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RESEARCH OF THE INFLUENCE OF THE HOOK LOAD OF THE UNSTABLE CHARACTER ON THE OPERATING INDICATORS OF THE ENERGY MEANS

Shchitov Sergey Vasilievich, Bumbar Ivan Vasilievich, Sennikov Vyacheslav Anatolievich, Sennikova Natalia Nikolaevna, Prisyazhnaya Serafima Pavlovna, Kuznetsov Evgeny Evgenievich

Far Eastern State Agrarian University, Blagoveshchensk, Polytechnicheskaya street, 86.
****Corresponding Author Email: ji.tor@mail.ru***

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ABSTRACT

When the machine-tractor unit (MTU) performs agricultural operations, there are significant fluctuations in the hook load, that is, the load of the tractor engine is unsteady in its characteristics, and the degree of unevenness of the moment of engine resistance during this period can reach 30-40%. To reduce the fluctuations of the hook load and eliminate the unevenness of the moment of engine resistance, the most promising direction is the increase in the moment of inertia of the MTU. The technical solution can be the installation of an additional device in the form of a flywheel driven by a power take-off shaft. The presence of an additional flywheel will contribute to smoothing the load oscillations, which will lead to an increase in the working speed, and, consequently, to an increase in the productivity of the machine and tractor unit. This particularly applies to the conditions of the Amur region, since the soils of this region are mainly loaming of varying degrees of severity, while the presence of a permafrost base during the spring field works strengthens the influence of the unsteady character of the hook load on the tractor output indicators. This is explained by the fact that the process of thawing the soil according to the depth is fairly uneven due to high daily temperature changes, which ultimately increases the uneven nature of the hook load of power resources in field work. Especially clearly its manifestation with increasing of working speeds of the agricultural unit. The foregoing shows that the problem of reducing the unstable character of the hook load on the output parameters of mobile energy equipment is currently topical, and the solution is in demand in engineering and agro-industrial production. In this connection, the purpose of the proposed studies is to reduce the influence of the unsteady nature of the traction load on the output indicators of the power facility when installing an additional device in the form of a flywheel. In the present work, we propose the construction of a perspective device for reducing the influence of unsteady load on the output indicators of the power tool (wheeled tractor) and the results of studies of the influence of the regime parameters of the additional flywheel on the operational performance of the power tool.

KEYWORDS

Power means, hook load, moment of inertia, traction balance, productivity.

1. INTRODUCTION

Based When performing various agricultural operations (plowing, discing, harrowing, sowing, cultivation and others), there are significant fluctuations in the hook load, that is, the load of the tractor engine is unsteady. At the same time, the degree of unevenness of the motor torque can reach 30-40% [1-12]. Such fluctuations in the load can be explained by the following circumstances: the field along which the tractor moves is heterogeneous in terms of the physical properties of the soil (density, hardness, humidity, height and homogeneity of the vegetation cover, etc.), hence its surface has a different microrelief. Due to this, the resistance to the rolling of the machine and tractor unit and the resistance of the working bodies to the movement of the agricultural machine is also continuously changing. Previous experiments have shown that changes in the acting forces or the moment of resistance of the tractor engine in an unsteady nature of the load can be represented with a sufficient degree of accuracy in the form of a chain of consecutive sinusoids with different experimental values [13,14]. Continuous oscillation of load and speed regimes affects the output parameters of the engine and affects its operation in the process of operation, reflecting on the reliability, performance, durability and productivity of the power facility.

In the studies it was noted that the main sources of oscillations of the machine-tractor aggregate in field operations are unbalanced forces arising in the course of use, while the operation of the MTU with an unsteady nature of the load causes a loss of effective engine power [3,9].

In work the authors emphasize that with the increase in the period of the change of the moment of resistance and the reduction of the given moment of inertia of the machine-tractor unit, with other conditions being equal, the frequency oscillations, the rotation of the engine's crankshaft increase, as a result of which the loss of the effective power of the engine increases, and indicates that the working capacity of the machine-tractor unit is greatly influenced by its reduced moment of inertia [5,19,20].

