

UDC 631.633

© 2015

Yu.H. Vozhyk, doctor of engineering sciences

National scientific center of «Institute of mechanization and electrification of agriculture»

Justification of operation parameters of machines which operate with costs technological materials

Aim. To investigate intercommunication between the operating features of work of machines that function with the charges of technological materials, with their parameters and modes. Methods. Analytical. Results. The mathematical model of Technical and operational indexes of machines that function with the charges of technological materials is worked out. Conclusions. For providing of burst performance of the field machines it follows to apply the shifting chart of their work with the use of container method of transportation of materials. The rational capacity of container depending on terms are 750-1250 kg, that answers the productivity of loader of these machines by 20-30 t/hours

Key words: the field machines, technological material, variable productivity, direct running expenses, operating parameters.

At the analysis of work of the field machines that function with the charges of technological materials (fertilizers, seed, others like that), there is a requirement in the calculation of variable-stroke of these machines and determination of them rational parameters and organizational forms of work.

Analysis of the last researches and publications. The technological features of work of the field machines investigated In. However there is a necessity to generalize these researches and work out concrete recommendations in relation to application of their results. Aim of researches — to set intercommunication between the technological and operating features of work of machines that function with the charges of technological materials (farther materials), with their parameters and office and date of recommendation hours in relation to determination of rational values last.

Results of researches.

Using well-known dependence for variable-stroke of aggregate () and exposing the constituents of variable time, will get:

$$T_3 = T + t_1 + t_2 + t_3 + t_4 \quad (1)$$

where W_3 , W is the productivity for unit accordingly variable and basic time, m^2/c ; η it is a coefficient of the use of variable time, S_r — working width of capture of machine, m ; η_p is working speed of aggregate, $m/of\ c$; T_3 , T is duration accordingly variable and basic work, c ; t_1 are charges that does not depend on the parameters of aggregate (time on technical service, preparation of aggregate to work, removal of technological disrepairs and others like that according to normative given [7] with some supposition of $t_1=0,1T_3$); t_2 is time of moves from a machine court to the field and back, where L_1 , L_2 , L_3 is distance accordingly from a machine court in the complement of expense/pl materials, from composition to the field and from the field to the machine court, m ; η_T is a transport speed of aggregate, $m/of\ c$; t_3 is time that is spent on loading of machines by material, c , accepting, that the first loading of machine by material at chart will come true on composition during her motion from a machine court to the field of $t_3(t_5 + t_6 + t_7)$, where η_1 is an amount of loading of machine by material during a change; t_5 is time that is spent on preparatorily-finishing operations at one loading of machine, c ; t_6 is duration of one loading, c ; t_7 is duration of one journey for material from the field in composition and back, c ($t_7 = 2L_2/\eta_T$); t_4 is time, that is spent on the turns of aggregate on verge of the field, p .

Taking into account, that, but also, where t_8 is time of emptying of bunker of machine, c ; Q is a mass capacity (farther capacity) of bunker, kg ; H is a dose of bringing of material, $kg/of\ m^2$;, where W_{3B} is the productivity of loader for basic time, $kg/of\ c\ unit$;, where η_2 is an amount of turns of aggregate on verge of the field during a change ; t_{10} is time-of-flight of one chase, c — ; L_4 is length of chase, m ; t_9 is time

of one turn, c , where L_5 is length of one turn, m (at the shuttle method of motion and turn [6], what trudge large values of S_r approaches a turn after a circle), with some approaching is it possible to accept $L_5 \approx 3R = 1,5 S_r$, where R is a radius of turn, m ; it is speed of aggregate at a turn, and putting component dependences (1) the m /of c , will get:

(2)

from where after simplification and, accepting

(3)

Taking into account, that, will get in a count from m^2/c on and/год:

(4)

At a shifting chart, when a working machine is loaded by material in the field, constituents of variable time the same, only that $t_7=0$. At will get:

(5)

At further counts it was accepted $T_3 =$ of 7 год (25200 c) is complete time of change without the account of interruption on dinner; $L_1 =$ a 1500 m; $T =$ a 4,16 m/of c; $t_5 =$ 300 c [9]; $\rho_{Пв} =$ a 0,75 m/of p.

For more complete decision of problem of determination of technological parameters of such machines direct running expenses that take place in every concrete case were taken into account also [8].

