UDC
631,361,022

FUNKTSIONALNA OPTIMIZATION MODE PUSKU beater combine harvesters

VS Loveykin, PhD AP Sachyk, a graduate student *

The results of research to reduce the dynamic loads in the drive beater combine harvester by selecting the best mode of motion in both phases start. The most favorable law changes the driving torque and internal moment in the elastic element about ensuring the absence of fluctuations in the elements of the drive mechanism beater during start-up.

Broughtd, beater, driving time, the internal time optimization.

Resolutionska problem. Prand work combine takes variables external load. The process works combine depends on many factors: the biological characteristics of culture, which is collected; field relief; combiner skills, but also on the design features of the processor. Sometimes in the same field changes yield and, consequently changing supply meat supply.

Prand changes in these factors combine operator shall ensure optimum speed of the beater. When starting and when moving at different speeds vymolotu beater there are significant variations, like drum and drive mechanism. These fluctuations give rise to significant dynamic loads acting on the drive, drum design and bearings. This leads to reduced reliability of the beater, and increased energy costs.

AnaLease Latestix dossurvey findings. Toslidzhennyu danddynamics beater combine harvester its work devoted Alferov SA [1] Greek AI [5]. In the work "Andssledovanye drive speakers combine zernouborochnoho "[1] Alferov investigated cases acceleration, coasting, driving and normal operation of the beater and the equations of motion beater.

*** Supervisor - PhD VS Loveykin**

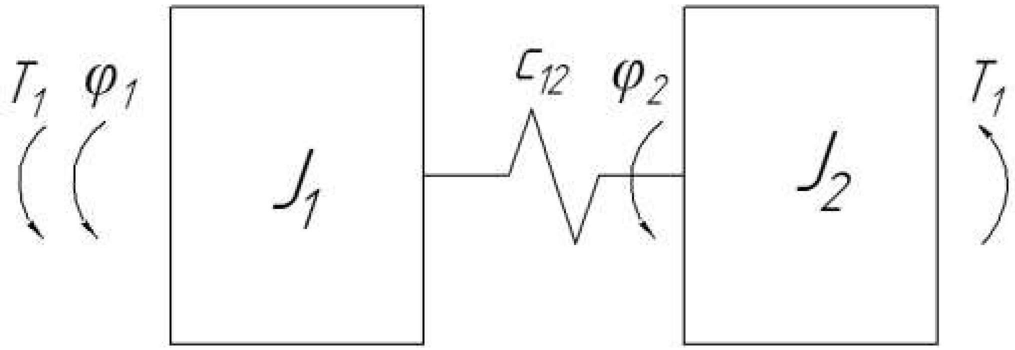
The paper contains graphics, so you can determine the best moment of inertia beater, while the average asking rate maximum external load and allowable value of technological requirements fall angular velocity. The resulting moment of inertia is functionally dependent on the type of drive, engine, design features and character of feeding meat supply.

And.And. Greek in his work "Questions thrashing" experimentally investigated the dynamics of the threshing threshing machine and process. Got dynamic parameters (flow H threshing capacity, power youUWC linings and resistance, the velocity of mass) and compared them with theoretical.

Protf there was the influence of drive beater on its dynamics.

Metand research - Optimization mode start threshing Barabooon the combine harvester.

Rezultaty lit.idzhen. Dll optimizatsiyi Dbench startin beater combine harvester use dvomasovu model (Fig. 1), with sufficient accuracy to reflect dynamic processes start beater.



Ric. 1. Dvomasova dynamic model drive beater combine harvester.

In this model, adopted the following notation: I_1, $I2$ - fromled to the axis of rotation beater moments of inertia corresponding drive mechanism and beater; $C12$ - Reduced to the axis of rotation stiffness beater drive mechanism; T_1-rushiynyy time of the drive motor is reduced to the axis of rotation of the drum; T_2-suuseless static torque resistance beater on the axis of rotation; φ1, φ2 - angular coordinates of the rotation first and second pivot masses.

