 ISSN 1310-3946

MODELING OF MACHINE-TRACTOR UNITS WORKFLOW ON THE USE OF BIOFUELS

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Abstract: *It is considered in the work integrated mathematical model of the machine-tractor units (MTU) that takes into account the physic-chemical properties of biofuel. The novelty of this model is that it takes into account the impact of the working processes in the structural elements of the MTU, one by one influencing each other. This scientific approach to the calculation of the MTU provides the opportunity to evaluate objectively the impact of biofuel on the operational and technological indicators, taking into account the weather conditions, the physical and mechanical properties of the soil and other conditions that may diminish the impact of biofuel on the operation of the unit and distort the final results. In addition the model is adapted to use computer applications, which makes it possible to reduce significantly the complexity of the calculations and reduce the influence of the human factor.*

Formulation of the problem. Existing mathematical models of calculation of machine-tractor units do not give a complete picture of the MTU with the use of biofuel and their use does not always provide an opportunity to assess adequately the changes that occur in the workflow of the unit when changing type of fuel.

Statement of the base material. Let`s analyze the traction machine-tractor unit consisting of tractors and agricultural machines, controlled by the operator. This system consists of a plurality of different processes, which are sequentially influence each other. The mathematical description of these processes is the objective of the simulation work MTU.

Energy assessment of MTU. The essence of the energy evaluation of MTU is to determine the loading tractor power balance [1]. To determine the balance of the traction of the tractor on a particular transmission, you can use the concept of the engine download factor k_{ed} [2]:

$$k_{ed} = \frac{R_T + f \cdot G}{P_{ti}} \le k_{ed\,\lim}, \qquad (1)$$

where R_T – the traction resistance of the machine, kN; f – coefficient of resistance movement; G – operating the tractor weight, kN; P_{ti} – tangential traction on the *i*-th transmission, kN; $k_{ed\,\lim}$ – allowable engine download factor.

To determine the tangential traction P_t we offer the formula:

$$P_t = \frac{M_e \cdot U_{mgb} \cdot U_{rg} \cdot U_{mg} \cdot U_{fg} \cdot \eta_{cgt}^{K_c} \cdot \eta_{bgd}^{K_b} \cdot \eta_{it} \cdot 78{,}74}{\left(d_{dw} + 1{,}66 \cdot b_{bw}\right)}, \qquad (2)$$

where M_e – effective engine torque N·m; U_{mgb}, U_{rg}, U_{mg}, U_{fg} – the gear ratio, corresponding: the manual gearbox, reduction gear, the main and final gear; η_{cgt}, η_{bgd}, η_{it} – efficiencies corresponding: cylinder and conical (bevel) gear drive transmission, idle transmission; K_c, K_b – amount of corresponding cylinder and conical (bevel) gears in the transmission; d_{dw}, b_{bw} – bore rim diameter and width of the profile of the drive wheel tire in inches.

The parameter M_e in the formula (2) takes into consideration the connection of the tractor drawbar settings with efficient engine options.

The relationship is described by the effective parameters of the engine known dependence [3]:

$$M_e = \frac{9550 \cdot N_e}{n}, \qquad (3)$$

where N_e – effective engine power, kW;

n – speed of the engine crankshaft $\min^{-1}$.

Thus, the formulas (2 - 3) show the effective connection of engine parameters with the parameters of the traction of the tractor, which ultimately affects the energy parameters of the MTU.

For the modeling, for example, change a tangent force P_t depending on the engine effective power, we use the data presented in the paper [4], where the engine 4CH11,0/12,5 (factory mark D – 240), studied are the changes and frequency of the engine speed experimentally on diesel and biodiesel fuels B100 for all operating modes.

Technical characteristic of loading tractor category 1,4 with the engine 4CH11,0/12,5 is given in the work [5].

Using indicators N_e and n for external characteristics of the motor [4], by the formulas (2 - 3), we obtain the relation $N_e = f(P_{ti})$ of different transmissions. Modeling of such changes can be made by using Microsoft Excel spreadsheets. By the results of calculations with Microsoft Excel, we build charts obtained relations for four working gears (see. Fig.).

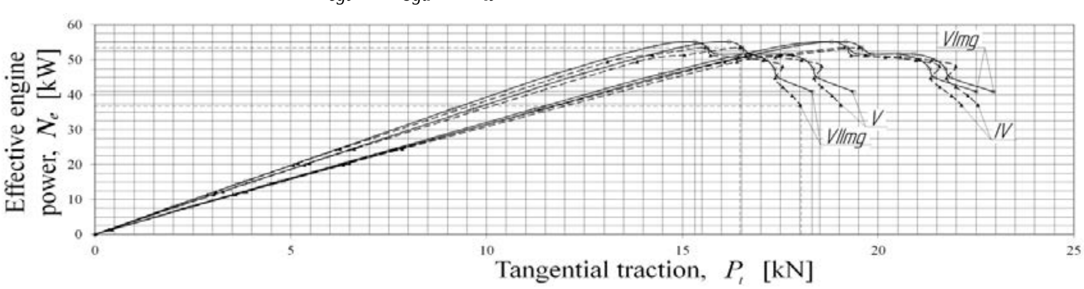

Fig. The effective power dependence N_e on the tangential traction P_t: —□——□——□— - diesel fuel; - ▲- - - ▲- - - ▲- - on biodiesel;

VImg, *VIImg* – on gear reducer;

IV, V – without gear reduction.

 YEAR XXIV, P.P. 74-75 (2016)

Analyzing the graphics, for example *VII_{mg}* transmission, see: diesel maximum effective power (N_e = 55,2 kW) is reached at $P_t = 15,31$ kN on biodiesel – the maximum power is equal to N_e = 53,67 kW by $P_t = 15,63$ kN, indicating a slight improvement in traction properties of energy resources is part of the MTU at rated engine mode and close to the nominal. At the maximum value of the tangent of the tractor traction on the same transmission: when using diesel fuel ($P_t = 18,01$ kN) effective power is 40,89 kW, when using biodiesel

($P_t = 18,01$ kN) – N_e = 37,11 kW.

Conclusions

1. In the work is considered a part of the mathematical model, through which it can be discovered, for example, the dependence of the effective power of the tractor tangential traction on the driving wheels at different gears. The modeling results show that in the nominal mode and its related modes use of biodiesel can increase traction MTU energy funds to 2,1%, with the engine at overload conditions, the use of biodiesel reduces traction energy MTU funds by 1,7%.

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