The problems of dynamics and determination of flywheel in relation to cars and agricultural tractors were engaged in a sufficiently large number of scientists, who proved that the influence of the unsteady nature of the load on tractor outputs can be reduced by increasing the moment of inertia flywheel [9,10,12, 17,18,21]. Determination of the given moment of inertia makes it possible to take into account both the periodic unevenness of the internal combustion engine operation and the fluctuations of external loads arising during the operation of the MTU. Also in the works it is established that it is possible to reduce the unsteady nature of the hook load by installing an additional flywheel on the power tool (tractor), which allows to accumulate the energy reserve when the hook load is lowered and give away during the period of its increase [4,6,7].

The analysis of earlier performed works allows us to conclude that it is possible to reduce the influence of the unsteady nature of the load on the output indices of the power tool by using the moment of inertia of an additionally installed flywheel of an optimal design. Production experiments established that the magnitude of the unsteady nature of the load is greatly influenced by the natural and environmental conditions of

the region. Especially this influence is noticeable in the operation of the power tool in the presence of a solid foundation in the soil layer in the form of a permafrost and its uneven thawing in the spring period. In this regard, there is an urgent need for further research on the above topics for the natural and climatic conditions of the Amur region of the Far Eastern region.

2. MATERIAL AND METHODS

It has been established by industrial experiments that during the execution of works the influence of the unsteady nature of the hook load on the performance of the power tool (tractor) can be reduced by using of a device, schematically representing the installation of an additional flywheel on the tractor's power take-off shaft (Figure 1), to which the patent of the Russian Federation was obtained on intellectual property [2].

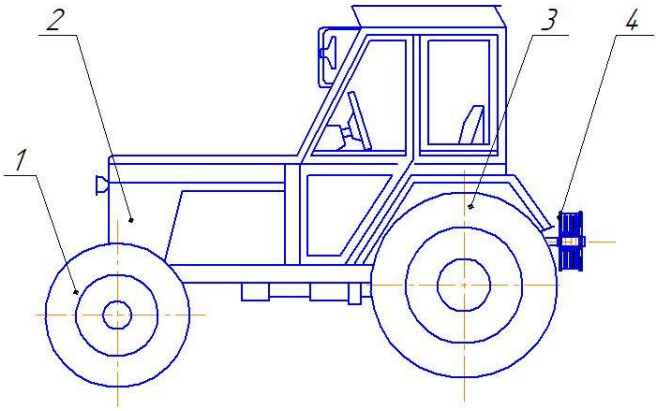

Figure 1: Scheme of a wheeled tractor with a regulator of inertia (additionally installed flywheel): 1-front steering axle; 2- tractor; 3-rear axle;4- regulator of inertia (flywheel)

Figure 2: Tractor with an optional flywheel

Additionally, installed flywheel is functionally a device that allows you to accumulate energy while reducing the hook load and return it with increasing, which allows you to improve the performance of the tractor (Figure 3).

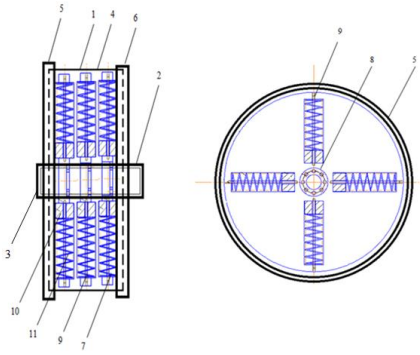

Figure 3: Schematic diagram of the inertia regulator (additional flywheel):

1 –mechanism; 2-rear PTO; 3-shaft of the tractor; 4 - a casing of a cylindrical type;5- front fixing screw cap; 6- rear installation screw cap; 7 - flywheels; 8- central fastening holes for flywheels; 9-guides; 10-moving unbalanced loads; 11 - return coil springs

The device (inertia regulator-additional flywheel) contains a mechanism 1, consisting of a tractor mounted on the rear power take-off shaft 2 of a monoblock circuit 3 of a light-alloy metal casing of the cylindrical type 4 with a front fixing 5 and a rear fixing 6 screw caps in which there are three flat flywheel discs 7 with a central fixing hole 8 and guides 9 on which mobile unbalance weights 10 are mounted, pressed by returnable coil springs 11, also placed in parallel, but with a by means of a single adjustment slot, on the rear power take-off shaft 2.

Andworksasfollows: When the engine is idling or the power take-off shaft unconnected, the unbalance weights 10 are in a position close to the center of the flat flywheel 7.