AboutThisstart with beater in accordance with the adopted dynamic model in two steps. The first stage is set in motion only the first mass. And movement ciyeyi mass is made to the time until the internal point *T12* in the elastic element becomes equal to the external moment *T2*Ie *T12T2* =. From this point of time comes the second stage start, which resulted in the movement of both mass and carried it to the time until the angular velocity of the second reduced mass reaches its inserted value ω_y.

RoseLet us consider the process of optimizing the start-up mode threshing

Barabooat each of the stages separately.

The first stage. At this stage, the first mass equation of motion is:

$$J_1 \cdot \ddot{\varphi}_1 = T_1 - T_{12}, \tag{1}$$

where $T_{12} = C_{12} \cdot \varphi_1$- Internal efforts in the elastic element occasion.

As the first phase starting effort *T12*≤ *T2*Then define

most withpryyatLibya law frommines rushiynoho IOMthNTU drive.

According to equation (1) currently defined relationship:

$$T_1 = J_1 \cdot \ddot{\varphi}_1 + C_{12} \cdot \varphi_1 . \tag{2}$$

EIDnachymo at this stage start this first law of motion of the mass, Wormsand will providethere is minimAlnot amongnokvadratychne value locomotiveth of the engine:

$$T_{1cp} = \left[\frac{1}{t_1} \int_0^{t_1} T_1^2 dt \right]^{1/2} , \tag{3}$$

where *t*- Time; *t*- The duration of the first phase of launch.

Given the dependence (2) the term optimality criterion first phase start (3) takes the form:

$$T_{1cp} = \left[\frac{1}{t_1} \int_0^{t_1} \left(J_1 \cdot \ddot{\varphi}_1 + C_{12} \cdot \varphi_1 \right)^2 dt \right]^{1/2} . \tag{4}$$

The condition of a minimum criterion (4), which is an integral functional is Poisson's equation [7]:

$$\frac{\partial F}{\partial \varphi_1} - \frac{d}{dt} \cdot \frac{\partial F}{\partial \dot{\varphi}_1} + \frac{d^2}{dt^2} \left(\frac{\partial F}{\partial \ddot{\varphi}_1} \right) = 0, \tag{5}$$

where *F*- Integrand function test (4).

Pislya Sectionidstanovky Sectionidintehralnoho toyrazin criterionuw (4) inpivnyannya (5) we have:

IV

$$\varphi_1 + 2\cdot K_1^2 \cdot \varphi_1 + K_1^4 \cdot \varphi_1 = 0. \qquad (6)$$

Tut $K_1 = \sqrt{C_{12}/J_1}$ - Frequency of oscillation of the first mass.

In the rezultati Rosebundle dyferentsialnoho pivnyannya (6)get:

$$\varphi_1 = (A_1 + A_2 \cdot t) \cdot \sin K_1 t + (A_3 + A_4 \cdot t) \cdot \cos K_1 t;$$
$$\dot{\varphi}_1 = [A_2 - K_1 \cdot (A_3 + A_4 \cdot t)] \cdot K_1 \sin K_1 t + [A_4 + K_1 \cdot (A_3 + A_4 \cdot t)] \cdot K_1 \cos K_1 t; \qquad (7)$$
$$\ddot{\varphi}_1 = [2A_2 - K_1 \cdot (A_3 + A_4 \cdot t)] \cdot K_1 \cos K_1 t - [2A_4 + K_1 \cdot (A_3 + A_4 \cdot t)] \cdot K_1 \sin K_1 t,$$

where *A1, A2, A3, A4* - Integration constant, determined from the boundary conditions of motion.