For the calculation of amount of journeys of loader with fertilizers from composition to the field and back at a shifting chart used equalization for determination of T , from where at and $t_7=0$ got:

(6)

By a weekend data for the calculation of direct running expenses for the terms of bringing of mineral fertilizers were such: machines on composition were loaded by the tractor loader 3101; as a mobile loader was used autoloader of KAMA3-65117-03-62, equipped by a faucet-manipulator; $\rho_i=1$; $t_i=7$ год; $r_i=7,95$ hrn.s/of люд.-год; $k_D=1,17$; $\rho_i=1,375$; $\rho_{Пв}=11,56$ hrn.s/of kg; $\rho=9,25$ hrn.s/of л; $\rho=7 \cdot 10^{-8}$ kg/W·c; $N_{eMT3} = 80=58900$ W; $N_{eM} = 150=110000$ W; БТМТ3-80= 165000 hrn.s; БТ-150=500000 hrn.s; ББОРЕКС=280000 hrn.s; БКАМА3=550000 hrn.s; БМ = at $Q=500$ kg — 7500 hrn.s; $Q=2000$ kg — 20000 hrn.s; $Q=4000$ kg — 50000 hrn.s; $Q=6000$ kg — 70000 hrn.s; $Q=8000$ kg — 90000 hrn.s; $Q=10000$ kg — 110000 hrn.s; $Q=12000$ kg — 130000 hrn.s; $\rho_{т}=0,11$; $\rho_{м} = 0,115$; $T_{т} =$ of 1350 год; $T_{м} =$ of 450 год; ТБОРЕКС=of 210 год; ТКАМА3=of 1840 год; $K_6=1,1$; propulsion MODULE=0,1; $\rho_{ам}=0,125$; at $Q =$ from 500 to 6000 kg the tractor of MT3 was used-80; $Q =$ from 8000 to 12000 kg — T-150K.

As evidently from lines. 1, chart and dose of top-dressing to 100 kg/and the variable productivity of aggregate with the increase of working width of capture a to 30 m grows intensively enough, and direct running expenses go down at the capacity of bunker over 500 kg At a less capacity, that characteristically for hanging machines, to promote the working width of capture an over 12-15 m beside the purpose. For the doses of bringing over 500 kg/and expediency of increase of working width of capture with exceeding of this limit comes at the capacity of bunker over 4000 kg

At a shifting chart (rice. 2) and doses of top-dressing to 500 kg/and top limit of expediency of increase of working width of capture in a range a 0-35 m practically unlimited.

Comparing rice. 1 and 2, it is possible to see that at the dose of bringing to 100 kg/and and distances from the field in composition a to 4000 m a shifting chart has considerable advantages comparatively with t the capacity of bunker to 4000 kg At the dose of bringing 500 kg/and this limit of capacity of bunker increases already to 12000-14000 kg

Rice. 1. Dependence of variable-stroke of aggregate of W_3 and direct running expenses of I on his working width of capture at chart: and, is a dose of top-dressing according to 100 and 500 kg/and; 1-4 is a capacity of bunker according to 500; 2000; 4000; 16000 kg; $\rho_p =$ a 3 m/of c; $W_{3в} =$ of 32,4 т/год; $L_2 =$ a 4000 m; $L_4 =$ a 1000 m; it is the variable productivity; --- are direct running expenses

Rice. 2. Dependence of variable-stroke of aggregate of W_3 and direct running expenses of I on his working width of capture at a shifting chart: and, is a dose of top-dressing according to 100 and 500

kg/and; 1-4 is a capacity of bunker according to 500; 2000; 4000; 16000 kg; $\rho = 3 \text{ m/of c}$; $W_{зв} = \text{of } 32,4 \text{ т/год}$; $L_2 = 4000 \text{ m}$; $L_4 = 1000 \text{ m}$ — variable productivity; — are direct running expenses

With the increase of working speed of aggregate in her real range (to 5 m/of c) at the capacity of bunker to 4000 kg and to the dose of bringing to 500 kg/and the variable productivity increases substantially, and direct running expenses diminish, thus at a shifting chart it takes place more intensive than, that is why this criterion must be determined by the mainly safe level of speed of movement on the field, that, as known, for tractor aggregates presents a 3-4 m/of p.

On all range of doses of top-dressing and, that are (from 100 to 10000 kg/and) used, and at the width of capture a to 30 m the productivity of loader beside the purpose to raise higher 20 т/год at chart and 30 т/год — at shifting through an unimportant decline here of direct running expenses.

The increase of distance from the field in composition reduces the variable productivity and promotes direct running expenses at a chart the more intensive, than less capacity of bunker. Thus for the doses of bringing to 500 kg/and and capacities of bunker to 500 kg more noticeable in all the variable productivity falls at distance a to 5 kilometre, and at a capacity to 4000 kg — to 8 km

The analysis of other graphic dependences showed that at the middle dose of top-dressing (500 kg/and) and capacity of bunker 4000 kg length of chase influences on the variable productivity and direct running expenses sufficiently in a narrow range: a to 500 m — at a прямоточній chart and a to 1000 m — at shifting.

Thus, with the aim of achievement of high-performance work of machines for top-dressing, especially at the compressed agrotechnical terms during sowing, signup of winter crop and other, it follows to apply a shifting chart that at the most widespread capacities of bunker from 500 to 4000 kg comparatively with chart the productivity can promote in 3-4 times. On hanging machines with the capacity of bunker to 500 kg it is expedient to set to REALTOR with the working width of capture a to 15 m, and on equipped semitowed, by bunkers, is to 30 m.