In motion, with an increase in the speed or power input from the tractor engine, under the effect of centrifugal acceleration, unbalance loads 10 produce rotation around the fastening axis - guides 9 and movement along the guides 9, compressing the return screw springs 11 and accumulating kinetic energy. With increasing short-term overloads, skidding, interruptions in the stable operation of the engine and transmission, the rotation of the power take-off shaft is slowing down, resulting in the reverse movement of unbalance weights 10 and the release of the energy stored by them, tractor, reducing overload and leveling the power balance of the tractor. At the same time, the volume of the fuel mixture produced by the high-pressure fuel pump of the tractor also decreases, which leads to the saving of fuel and lubricants.

3. RESULTS

Theoretical and experimental studies on the use of the proposed device installed on the MTZ-82 wheeled tractor in the field were conducted on the basis of the Far Eastern State University of Agriculture, Amur Region, the city of Blagoveshchensk, the Russian Federation. As a comparison, the MTZ-82 tractor was used with an additional flywheel powered by the tractor's rear PTO as a part of the tractor-transport unit (TTU), which ultimately raises the efficiency of the use of energy in transport operations with an agricultural trailer, in particular with 2TTD-4.

So it is established that the use of the MTZ-82 tractor with an additional flywheel of mass m = 50 kg and engine speed n = 500 rpm allows to increase the working speed from 7.4 to 7.96 m / s, the capacity of the unit from 48.9 to 58 , 5 m · km / h, while reducing fuel consumption from 1.75 to 1.64 kg / m·km, which is a percentage of 7.56; 19.63; 6.28% in comparison with the serial power means. When using the MTZ-82 tractor with an additional flywheel m = 50 kg and a speed of n = 1000 rpm in relation to the serial one, the working speed increased by 12.7%, the output by 33.5%, fuel consumption decreased by 9.7%. The results of comparative economic tests show that the use of a transport aggregate with an additional flywheel increases working speed and productivity, reduces slippage and specific fuel consumption, that is, the regulation of the moment of inertia of the MTA increases the efficiency of using wheeled tractors in transport operations.

The tests were carried out on a section of a dirt road with a varying terrain, which had gentle slopes and elevations according to recommended general and specific methods using specialized mathematical calculation programs, experimental modeling, and regression analysis methods [8,11,15,16]. To measure the above parameters, specialized instruments and apparatus were used. The processing of data obtained during the experiment was carried out by known methods of mathematical statistics using information technology.

The analysis of comparative traction tests presented in Figure 4 showed that for the same hook load, the nature of the change in slippage, speed and traction is the same, however, setting an additional flywheel reduces the slippage, which in turn increases the operating speed and traction power of the transport unit [21-26]. The results of the experiments show that when the hook load Pkp = 14 kH, the slippage of the experimental transport aggregate decreased by 6%, while the traction capacity increased by 7%, and the TTU operating speed increased by 7.5%.

Comparing the tractive forces of the serial and experimental aggregates with the same slipping, it can be noted that at a slippage of 8%, the pulling force Pkpof the experimental transport aggregate was 10 kH, and the serial one - 7 kH, that is, the traction force increased by 30%.