RoseLet us consider the process of launching the first mass. This process begins at the moment *t = 0*When the first coordinate mass, its speed and driving time on the drive shaft equal wellLiu, that is, $\varphi_1 = 0, \dot{\varphi}_1 = 0, T_1 = 0$. Ocandtion UMOva from hurrayinto account bydependence (2) is equivalent to the condition $\ddot{\varphi}_1 = 0$. Ends the first phase puUWC first mass at time *t = t1*When internal efforts MDPzhnomu drive element $T_{12} = C_{12} \cdot \varphi_1 = T_2$. Where we find that time *t = t1*, $\varphi_1 = T_2 / C_{12}$.

DFor these boundary conditions constant motion integration expressed dependencies:

$$A_1 = \frac{T_2}{C_{12}(\sin K_1 t_1 - K_1 t_1 \cos K_1 t_1)}; A_2 = A_3 = 0; A_4 = -A_1 K_1. \qquad (8)$$

Pislya substituting expressions (8) in dependence (7), the latter equation (2) willmo legisCategories frommines propellertion moIUNTU Categoriesand atWater shaft, Wormsand will providethere is mandnimizatsiyu yogiabout RMS:

$$T_1 = \frac{2T_2 \sin K_1 t}{\sin K_1 t - K_1 t \cos K_1 t}. \qquad (9)$$

Depending (9) is unknown time *t1*, The end of the first phase of launch. We assume that at the end of the first stage start moving moment T_1toreaches its maximum value, ie, $T_1 Tm$ =. To drive mechanism, for example, which incorporates clutch, this means that at the end of the first phase is achieved starting clutch half-full. Based on this condition, we obtain the equation:

$$T_m = \frac{2T_2 \sin K_1 t}{\sin K_1 t - K_1 t \cos K_1 t}. \qquad (10)$$

Roseassigning numerator and denominator of the right side of the equation (10) To *sinK1t1* and making replacement *sinK1t1 = ψ1*We obtain the equation:

$$\psi_1 ctg \psi_1 1 - 2T_2 / T_m. \qquad (11)$$

Pivnyannya (11) can be solved only by numerical methods. As a result, we find the solution of the equation *ψ1*From which we define the duration of the first phase of launch:

$$t_1 = \psi_1 \ K_1. \tag{12}$$

The second stage. Pislya start the first phase begins the second phase, which is introduced in the second movement shows the mass. Differential equations of both masses at this stage are as follows:

$$\begin{cases} J_1\ddot{\varphi}_1 = T_1 - T_{12}; \\ J_2\ddot{\varphi}_2 = T_{12} - T_2. \end{cases} \quad (13)$$

From the second equation of (13) define an internal point in the elastic element:

$$T_{12} = J_2\ddot{\varphi}_{12} + T_2. \quad (14)$$

ElDnachymo to druhomin phaseand Sectionusku stilland modemWormsand will provideis the minimum mean square value of the internal point in the elastic element during start-up:

$$T_{12Wed} = \left[\frac{1}{t_2 - t_1}\int_{t_1}^{t_2} T_{12}^2 dt\right]^{\frac{1}{2}}, \quad (15)$$

where t_2- Time start the second stage.

Given the dependence (14) the expression optimality criterion start of the second stage (15) is expressed functional integral form:

$$T_{12withp} = \left[\frac{1}{t_2 - t_1}\int_{t_1}^{t_2} (J_2\ddot{\varphi}_2 + T_2)dt\right]^{\frac{1}{2}}. \quad (16)$$

The condition of the minimum of the criterion is the Poisson equation (5), in which the function *F*bydiated at integrand functional (16) and to coordinate φ1 $\varphi_2$tand its derivatives. As a result of these substitutions we obtain differential equation $\varphi_2^{IV} = 0$After integration even asFirst we have:

$$\begin{aligned} &\dddot{\varphi}_2 = B_1; \\ &\ddot{\varphi}_2 = B_1(t - t_1) + B_2; \\ &\dot{\varphi}_2 = \frac{1}{2}B_1(t - t_1)^2 + B_2(t - t_1) + B_3; \\ &\varphi_2 = \frac{1}{6}B_1(t - t_1)^3 + B_2(t - t_1)^2 + B_3(t - t_1) + B_4, \end{aligned} \quad (17)$$

where *B1, B2, B3, B4* - onindependently of integration are determined from the boundary conditions of the second stage start.

