge (blade), the inside and the outside of the knife shelf. Once inside the space of the milling drum, large-sized soil clumps, cut off from the array or appearing after preliminary loosening, remain untreated and enveloped in the inner space of the milling drum or are thrown back along the machine with knives of the milling drum.

When enveloping and dropping, lumps partially shatter, hitting the knife or other lumps, but the majority do not lose their original dimensions, which make it difficult for subsequent machines to work on the cultivation of agricultural crops.

To improve the quality of tillage into the internal space of the milling drum, we introduce passive knives, which additionally crush the soil, separates, and thus prevents subsequent tillage to improve the quality of crumbling.

In the cut chips in the mind of a complex effect, bending, compressive, abrasive, scorching forces act. In addition, in the working process of the proposed model there is a separation of soil between passive knives, between the cracks of passive knives does not pass a soil clump with a size larger than the distance between the passive knives.

II. LITERATURE SURVEY

An analysis of the soil tillage research with milling tools provided with l-shaped knives showed that the researchers mainly examined the cutting and grinding of the soil layer. The phenomenon of self-unloading and separation of cut soil is not well understood. Parameters and their limiting values affecting this phenomenon are not fully defined. According to I.M. Panov the cut volume of the cut soil should be equal to the volume occupied by the active knives and knife mounting disks. According to his calculations, with the radius of the milling drum R = 21.8 cm, unloading is not provided, it is necessary to increase the radius of the milling drum [1]. This means that equal volumes of cut soil and occupied by knives and discs are not the ultimate limit of self-dischargeability.

The authors considered all cases of interaction of the active knife with soil lumps, but also not given to the process of self-unloading. [2, 3]

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Based on the foregoing, it is necessary to conduct theoretical and experimental research to determine the relationship of the parameters of the milling drum with its self-unloading capacity.

III. METODOLOGY

As an additional volume, passive knives, is input into the inner space of the milling drum, it is necessary to check the condition for the free unloading of cut soil from the space between the knives and the drum shaft. Otherwise, the cut soil will completely fill this space and will lead the drum block up driving and increased energy consumption for crushing and rubbing the soil against the drum.

For the free discharge of the volume of cut soil from the space between the knives and the drum shaft, the following conditions must be met

$$Q_{cs} = Q_{dv} + Q_{ak} + Q_{pk} + Q_d, \quad (1)$$

where Q_{cs} - the volume soil cut by the drum per unit of time, m ;
Q_{dv} - the volume of the drum for accommodation of cut soil without volume canting volume, occupied by knives and discs, m ;
Q_{ak} - the volume occupied by the drum knives, m ;
Q_{pk}–volume occupied by passive knives, m ;
Q_d- the volume occupied by the disks for mounting knives, m .

The volume of the cut drum soil per unit of time

$$Q_{cs} = B \cdot a \cdot \upsilon \cdot k_{loos}, \quad (2)$$

where B - milling drum cutting width, m;
a - depth of processing, m;
υ - translational speed of the rotary machine, m/s;
K_{loos}- soil loosening coefficient. According to A.D. Lukyanov, the coefficient of loosening for mineral soil is from 1.2 to 1.5. [4]

The volume of the drum for accommodation the cut soil, without counting the volume occupied by knives and discs, is equal to

$$Q_{dv} = \left(R^2 - r^2\right)\frac{\pi \cdot \alpha_к}{2\pi} \cdot \frac{\omega}{2\pi} B \cdot k_{fil}, \quad (3)$$

where R - milling drum radius, m;
r - radius of the drive shaft , m;
φ- milling drum angular speed, m/s.
k_{fil} - the filling factor of the soil between the body of the drum and the surface of the face within the contact angle $\alpha_к$. The fill factor k_{fil} is recommended to take in the range of 0.2 - 0.7. [4]

The volume occupied by the drum knives

$$Q_{ak} = 3\frac{B}{b_k} b_b \left(R - r + b_k\right)\delta_k, \quad (4)$$

where b_b- blade width, m;
b_k - knife wing width, m;
δ_k - knife thickness, m.

