УДК 621.1.004

ANALYSIS OF FREQUENCY OF RESTORATIONS SERVICEABILITY OF FORESTRY MACHINES

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Annotation. *The paper presents the results of analytical scientific research of analyzing the frequency of maintenance machines for forestry work.*

Key words: *rejection, frequency, forestry machine*

Introduction. The expediency of closing operations in a particular type of service is determined based on their purpose and relevance. If delayed operation is failure of the assembly unit, and its consequences result in danger to the life of staff, given the likelihood of timely implementation of the operations accepted $P_{(t)}$>0,98; high costs of machinery failure – $P_{(t)}$>0,95. In the absence of specific requirements for the operation level $P_{(t)}$ is set on the basis of technical and economic calculations of the criterion of minimum unit costs:

$$C_{\partial} = \frac{\sum_{i=1}^{П_1} S_{TO_i} \cdot Ц_1 \cdot K_1 + \sum_{j=1}^{П_2} Q_{TO_j} \cdot Ц_2 \cdot K_2 + \sum_{\iota=1}^{П_3} t_{TO_\iota} \cdot C_{уд} + \sum_{l=1}^{П_4} S_P \cdot P_l \cdot Ц_1 \cdot K_1 + \sum_{k=1}^{П_5} Q_P \cdot P_k \cdot Ц_2 \cdot K_2 + \sum_{\beta=1}^{П_6} t_P \cdot P_\beta \cdot C_{уд}}{W_ц} \to \min \quad (1)$$

where: $C_{уд}$ – unit cost of maintaining the machine in working condition, UAH/hour;

K_1, K_2 – factors that take into account overhead costs for wages and materials;

S_{TO}, S_P, t_{TO}, t_P – the complexity and duration of maintenance and elimination of consequences of failures, man-hour;

Q_{TO_j}, Q_P – consumption of materials and spare parts for maintenance and elimination of the consequences of failure of the maintenance cycle, kg, packages;

$Ц_1$, $Ц_2$ – hour tariff rate performer and the cost of 1 kg of fuel, or 1 set of spare parts, UAH/hour; UAH/kg; UAH/set;

$C_{уд}$ – loss per 1 hour of downtime of the machine, UAH;

$W_ц$ – product group for the cycle, hour;

i, l – number of types of work performed during maintenance;

P_l, P_k, P_β – given the probability;

j, k – number of materials used in the maintenance;

ι, β – number of species of downtime for maintenance;

$\Pi_1 \ldots \Pi_6$ – number of tipes, materials and downtime for maintenance.

For minimum unit costs set the optimum value periodicity perform maintenance operations.

Analysis of recent research. Clarification maintenance structure by this method [1] and its implementation in production [2] made it possible to reduce the consumption of resources by 15...20% without compromising machine performance reliability [3].

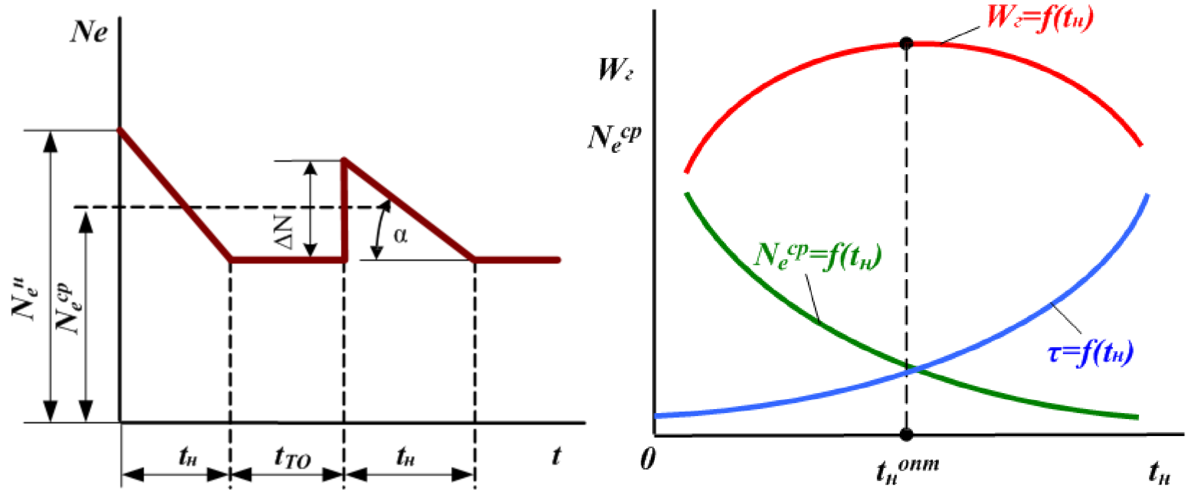
The reliability of the machine during operation depends not only on the design and quality of manufacturing perfection, but also on the quality of service at its use and storage. Only if timely and quality maintenance services guaranteed by its normal parameters of reliability. In practice, there are cases of violation of terms of service, do not perform a full range of operations, or perform them with violation of technical requirements [4].

