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Analytical Research of Determining the Maximum Performance of Planning Machines

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ABSTRACT: The article presents theoretical attempts to determine the theoretical hourly performance of the scheduler, depending on the function of the rate of translational motion.

KEYWORDS: agriculture, technology, machine, productivity, engine power, unit resistance, efficiency.

I.INTRODUCTION

Further development of agriculture in modern conditions leads to the introduction of new advanced technologies and machines for their implementation.

It is known for the hobby of agricultural production requires the intensification of agriculture, one of the means of which – wide land reclamation, which provides as one of the most important measures the planning of the surface of irrigated land. In the complex of planning works of great importance is the leveled surface of the fields by planners, the improvement of which is carried out a lot of work both in Uzbekistan and abroad [1].

As is known, the theoretical hourly productivity of the long-base scheduler can be expressed through the power of the tractor engine and the specific resistance of the unit, or through the speed of translational motion and the width of the capture by the following dependence [2]:

$$W_m = \frac{27 N_э}{K_{(v)}} \cdot \xi_{N_э(v)} \eta_{T(v)},\ ha/h \qquad (1),$$

$$W_m = 0{,}1 \cdot BV,\ ha/h$$

where - $N_э$the nominal effective power of the engine, kw

$K_{(V)}$ - the resistivity of the long base of the planner, depending on the speed of movement, n/m;

$\xi_{N_э}$ - the utilization rate of engine power, depending on the speed of movement;

$\eta_{T(v)}$- traction efficiency of the tractor, depending on the speed of movement of the unit and load on the hook of the tractor;

V - translational speed of the unit, km/h;

Analysis of available studies show that the resistivity of the unit *"K_V"* in the function of the translational velocity of the long-base scheduler can be expressed by dependence:

$$K_V = K_н + a_к(\boldsymbol{V^{C_k} - -V^{C_k}}), \qquad (2)$$

where $K_н$ - the specific resistance of the unit at low speeds (at $V_н$=3÷4 km/h), n/m;

$a_к$ – the coefficient of proportionality, taking into account the change in the traction resistance of the unit for each kilometer of the translational speed, n. h/m. km;

C_K – a constant coefficient, equal in our case, you can take 1,2 ÷ 2,0 .

The degree of use of engine power $K_м$ depends on both the coefficient of adaptability of the engine, and the degree of unevenness of the traction resistance of the long-base planner, V_R.

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According to prof. Kirtbay Yu. K. the increase in the degree of unevenness of the traction resistance, which occurs with increasing operating speeds, reduces the permissible value of the load factor of the engine, which will be determined by the expression:

$$\xi_{N\text{э}} = \xi_{м} = 0{,}98 \cdot K_{М} - 0{,}5 \cdot V_R$$

Available studies of other authors show that with increasing speed of the unit, the degree of use of engine power can increase, since the frequency of oscillations of the traction resistance increases and as a result the dynamics of the unit improves. Given the above with some approximation, with a small change in the speed of the long-base planner (3 9 km/h), the value of ξne can be taken as a constant [3]. In our case, for the average values of $K_м$ =1,16 and V_R = 0,4 when performing planning work we have:

$$\xi_{N\text{э}} = \xi_{м} = 0{,}98 \cdot 1{,}16 - 0{,}2 = 0{,}94$$

which is consistent with the recommendations of the S. A. Iofanov for average operating conditions.

Traction efficiency of the tractor in the function of translational speed $\eta_{t(v)}$ in General, as is known, can be represented by:

$$\eta_{m(v)} = \eta_{f(v)} \cdot \eta_{\delta(v)} \cdot \eta_{м(v)},$$

taking into account the power loss on the rolling of the tractor in the speed function ($\eta_{f(v)}$), is determined by:

$$\eta_{f(V)} = \frac{K_{(V)} \cdot B}{K_V \cdot B + P_{f(V)}} = \frac{K_{(V)} \cdot B}{K_{(V)}B + G_{\text{Э}} \cdot f_{(V)}}, \quad (3)$$

Here $f_{(V)}$ is the coefficient of rolling resistance of the tractor in the function of the translational velocity, which can be represented by the dependence:

$$f_{(V)} = f_H + a_f(V^{C_f} - V_H^{C_f}), \quad (4)$$

where $f_н$ – coefficient of rolling resistance of the tractor at low speeds ($V_н$ =3÷4 km/h);

For crawler tractor on the background close to the work of planning machines rolling resistance coefficient $f_н$=0,06÷1,10, and the coefficient of proportionality a_f=0,005÷0,006, h/km. the Exponent C_f is in the range of 0,3÷1,5. In simplifying calculations, C_f =1,0 can be assumed. $C_э$– operational weight of the tractor taking into account the weight of fuel, maintenance personnel, kg.

