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Research in movement of combined sowing unit with simultaneous importation of fertilizers

The purpose. To make differential equations of plane-parallel movement of combined engine assembly unit. That will allow discovering its rationalized constructional and kinematic parameters which ensure persistence or movement and quality or execution or production process. Methods. They applied methods of simulation based on methods of higher mathematics and theoretical mechanics to derive differential equations of movement. Results. New mathematical model of movement of combined assembly unit consisting of wheel tractor with artificial manure seeder, which enter fertilizers by strip method, and grain seeder. Conclusions. Equivalent scheme of combined machine-tractor assembly unit is made and the system of 6 differential equations of movement is received, alowing evaluating persistence or movement in a plane of surface of a field at production process.

Key words: tractor, fertilization, sowing, equivalent scheme, kinetic energy, generalized force, system of differential equations of movement.

Formulation of the problem. Recently, there was a sharp problem of redevelopment of arable land in view of the high pressure on agricultural machinery and multiplicity of passageways. This necessitates the search for new variants of modern energy-saving technologies and ways of minimizing the impact on the ground systems of machines due to the combination during one pass of the aggregate of operations of sowing, introduction of mineral fertilizers, pre-planting and post-sowing processing. In general, this makes it possible to reduce the ag-rotechnical terms of the fieldwork, reduce the loss of moisture due to shorter inter-operative intervals, save fuel and lubricants, etc. Analysis of recent research and public. The method of constructing calculated mathematical models of agricultural machines and machine aggregates is widely presented in numerous works by Academician P.M. Vasilenko [2, 3, 5, 6]. In this case, the main type of motion of agricultural machines (trailing, hinged and self-propelled) is their plane-parallel motion, since this kind of motion determines the quality of the implementation of given technological processes. A series of works is devoted to the study of the work of combined agricultural machine aggregates [1, 4, 7, 9, 10]. It should be emphasized that the agrotechnical and operational-technical performance indicators, as well as the performance of combined tractor and tractor machinery, depend to a large extent on the nature of their plane-parallel movement. Therefore, the investigation of the plane propulsion of various machine aggregates is necessary both for comparative estimation of available and for the design of fundamentally new self-propelled and traction units. The main method of such studies is the compilation and solution of differential equations of motion of machine aggregates [5]. The purpose of research. Make a differential equation of the plane-parallel motion of a combined machine assembly, which will enable to find its rational structural and kinematic parameters, which ensure the stability of motion, and, consequently, the quality of the implementation of the technological process. Research methods. For obtaining di-ferential motion equations, methods of simulation based on methods of higher mathematics and theoretical mechanics are used. Research results. We construct a calculation mathematical model of motion of a combine seed unit with the simultaneous introduction of mineral fertilizers. Such a unit will consist of an aggregate wheeled tractor, to which an agitator (mineral fertilizer spreader) is connected with the coupling device, and to it, in turn, the seeder is tied behind. To construct a calculated mathematical model of a combined sowing unit, we use the basic provisions outlined in [6]. We first construct an equivalent scheme of such a combined unit. For this purpose, a number of assumptions should be made.

So, you need to consider only the main elements that carry out different movements. Since the dynamical system to be considered is multivariate, for the sake of simplification of calculations, only movements that affect the quality of the technological process will be taken into account. Let's consider such a machine aggregate (mechanical system) to Cartesian coordinate system Ohh. We also assume that during the movement of the unit along the surface of the field, all its points move in planes parallel to the plane (figure). To compile a system of differential equations of motion of this mechanical system, let's look at it in a positive current position and describe its position during the motion on the plane by 6 independent generalized coordinates. We also assume that at the initial moment of time 1 = 0, the mechanical system was oriented along the axis Oh and began to move from rest. The motion of this mechanical system is described by 6 differential equations of the 2nd order relative to independent generalized coordinates. The mathematical model of this machine-tractor unit is a model of a mechanical system that has 6 degrees of freedom. Let's consider the mechanical system, which studies, to the fixed Cartesian coordinate system Ohh. The Ax and Ou axes will be placed in a horizontal plane (in the plane of the surface of the field), and the axis Og will be directed vertically upwards. To compile the differential equations of motion of the resulting mechanical system, we will show it in a moving position in a positive direction, and its position in motion will be described by 6 independent generalized coordinates of the X-r of R, P2, Rz, P4, where Xi , Y is the coordinates of the center of the tractor's masses, Ri> Pg> Pz> P4 - according to the angles formed by the longitudinal axes of the links of the mechanical system with the axis Oh; Those ^ and = 1,4 ^ - the masses of the links of the mechanical system; O, (Xi, y) is the center of the masses of the system (i = 1,4); A <- distance from the center of mass to its front hinge; And, - the distance between the two neighboring axes of the joints. Suppose at the initial moment of time (I = 0) the mechanical system was oriented along the axis Oh and began to move from rest. The motion of the resulting mechanical system is described by the Lagrange II equations [2]: ZT Ng = o. (Z = 1'b), where 7 is the kinetic energy of the mechanical system; - generalized coordinate; C - number of the generalized coordinate; 05 is a generalized force corresponding to the general coordinate. The kinetic energy of the considered mechanical system is calculated as the sum of the kinetic energies of each link in the system: t = 1T ^ e [t, (x; Chu?) = 1 ^], where Ii- Moment of inertia / -this link relative to the vertical axis passing through its center of mass; Koi = - angular speed of turn of the i-th link; Hi9 yi-projection of the velocity vector of the center of mass of the second-order system. The coordinates of the center of the masses of the i-th (i = 2,4) link were defined, expressed in terms of x, y, the coordinates of the center of mass and the angles of rotation of the foreground units, and the given parameters:

The equivalent scheme of the trailer combination unit: 1 - tractor, 2 - fodder seeder (mineral fertilizer), C - trailer unit, 4 - grain seeder. Substituting (7) into (2), we obtain the expression for the kinetic energy of the system: (8) taking derivatives By time from expressions (6), we define the velocities of the centers of mass systems of the system: We compute the generalized forces that are responsible for the generalized coordinates. For this purpose, the forces acting on the wheels of the ma-shin-tractor unit, we shall refer to the front and rear bridges. The tractor that aggregates this system has a 4K2 wheelbase with an actuating rear axle, and its adjustments are made by changing the position of the front wheels by turning to angle a. We denote the mentioned forces as follows: Pк ', - traction effort of the tractor; Rope - the resistance of the i-th link unit; P is the lateral force that acts on this link; Mpo - moment of resistance of the rotation of this link; R1 and Rn are the forces of rolling resistance of the wheels brought to the rear axle and included in the force P0p2 and the moment M0p2; I ^ 2 - total force of resistance of fertilizer spreaders; IR3 is a super-effective resistance force of the drill shafts. All these power factors are determined according to [3] and the corresponding experimental studies depending on the type of pound, wheel parameters and tractor type. Then the generalized forces are determined according to the definition, that is, the seed aggregate in the horizontal plane, consists of the equation of motion of the tractor along the axis Oh (13), the equation of motion of the tractor along the axis Ou (14), the equation of rotation of the tractor around its center of mass (15) , As well as from the equations (16-18), which describe the rotations of the solid silo roller, coupling device and a linear grain seeder. Here we take into account that So, Similarly: de Rh, Rui - the sum of the projections of all forces acting on the i-th link of the mechanical system, respectively - on the axis Oh and Ou. In order to determine the generalized forces that correspond to the angles of the rotations P | (i = 1,4), the coordinates of the joints O, (hoi: UOI)> ('= 2,4), their variations, and finally Defined expression for generalized force. Where MOI is an algebraic sum of moments of all forces acting on the i-th link relative to the point O. After performing the necessary transformations provided by the use of the Lagrange II equations (1), we obtain a system of diferential equations that describes the behavior of the dynamic system (13-18). A system of differential equations that describes the motion of a trailed combination. Thus, a system of six differential equations (13-18) describing the movement of a combine seeded machine-tractor unit with the simultaneous introduction of mineral fertilizers in the presence of a 6- You degrees of freedom. The solution of these equations on the PC will establish not only the patterns of motion of each link of the unit in the horizontal plane, but also determine the structural and kinematic parameters that ensure the stability of motion in the indicated plane.

Conclusions

The equivalent scheme of a combined machine-tractor unit, which simultaneously performs technological operations of mineral fertilizers application and grain crops, is formed, that is, a trims dynamic system, which carries a plane-parallel motion, is considered. For the dynamical system under study, expressions for the coordinates of its mass centers are determined, generalized coordinates are adopted, and expressions for kinetic energy and generalized forces are made. On the basis of the initial equations of dynamics in the form of the Lagrange II type, the operations provided for their use were executed, and a system consisting of 6 differential equations describing the velocity of the dynamical system in question in the horizontal plane was finally obtained. The numerical solution on the PDO of the obtained system of differential equations of motion will enable to choose such structural and kinematic parameters of the combined sowing machine unit, which will ensure the stability of its motion in the horizontal plane.

Bibliography

1. Bulgakov V.M. Theory of motion of flax harvesting combines: monograph / V.M. Bulgakov, A.Yu. The humpback - Lviv: Publishing House of Lviv Center for the Performing Arts, 2007. - 115 p.

2. Vasilenko P. M. On equations of motion of mobile machine aggregates. Collected Works on Agricultural Mechanics / P.M. Vasilenko - M .: Sel'khozgiz, 1952. - T. II. - P. 76-84.

3. Vasilenko P.M. Elements of the theory of stability of the movement of trailed agricultural machinery and implements. Collected Works on Agricultural Mechanics / P.M. Vasilenko - M .: Sel'khozgiz, 1954. T. II -S. 202-211.

4. Vasilenko P.M. Equation of motion of self-propelled machine aggregates when moving from place and overclocking / П.M. Vasilenko, V.G. Kuz-MINSKY // VASKHNIL. Agricultural mechanics: Sat. Tr. Ed. VA Zheligovsky - Moscow: Mechanical engineering, 1965. - T. V. - S. 28-43.

5. Vasilenko P.M. Method of construction of calculation models for the functioning of mechanical systems (machines and machine aggregates): study. Allowance / PM Vasilenko, VP Vasilenko - K .: USHA, 1980. - 137 pp.

6. Vasilenko P.M. Introduction to Agricultural Mechanics / P.M. Vasilenko - K .: Agriculture and education, 1996. -252 p.

7. Guskov VV Tractors. Theory / VV Guscu, H.H. Velev, Yu.E. Atamanov et al. - M .: Ma-shinostroenie, 1988. - 376 pp.

8. Kut'kov GM Tractors and cars. Theory and technological properties / G.M. Kutkov - M .: Kolos, 2004. - 504 pp.

9. Nadtiko V.T. Fundamentals of aggregation of modular energy means: monograph / B.T. Nadykot. - Melitopol: KP "MMD", 2003. - 240 p.

10. Timofeev AI Analysis of the energy mode of operation of the tractor unit during the expansion / AI. Timofeev // VASKHNIL. Agricultural mechanics: Sb. Tr. Ed. VA Zhyligovsky - M .: Mashinostroenie, 1965. - T.V. - C. 391 -405.

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