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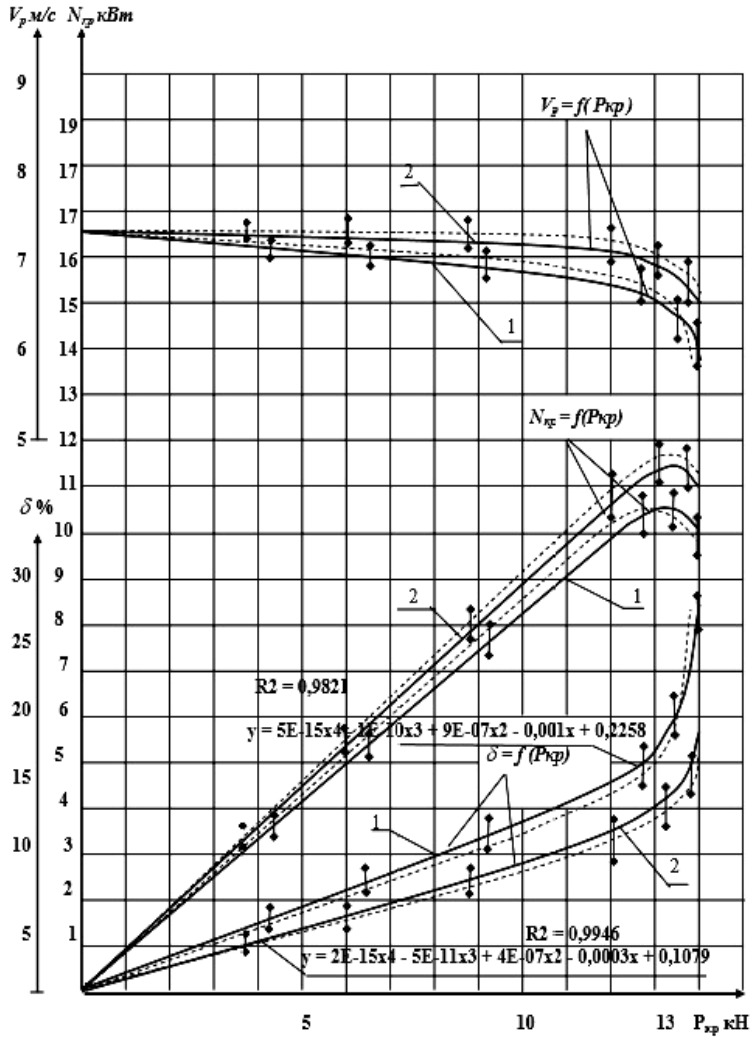

Figure 3: Results of traction tests of MTZ-82 tractor in transport operations 1- serial; 2-experimental m = 50 kg, n = 500 rpm; theoretical experimental.

4. DISCUSSION AND CONCLUSION

The results obtained by the experimental method make it possible to conclude that the use of the proposed inertia regulator device (additional flywheel) makes it possible to reduce the influence of the unsteady character of the hook load on the output indicators of the tractor, which ultimately increases the productivity of machine and tractor units in agricultural work.

The data of the experiments within the confidence interval correspond to the results of theoretical studies, which indicates their reliability. Compared with earlier studies on this issue, the recommended device is the least energy-intensive, labor-intensive, and metal-consuming, which undoubtedly distinguishes the proposed technical solutions by forming a new conceptual line in the applied science environment, in particular, field of knowledge "man-machine-nature".

It has been experimentally confirmed that the proposed device is a highly effective design that implements original ideas, in connection with which the materials of the work are introduced and successfully used in agricultural production of the" Zhukovin" Farm, "Leiko" Farm,"Kovalev" Farm, a number of other leading agrarian enterprises in the Amur Region, which made it possible to significantly increase the efficiency of wheeled tractors in crop cultivation technology.

REFERENCE

[1] Vlasenko, A.N. Sharkov, I.N., Iodko, L.N., Known, S. 2010. Prospects for minimizing the main processing of Siberian chernozems during the cultivation of grain crops. Science, 7, 5-14.

[2] Sennikov, V.A., Shchitov, S.V., Kuznetsov, E.E. 2016. Patent of the Russian Federation No. 2595008 Combined inertia regulator. No. 2015130389 of July 22.

[3] Kuznetsov, E.E., Sennikov, V.A., Shchitov, S.V., Sennikova, N.N., Kuznetsov, E.E. 2015. Tractor class 1.4 in transport works Rural mechanizer, 6, 9-9.

[4] Kuznetsov, E.E., Sennikov, V.A., Shchitov, S.V., Sennikova, N.N., Kuznetsov, E.E. 2015. Decrease in the effect of the unsteady nature of the hook load on the output parameters of the tractor. Engineering and equipment for the village, 5, 13-15.

[5] Sennikov, V.A., Sennikova, N.N. 2013. Influence of unused engine energy and the moment of inertia of the additional flywheel, on the operational characteristics of machine-tractor units. Mechanization and electrification of technological processes in agricultural production: coll. sci. tr. Dal'Gau.-Blagoveshchensk, 20, 161-163.

[6] Sennikov, V.A., Shchitov, S.V., Spiridanchuk, N.V. 2013. Influence of the unsteady nature of the load on the traction-coupling and operating parameters of the power tool: monograph Blagoveshchensk: Publishing House of the Far-Far East State University, 177c.