The coefficient that takes into account the loss of power on the slipping is known to be expressed by the dependence:

$$\eta_{\delta(v)} = 1 - \frac{\delta_{(v)}}{100},$$

where $\delta_{(v)}$-- tractor slipping in the function of speed and traction on the hook of the tractor.

Tractor slipping can be analytically represented by a parabolic equation of the highest order.

$$\delta = a\frac{P_{кр}}{G_э} + в\left(\frac{P_{кр}}{G_э}\right)^C,$$

where *a*, *b*,*c* are numerical coefficients.

Neglecting the latter with a sufficient degree of accuracy we obtain:

$$\delta = a\frac{P_{кр}}{G_э},$$

To improve the accuracy of the last dependence, the coefficient (a) can be expressed as a function of the speed of movement on the basis of the slip curve obtained when removing the traction characteristics for a particular tractor or according to the standard traction characteristics on the corresponding agricultural background. Then:

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$$\delta_{(v)} = a_{(V)} \frac{P_{кр}}{G_э} \quad ,$$

In this case:

$$\eta_{\delta(v)} = 1 - \frac{a_{(V)} \cdot P_{kp}}{100 \cdot G_э} = 1 - a_{(V)} \frac{K_{(V)} \cdot B}{G_э}, \tag{5}$$

The change in the efficiency of the power transmission and the caterpillar $\eta_{мг(V)}$ depending on within the agricultural speeds (up to 20 km/h) can be taken as a linear dependence [4]

$$\eta_{мг(V)} = \eta_{мгн} - a_{мг}(V - V_н) \quad , \tag{6}$$

where $a_{мг}$- the coefficient of proportionality equal to 0.002 0.004 h/km; - the value of efficiency at low speed.
According to [1,3,4] is 0.86-0.88 at low speeds:
V - any set speed, km/h .
Finally, the traction efficiency of the tractor in the function of the speed of movement and the width of the grip, taking into account the equations (4,5), will be presented as an expression:

$$\eta_{T(V)B} = \frac{K_V \cdot B}{K_{(V)} \cdot B + G_Э[f_H + a_f(V^{C_f} - V_H^{C_f})]} \cdot \left(1 - a_{(V)} \frac{K_{(V)} \cdot B}{G_Э}\right) \cdot [\eta_{мгн} - -a_{мг}(V - V_H)] \; ; \tag{7}$$

Solving together the equation (1) and (2), we find the value of the width of the capture unit in the function of the speed at the accepted load of the engine and constant power consumption:

$$B = \frac{270 \cdot N_e \cdot \xi_{N_e(V)} \cdot \eta_{T(V)}}{K_{(V)} \cdot V}, \text{ м} \tag{8}$$

After setting the value of the traction efficiency of the tractor and mathematical transformations, the width of the capture unit is determined:

$$B = \frac{270 N_e \xi_{Ne(V)} \cdot \eta_{мг(V)} - V \cdot G_Э \cdot f_{(V)}}{\left(V + \frac{2{,}7 \cdot a_{(V)} \cdot N_e \xi_{Ne(V)} \cdot \eta_{мг(V)}}{G_э}\right) \cdot K_V}, \text{ м} \tag{9}$$

Or in a more expanded form:

$$B = \frac{270 \cdot\cdot N_e \cdot\cdot \xi_{N_e(V)} \cdot [\eta_{мгм} - a_{mг}(V - V_H)] - V \cdot G_Э \cdot \left[f_H + a_f(V^{C_f} - V_H^{C_f})\right]}{\left\{V + \frac{2{,}7 \cdot a_{(V)} N_Э \xi_{N_e(V)} [\eta_{мгн} - a_{мг}(V - V_H)]}{G_Э}\right\} \cdot\cdot \left[K_H + a_K(V^{C_K} - V_H^{C_K})\right]}, м \tag{10}$$

Substituting the obtained values of the width of the capture unit in the function of the translational velocity in equation (2). We obtain the value of the theoretical hourly productivity also in the function of the translational velocity.

$$W_{T(V)} = 0{,}1 \cdot V \frac{270 N_e \xi_{Ne(V)} [\eta_{мгн} - a_{мг}(V - V_H)] - V G_Э [f_H + a_f \cdot (V^{C_f} - V_H^{C_f})]}{\left\{V + \frac{2{,}7 a_{(V)} N_e \xi_{Ne(V)} [\eta_{мгн} - a_{мг}(V_г - V_H)]}{G_Э}\right\} \bullet \cdot \left[K_H + a_K(V^{C_k} - V_H^{C_k})\right]} \; ha/h \tag{11}$$

II. CONCLUSION.

Substituting the obtained values of the width of the capture unit in the function of the translational velocity in equation (2). We obtain the value of the theoretical hourly performance also in the function of the translational velocity.

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