The reason for this neglect of maintenance of machines is often a so-called "implicit" inoperable machines. The machine, in fact, can continue to operate, but it is uneconomical, with the worst quality, and the continued use of such a machine leads to a dramatic increase in catastrophic failure and the additional costs of their removal. Thus, the system maintenance machines is preventive in nature. The advantage of this system is its planned nature, which allows pre-define terms serving impacts and required funds for this purpose, the materials and the number of performers.

Purpose of research. The frequency of performing maintenance operations usually determined on the basis of accepted valuation indicator (criterion), for example, the maximum performance of the machine, at the lowest unit costs, according to statistics on the timing to achieve the maximum permissible values of the estimated parameter and others.

Results of research. Method for determining the maximum maintenance performance periodicity based on the fact that over time due to wear performance of the machine mechanisms (engine power N_e) decreases. When maintenance is reduced performance, but they are again reduced in the course of further work (Fig. 1, a). The effective power is a periodic function of the length of the work or developments $t_н$.

Thus, the increase in the average power increases $t_н$ by reducing the seasonal (annual) production or machine performance $W_г$, and utilization time reduction by increasing the time spent τ on maintenance (t_{TO}) decreases $W_г$. Graphically, this is shown in Fig. 1, b.



a) b)

Fig. 1. Power change (a), and performance parameters affecting it (b), depending on the length of the machine ($t_н$) and the duration of maintenance (t_{TO})

The dependence of the average effective capacity of the engine on the maintenance intervals can be represented as follows:

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$$Ne^{cp} = Ne^{н} - \frac{\Delta Ne}{2} = Ne^{н} - \frac{t_н}{2tg\alpha}, \qquad (2)$$

where: α – angle of the line $Ne = f(t_н)$ to the horizontal axis.

The utilization factor of the change of time, taking into account the time required for periodic maintenance $\tau_{t_н}$ is determined by the expression:

$$\tau_{t_н} = 1 - \frac{t_{TO}}{t_н}. \qquad (3)$$

Using expressions (2) and (3) the determination of the annual performance units as a function of the tractor engine output is obtained:

$$\tau_{t_н}^{onm} = \sqrt{\frac{2t_{TO}}{tg\alpha / Ne^{н}}}. \qquad (4)$$

Equation (4) shows that the expression is directly proportional to the square root of time for maintenance (t_{TO}) and inversely proportional to the relative speed of the engine power loss $tg\alpha / Ne^{н}$.

Similarly, we can determine the optimal frequency of maintenance on the criterion of minimum unit costs. The disadvantage of this method is that as the optimality criterion in dependence of the initial average values taken without regard to their probabilistic nature. So often use a statistical method for determining the frequency of maintenance. To determine the frequency of this method it is necessary to establish the law of distribution of time to achieve the maximum permissible values of power or machine productivity (Fig. 2).