[7] Sennikov, V.A., Shchitov, S.V., Sennikova, N.N, Kuznetsov, E.E. 2015. Increase in productivity of tractor-transport units. Scientific Review, 7, 40-44.

[8] Shchitov, S.V., Shields, S.V. 2004. Ways to reduce the technogenic impact of wheeled power in the Far East: monograph. Blagoveshchensk: DalGaU, 211.

[9] Shchitov, S.V., Sennikov, V.A., Shchitov, S.V., Sennikova, N.N., Bumbar, I.V. 2016. Influence of the additional flywheel on the degree of unevenness of the leading moment of the power tool. Scientific Review, 2, 57-61.

[10] Yakovlev, N., Yakovlev, N.S., Kolinko, P.V. 2016. Tractive resistance of soil-cultivating and sowing machines. Siberian Herald of Agricultural Science. Novosibirsk, 1, 73-82.

Cite The Article: Shchitov Sergey Vasilievich, Bumbar Ivan Vasilievich, Sennikov Vyacheslav Anatolievich, Sennikova Natalia N ikolaevna, Prisyazhnaya Serafima Pavlovna, Kuznetsov Evgeny Evgenievich (2018). Research Of The Influence Of The Hook Load Of The Unstable Character On The Operating Indicators O f The Energy Means . *Journal of Mechanical Engineering Research and Developments*, 41(3) : 14-17.

[11] Baghenov, S., Beietslci, A., Dedjaev, M. 2006. The modeling and optimization methods for torque transformer design factors of inertial automotive transmissions. Trans & MOTAUTC), 06 (2), 132. 135.

[12] Robert, G.M. 2001. Probability, random processes and ergodic processes. New York, 209.

[13] William, P.H., Saul, T.A. 2001. Numerical recipes in Fortran-77: The ait of scientific computing. Press Syndicate of University of Cambridge, 10-15.

[14] Random Number Generation and Testing.Электронныйресурс. / USA National Institute of standards and Technology Режимдоступа: http://www.csrc.nist.gov/mg/, свободный. - Загл. сэкрана. - Яз. англ.

[15] Wichmann, B.A., Hill, I.D. 1987. Building a random number generator. Byte, 12 (3), 127-128.

[16] Ashley, S. 1995. Testing vehicle inertia Text. Mechanical Engineering, 117.

[17] Hecker, F., Hahn, H. 1997. Mathematical Modeling and Parameter Identification of a Planar Servo-Pneumatic Test Facility Text. Nonlinear Dynamics, 14, 269-277.

[18] Box, G.E.P., Draper, N.R. 1987. Empirical model-building and response. New York: Wiley.

[19] MEA. 2001. Unameccanizzarione a basso impattoambientall. Macch. emot. agr., 59 (ll), 102-105.

[20] Eddie, C.B., James, H.T., Larry, G.W. 1984. Traction benefits of prepared traffic lanes. Research in Agricultural Engineering, 65 (9), 16-18.

[21] Fanners Weekly. 1992. Trend to larger equipment forecast after CAP reform, 25, 33 p.

[22] **Wulfsohn, D., Way, T.R. 2009.** Factors that influence tractive performance of wheels, tracks and vehicles. In: Advances in Soil Dynamics, St Joseph Michigan ASABE, 3, 209-252.

[23] **Gholkar, M.D., Salokhe, V.M., Keen, A. 2009.** The Effect of axle load and tyre inflation pressure on the tractive performance of a two-wheel drive tractor on soft clay paddy field. An ASABE Meeting Presentation Paper Number 096606, 1-12.

[26] Materek D. 2004. Analizawlasciwoscitrakcyjnychkolowego ciągnika rolniczego w wybranychtechnolo- giachuprawyroslin. ZeszytyNaukoweAkademiiRolniczej we Wroclawiu. Rozprawy CCXIX nr 493

Cite The Article: Shchitov Sergey Vasilievich, Bumbar Ivan Vasilievich, Sennikov Vyacheslav Anatolievich, Sennikova Natalia N ikolaevna, Prisyazhnaya Serafima Pavlovna, Kuznetsov Evgeny Evgenievich (2018). Research Of The Influence Of The Hook Load Of The Unstable Character On The Operating In dicators Of The Energy Means . *Journal of Mechanical Engineering Research and Developments*, 41(3) : 14-17.