Technological Features of Irrigation and Assessment Indicators of Multibasic Irrigation Machines Running Systems Efficiency (on the Example of IM Kuban-LK1)

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[1]***Abstract:It is proved that decrease in material capacity of machines and power consumption of irrigation, in particular, of IM Kuban-LK1, is the important direction of increase in economic efficiency of agro-industrial complex as economical expenditure of energy and material resources provides an increase in the output and decrease in prime cost, both for technological means of irrigation, and crop harvesting. At the same time, the equipment - economic indicators of irrigation machines are defined by their constructive and operational characteristics depending on key parameters of machines and on service conditions. The most important of them are productivity and power consumption.***

The conducted researches IM allowed to establish that decrease in its productivity, often, happens because of the reduction of change working hours efficiency (K_{cm}). Its decrease is indicated by losses of basic passability of carts of the machines in places on the low bearing ability of the soil (because of the increased rutting) and when overcoming rises (because of insufficient coupling properties of running systems, or drive power).

It is proved that expedient to carry out the most objective assessment of growth of the technological level of the Kuban-LK1 IM running systems on the generalized efficiency indicator the propeller determining optimum parameters wheel proceeding from the highest indicators of power costs of movement and material capacities.

Keywords: irrigation machine, disk, leveler, irrigation technology.

I. INTRODUCTION

Nowadays in our country irrigation by overhead irrigation by means of wide-cut multibasic irrigation machines "Frigate", "Kuban-LK1" is widely adopted.

Along with merits, these machines have an essential shortcoming - the wheels of self-moving carts form a track up to 35 cm in depth and more and 30...70 cm wide that causes considerable indicators resistance on movement [2].

Known ways of track reduction (supply of wheels of self-moving support with expanders of different types; replacement of metal wheels with pneumatic; lowering irrigation norms at the first passes of irrigation machinesetc.) do not allow to solve the specified problem, especially when irrigating the long-term herbs when during their use the number of passes of the machines on one trace is up to 30 and more times.

Besides, it causes the necessity of equipping theIM carts with wide-profile massive wheel propellers that leads to, along with an increase in their material capacity, additional increase in energy consumption on a swing [3].

II. RESEARCH PART

Decrease in material capacity of machines and power consumption in the production of irrigation machines, in particular, of IM Kuban-LK1, is the important direction of increase in economic efficiency of agro-industrial complex as economical expenditure of energy and material resources provides an increase in the output and decrease in prime cost, both technological means of irrigation, and a crop harvesting [4].

The equipment - economic indicators of irrigation machines are defined by their constructive and operational characteristics depending on key parameters of machines and conditions of their operation. The most important of them are productivity and power consumption.

Technological process of irrigation by the Kuban-LK1 machines includes consecutive operations of delivery of irrigation norms m_M in time for the irrigated area:

$$m_M = 7400\frac{R_k Q}{VR^2} m_M = 7400\frac{R_k Q}{VR^2}, \qquad (1)$$

where R_k -distance from motionless support to the last cart, m;

R - rain capture length, in m;

Q -consumption of water, p/a;

V -the speed of movement of the last cart, m/min.

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The productivity of the irrigation machine in 1 hour of clean time (hectare) can be calculated on the following formula:

$$\omega_ч = \frac{3{,}6 \cdot Q}{m\beta}\omega_ч = \frac{3{,}6 \cdot Q}{m\beta}, \quad (2)$$

Productivity or loading for change with one IM Kuban-LK1 is defined with all losses of water and time by the following dependence [2]:

$$\omega_{см} = \frac{3{,}6 \cdot Qt_{см} \cdot K_{см}}{m\beta}\omega_{см} = \frac{3{,}6 \cdot Qt_{см} \cdot K_{см}}{m\beta}, \quad (3)$$

where Q -consumption of water, p/a;

m -irrigation norm, m3/hectare;

β -the coefficient considering losses of water on evaporation in a zone of a cumulonimbus cloud at overhead irrigation;

t_{cm} -a period of operation of the machines for change, h;

K_{cm} -change working hours efficiency.

According to researches IM, a decrease in its productivity, often, happens because of the reduction of change working hours efficiency (K_{cm}). Its decrease decides by losses of basic passability of carts of the machines in places on the low bearing ability of the soil (because of the increased rutting) and when overcoming rises (because of insufficient coupling properties of running systems, or drive power).