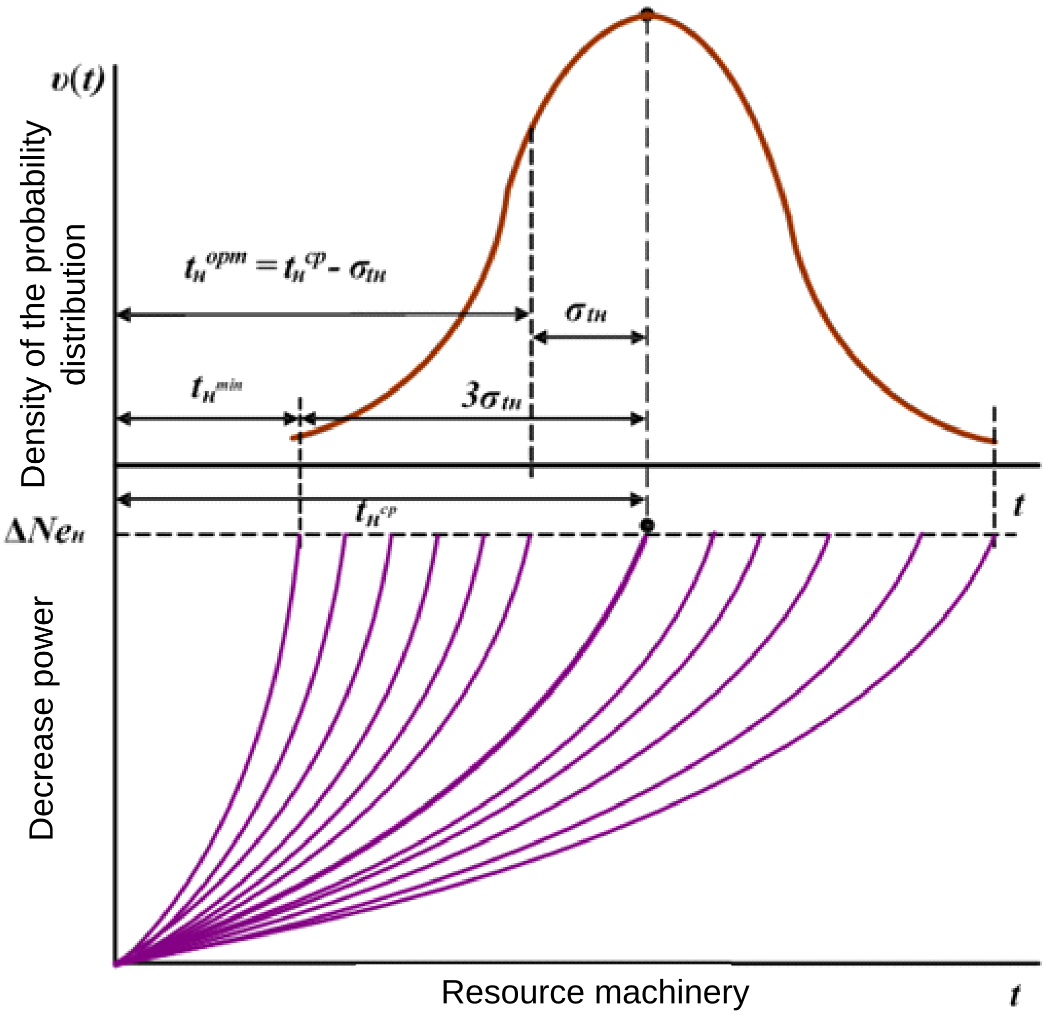

Fig. 2. Schematic of definition of periodicity maintenance machine.

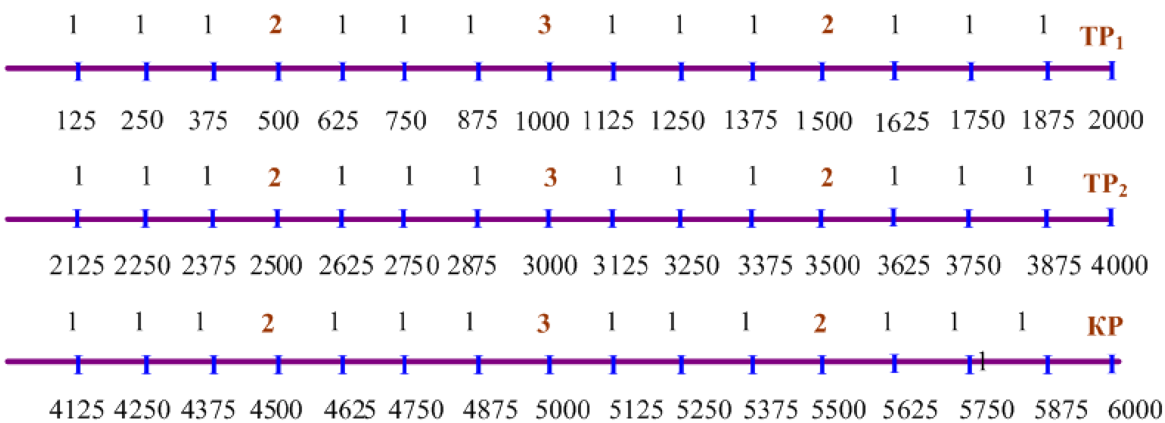

Fig. 3. Scale and frequency of alternation maintenance

Knowing the numerical characteristics of the distribution, you can find the desired time value $t_н^c$, which in the case of normal distribution usually take less than the average value of the standard deviation $\sigma t_н$. In this case, only 15–16% of the cars will undergo maintenance after the deadlines, the interval for maintenance will be big enough, so it will remain precautionary. If we take $t_н = t_н^c$, the maintenance may be too late, since half of all cars in this period reached the limit state for the parameter in question. The structure of the maintenance work (Fig. 3), their sequencing and frequency are as follows (for brevity TP_1 is replaced by the symbol 1, symbol of TP_2 by 2; symbol TP_3 by 3).

Conclusions. The current national standard is permitted to set maintenance intervals for other units – in kilograms (tonnes) or liters of fuel used in the conventional reference acres developments. The frequency of maintenance of machines for forestry work and their contents are specified in the accompanying technical documentation (operating instructions). The units of frequency measurement here can be used volumes treated area, hours worked, hours or volume of products obtained.

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Анотація. *В статті представлені результати аналітичних досліджень аналізу періодичності технічного обслуговування машин для лісотехнічних робіт.*

Ключові слова: ***відмова, періодичність, лісова машина***

Аннотация. *В статье представлены результаты аналитических исследований анализа периодичности технического обслуживания машин для лесотехнических работ.*

Ключевые слова: ***отказ, периодичность, лесная машина***