Volume occupied by passive knives

$$Q_{pk} = 3\left(\ell_{pk} b_{pk} \delta_{pk} + \frac{3}{4}\ell_{pk} b_{pk} \delta_{pk}\right)\frac{B}{2b_k} = \frac{3}{2} R b_{pk} \delta_{pk} \frac{B}{b_k}, \quad (5)$$

where b_{pk} - passive knife width, m;

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δ_{pk}- passive knife thickness, m

The volume occupied by the disks for mounting drum knives

$$Q_d = \pi \frac{B}{2b_k}\left(R_d^2 - r^2\right)\delta_d, \quad (6)$$

where R_d - is the diameter of the disk, m;
δ_d - thickness of the disk, m.

IV. RESULTS

The calculations made by the above formulas showed that the selected parameters of the drum and passive knives are performed on the conditions for the free unloading of cut soil from the space between the knives and the drum shaft. In addition, it turned out that the volume of cut soil increases in a straight line regardless of the parameters of the drum and passive knives, and the volume of the drum to accommodate the cut soil strongly depends on the peripheral speed of the drum.

According to the calculations made, the dependence is built (Fig.), for accommodation shows the above conclusions.

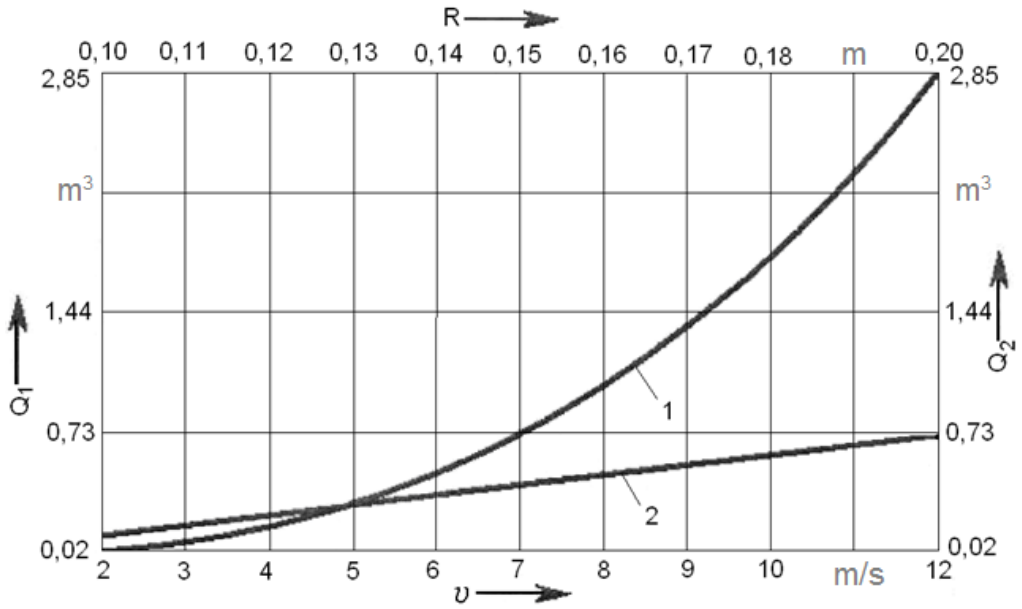

Fig. Changes in the volume of the internal space of the milling drum (1) and the soil to be cut out (2) depending on the peripheral speed and radius of the knife end

V. CONCLUSION

The main thing in this relationship is the intersection of the straight volume of the cut soil and the curve of the volume of the drum to accommodate the cut soil. This indicates that the peripheral speed with the given parameters the drum and passive knives should be at least 5 m / s. At smaller values of the circumferential speed, there will be no free unloading of cut soil from the space between the knives and the drum shaft. The space between the knives and the drum shaft is clogged, and the drum turns into a cylindrical roller, pressing in the soil.

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