The wideuse of shifting chart in Ukraine presently restrains temper a defect, and often and by absence of facilities for loading of mineral fertilizers in the field machines [2]. There are not facilities of mechanization for downloading of hanging machines fertilizers from the capacity of bunker of to 1 т and pneumatic with the general capacity of bunker of to 15 т and loading height to 3,5 m. The Last are loaded by own screw conveyers that need the special mobile unloaders for this purpose, and destroy seed and granules of mineral fertilizers during work.

Lately abroad get distribution of construction of loading device for fertilizers and seed, that transported in containers that set directly on the frame of the field machine. One of prime examples there is a hydraulic faucet-manipulator, that at a deadweight 273 kg can lift artificial loads mass 1000 kg on a height to 4 m. His defect is that he is set on the field machine and considerable time not used. Therefore more expedient to set such device on a transport vehicle with a basket, better in all on a cross-country multitonnage (10-15 т) car that would deliver containers with working material to the field and overloaded him in the field machines.

A question appears about the rational mass capacity of such container. For this purpose will analyse factors, that influence on the productivity of container loader, and intercommunication between this productivity and capacity of container.

The productivity of such loader will present:

$$(7)$$

where $W_{зв}$ is the productivity of loader, kg/of c; Q_1 is a capacity of container, kg; n_3 is an amount of cycles of loading in a hour, год⁻¹.

The amount of cycles of loading in a hour equals:

$$(8)$$

where n is an amount of cycles of loading in a hour; t_1 is a cycle of loading without the account of time of pouring out of material from a container (time on container, deliveries of him to the place of

unloading and reverse actions), c ; t_2 is time of unloading of material from a container in the bunker of the field machine, p .

Accepting the sizes of the opening of container on the investigated interval of his capacity (from 300 to 2000 kg) unchanging (500?500 mm) having regard to that here the height of container will change unimportant, it is possible to accept with certain suppositions dependence between time of unloading of container and his capacity straight proportional, id est: $t_2 = cQ_1$, where c is time, necessary on unloading 1 kg of material from a container in the bunker of the field machine, c/kg , from experimental data for a container with the above-mentioned parameters of $c \approx 0,025 c/kg$

Taking into account dependence (8) equalization (7) will purchase a kind:

(9)

Taking on a mean from time-study data value of $t_1 = 120 c$, from equalization (9) and taking to account that to promote the productivity of loader over 5,5-8,3 kg/of c (20-30 т/год) beside the purpose, will get the rational capacity of container of $Q_1 = 750-1250 kg$, that answers this productivity of loader.

Conclusions

The mathematical model of determination of indexes of aggregates is worked out for top-dressing depending on flowsheets, parameters and office hours. The rational flowsheets of work of aggregates are reasonable. Advantages of shifting chart of work of aggregates are well-proven comparatively with traditional at that the compressed agrotechnical terms are provided at sowing and signup of winter crop due to the substantial (in 3-4 times) increase of the productivity of work of aggregates comparatively with chart. Most rationally and it is effectively possible to carry out realization of shifting chart by means of the container system of implementation of transport and shifting operations during work with fertilizers and seed with application of universal containers of non-expendable, by means of that destruction of granules of fertilizers and seed is practically removed during implementation of freight-unloading operations. The rational capacity of such container are 750-1250 kg, that answers the productivity of loading of bunker of the field machine by 20-30 т/hours

Bibliography

1. *Адамчук В.В.* Теоретичне дослідження технологічних параметрів машин для внесення мінеральних добрив/В.В. Адамчук//Зб. наук. пр. НАУ. Механізація сільськогосподарського виробництва. — К.: НАУ, 2003. — Т. XV. — С. 203–224.
2. *Бойко С.* Навантажувач у господарстві/С. Бойко//Farmer. — 2013. — № 4. — С. 92–94.
3. *Догановский М.Г.* Механизация внесения удобрений/М.Г. Догановский, Е.В. Козловский. — Л.: Колос, 1976. — 320 с.
4. *Догановский М.Г.* Контейнерный способ доставки и хранения минеральных удобрений/М.Г. Догановский, Е.В. Козловский, Н.А. Колташов. — М.: Россельхозиздат, 1985. — 60 с.
5. *Зангиев А.А.* Расчет оптимальной скорости и ширины захвата МТА/А.А. Зангиев//Механизация и электрификация сельского хозяйства. — 1986. — № 7. — С. 43–49.
6. *Иофинов С.А.* Эксплуатация машинно-тракторного парка/С.А. Иофинов, Г.П. Лышко. — М.: Колос, 1984. — 351 с.
7. *Комплексная система технического обслуживания и ремонта машин в сельском хозяйстве.* — М.: ГОСНИТИ, 1985. — 143 с.
8. *Методи економічного оцінювання техніки на етапі випробування.* ДСТУ 4397–2005. — К.: Держспоживстандарт України, 2005. — 15 с.
9. *Типовой технологический процесс применения минеральных удобрений в Зоне Полесья УССР.* — К.: Урожай, 1973. — 30 с.
10. *Якубаускас В.И.* Технологические основы механизированного внесения удобрений/В.И. Якубаускас. — М.: Колос, 1973. — 231 с.

Acted 01.07.2015.