To druhomin phasein startin to pyx atusual dpyrand masa. Pochynayetsya stage start withmoment timein *t = t1*, countand $\varphi_2 = 0, \dot{\varphi}_2 = 0$. This stage ends at time *t = t2*When the angular velocity a second mass reaches steady-state value, ie $\ddot{\varphi}_2 = 0$.

$\dot{\varphi}_2 = \omega_y$In which

DFor these boundary conditions are determined by the constants of integration dependencies:

$$B_1 = -2\frac{\omega_y}{(t_2 - t_1)^2};\quad B_2 = 2\frac{\omega_y}{t_2 - t_1};\quad B_3 = B_4 = 0. \tag{18}$$

Pislya substitution constant of integration in dpyrth pivnyannya system (17) we obtain the dependence of the mass of the second acceleration time for the second phase of the launch:

$$\dot{\varphi}_2 = 2\frac{\omega_y}{t_2 - t_1}\left(1 - \frac{t - t_1}{t_2 - t_1}\right). \tag{19}$$

With dependences (14) and (19) determine the variation in time of the internal elastic element of the second phase of commissioning, providing minimize its rms value:

$$T_{12} = 2J_2\frac{\omega_y}{t_2 - t_1}\left(1 - \frac{t - t_1}{t_2 - t_1}\right) + T_2. \tag{20}$$

From dnotherth pivnyannya system (13), from hurrayinto account addition, uabout $T_{12} = C_{12}(\varphi_1 - \varphi_2)$, We define the coordinate of the first mass and its derivatives:

$$\varphi_1 = \varphi_2 + \frac{J_2}{C_{12}}\ddot{\varphi}_2 + \frac{T_2}{C_{12}};$$

$$\dot{\varphi}_1 = \dot{\varphi}_2 + \frac{J_2}{C_{12}}\dddot{\varphi}_2; \tag{21}$$

$$\ddot{\varphi}_1 = \ddot{\varphi}_2 + \frac{J_2}{C_{12}}\varphi_2^{IV}.$$

Because to Roselook optimallyth lawin pCCS to second stage start $\varphi_2^{IV} = 0$Then based on the latest dependence (21) getThat $\ddot{\varphi}_1 = \ddot{\varphi}_2$. Sectionidstavyvshy in the first equation of system (13) bydependence (19) and (20), we find the driving time of the law that provides optimum law of motion to start the second stage:

$$T_1 = 2(J_1 + J_2)\frac{\omega_y}{t_2 - t_1}\left(1 - \frac{t - t_1}{t_2 - t_1}\right) + T_2 \tag{22}$$