Noted phenomena cause a decrease in reliability of the technological process of irrigation of IM because of excessively raised power costs of movement causing, eventually, premature emergency stops of the machines because of a curvature of the pipeline and operation of protection.

In due time, there was such concept as "margin of safety", but the increased margin of safety, also the mass of a product increases that leads to increase in general material capacities of the machines and power expenses at its operation.

All this is whole belongs to the existing design of the Kuban-LK1 IM running systems which as it was noted, because of the increased power costs of swing and existence, at the same time, of high material capacity, do not provide fully low-cost and reliable technologies of irrigation.

In physical units, it is expedient to estimate preliminary estimate of the efficiency of the Kuban-LK1 IM running system on a specific value of material capacity and power consumption and to the generalized indicator [1].

Specific values of material capacity m_{ud} and power consumption of N_{ud} characterize respectively material (m) and power (power N) costs of the unit of hour productivity of IM ($\omega_ч$ $\omega_ч$).

The IM best running systems have the smallest sizes of indicators.

Complex assessment of efficiency of the IM running systems is made on the generalized indicator of N_{nm} characterizing their power and material inputs:

$$N_{Nm} = \frac{N_{уд}}{П_{уд}}N_{Nm} = \frac{N_{уд}}{П_{уд}}, \quad (4)$$

where $П_{уд}$ -specific productivity,

$$П_{уд} = \frac{\omega_ч}{m}П_{уд} = \frac{\omega_ч}{m}$$

is an inverse value of m_{ud} and characterizes machines productivity per unit mass of running systems. The IM best running system has the maximum value of an indicator.

Then expression (4) will take the following form [4]:

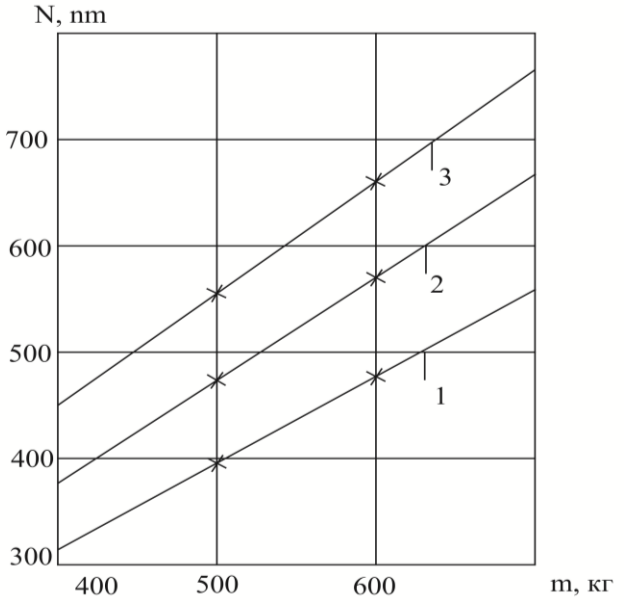
$$N_{nm} = \frac{N \cdot m}{\omega_ч^3}N_{nm} = \frac{N \cdot m}{\omega_ч^3}, \quad (5)$$

II. RESULTS AND DISCUSSIONS

The size N_{Nm} shows how many units of specific power consumption are the share of a unit of specific productivity. The IM best running system has a minimum N_{Nm} value.

On the basis of expression (5) with use of characteristics on productivity and parameters of running system, inherent basic (10 ph.) modifications of IM Kuban-LK1 (hour productivity$\omega_ч \approx 1{,}0$ га/ч$\omega_ч \approx 1{,}0$ га/ч; approximate ranges of increase, due to improvement, N_{dm} drive power expensesfrom 1,1 kW to 0,80 and the mass of wheel propellers of running system from 700 kg to 400 kg), the graphics dependence of the generalized indicator of efficiency of N_{Nm} (figure 3) is constructed.

Approximately the best indicator of NNm≈320 for the running system of the Kuban-LK1 IM cart corresponds to the power of its drive no more than 0,8 kW weighing wheel propellers about 400 kg [5,6].



1,2,3 - electric drive power according to N1=0,8kvt, N2=0,95kvt, N3=1,1kvt

Figure 3. Dependence of the generalized indicator of the efficiency of a running system of the Kuban-LK1 IM cart on its weight

IV. CONCLUSION

It is expedient to carry out the most objective assessment of growth of the technological level of the Kuban-LK1 IM running systems on the generalized efficiency indicator, determining optimum parameters of wheel propellers, proceeding from the smallest indicators of power costs of movement and material capacities.

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