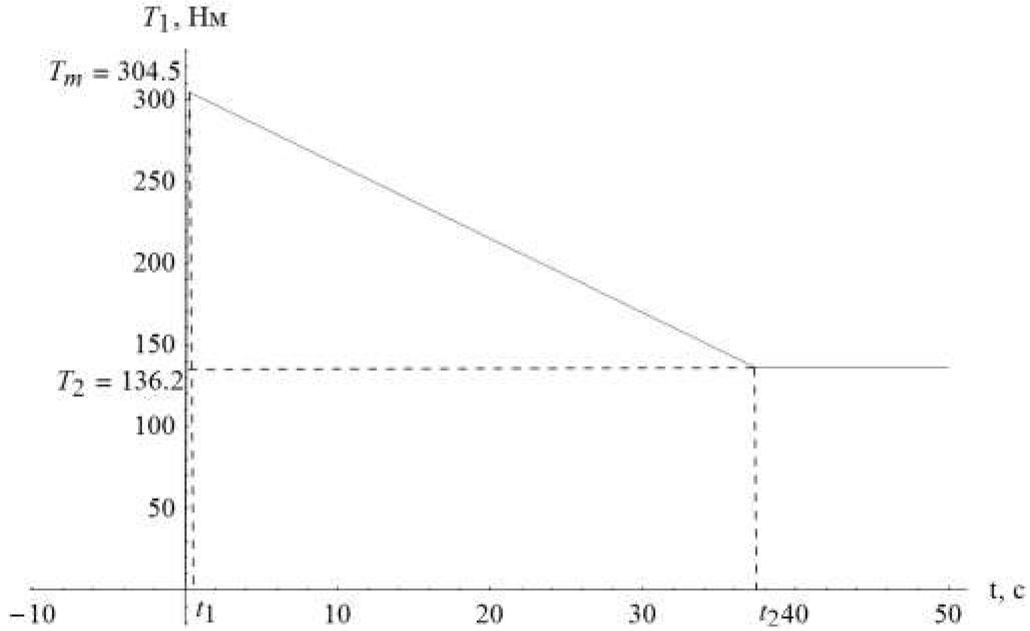
Depending on (22) is the value of an unknown point in time completion of the start-up *t2*. We define this value from the condition that the second phase starting when *t= T1*And *T1= Tm*. As a result, we have:

$$t_2 = t_1 + 2\frac{J_1 + J_2}{T_m - T_2}\omega_y. \tag{23}$$

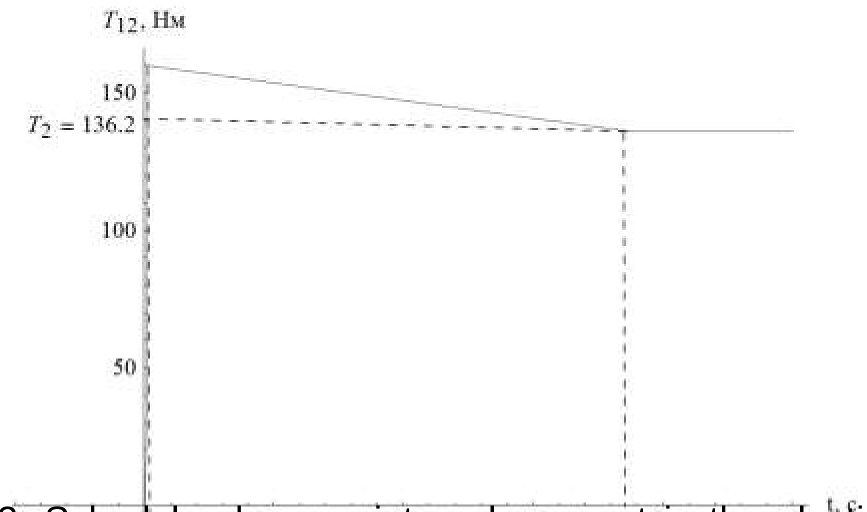
DA drive mechanism beater with parameters: *J1 = 31,5 khm2; J2 = 5,22 khm2; Tm = 304,5 Nm; T2 = 136,2 Nm; C12 = 6000 Nm / rad; ωy = 85,7 rad / s*From equation (11) numerically define a method parameter

$\psi 1$ = 1,5, and formulas (12) and (23) the length of the first and second stages *t1= 0,27 c, t2 = 37,36 c.*

With the help of dependencies (9) and (22) constructed a graph of the driving moment during the entire period start (Fig. 2), which provides optimal modes of motion in the first and second stages of start and graphics changes since the internal elastic element in two stages starting (Fig. 3).



Ric. 2. Schedule changes the driving time of about. T_1-rushiynyy drive time; T_m- The maximum value of the driving moment; T_2-suuseless torque resistance to static beater; t_1- The duration of the first phase of launch; t_2- The duration of the second stage start.



Ric. 3. Schedule changes internal moment in the elastic element $T1_2$-in internal elastic element; T_2-Sumaring torque resistance to static beater; t_1- The duration of the first phase of launch; t_2- The duration of the second stage start.

Andstitutionalism following graphs shows that the proposed optimal modes of traffic on both sites start no oscillatory processes as the driving time of the motor (Fig. 2) and the internal moment in the elastic element (Fig. 3). This can significantly reduce the dynamic forces in both Drivers and beater in a 1.9-fold compared with the start beater normal. And as a result, leads to increased productivity and quality of threshing, and the reliability and durability of the drive mechanism.

Conclusions

1. Obtain the variation of the driving point, and the variation in time of the internal elastic elements that provide both areas start no fluctuations as the driving point, and the internal moment in the elastic element.
2. Andstitutionalism results for the beater combine GLC-9 "Slavutich" showed that the proposed optimal modes of traffic on both sites start no oscillatory processes and the driving time of about internal moment in the elastic element that allows 1.9 times decrease dynamic loads.
3. The obtained research results enable the design drives threshing-separating device to select these modes starter drive that provide effective reduction of dynamic loads, and thus enhance the reliability and durability of the whole.

References

1. *Alferev S.A.* Study dynamics drive zernouborochnoho combine / *S.A.Alferev* // Zemledelcheskaya mechanics. - M., 1966. - Vol IX. - P. 4.
2. *Kozhevnykov SN* Dynamics nestatsyonarnыh processes in machines / *SN Kozhevnikov*. - K .: Naukova Dumka, 1986. - 288 p.
3. *Krasnov MA* In thearytsyonnoe yschyslenye / *Krasnov MA, Makarenko GI, Kiselev AI*. - M .: Nauka, 1973. - 191 p.
4. *Lypkovych Э.Y*. Processes and threshing separatsyy in molotylnыh apparatus zernouborochnыh combine / *E.Y.Tackyovych*. - Zernograd: Nauka, 1973. - 166 p.
5. *Drivers AI* In thePolls threshing / *And.Y.DRec.* - Vladivostok, Peace, 1970. - 204 p.
6. *ZbihnK. eV* In theyznachennya mass moment of drum combine Harvester /*K. Zbigniew FROM.Tomash* // Scientific Bulletin of National University of Life and Environmental Sciences of Ukraine. - K., 2011. - Vol. 144, p. 2. - P. 22- 30.
7. *Boyko AI* Changes in the level of reliability onsystems combine combines in unstable operation and maintenance /*And.And. Boyko, K.M.Dumenko* // Scientific Bulletin of National University of Life and Environmental Sciences of Ukraine. - K., 2011. - Vol. 144, p. 4. - P. 132-138.

Predstavlenы Results of research on Reducing Dynamic nahruzok in the drive beater zernouborochnoho combine putem Choice optimal mode of motion on oboyh stages Start. Opredelenы most blahopryyatnыe Laws Changed dvyzhuscheho moment and vnutrenneho momentum in elastic эlemente drive, obespechyvayuschyh absence oscillations in the drive mechanism element beater in the process start.

Broughtd, molotylnыy drum dvyzhuschyy moment inner point optimization.

The results of research on reduction of dynamic loads in threshing drum drive of combine harvester by selecting optimal starting mode in both period of start-up are conducted. The most favorable laws of variation motive moment and internal moment in resilient member of driver, which are ensure lack of oscillation in drive member of mechanism in threshing drum during start-up.

Drive, threshing drum, motive moment, internal moment, optimization.

UDC 631.356.42

RESEXPERIMENTAL RESEARCH ULTATY Cleaners heap root vegetables

VV Teslyuk, Doctor of Agricultural Sciences

The article presents experimental results obtained by the number of roots to vidmynalnyh passed through the gap between the roller screw and working branch supplying conveyor cleaner combined heap roots.

Eye heap of roots, root, screw, vidmynalni rollers, diameter, angular velocity.

Resolutionska problem. Dll provide the intensification of the process of separation of free soil and plant impurities from fodder beet root crop and remove residual tops of heads of roots by vidmynannya during mechanical harvesting their inventions at