PREVENTIVE SERVICING OF DRILLING EQUIPMENT

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All basic drilling equipment requires periodic technical servicing when in use. Technical servicing may be twofold: unplanned servicing or restoring its efficiency by replacement, repair or adjustment of faulty units or parts, and planned (preventive) servicing which includes periodic inspection and replacement of parts still in working order but which have reached a certain degree of wear and have shown other signs of aging.

To establish an efficient preventive servicing of equipment it is necessary to establish optimal servicing periods, taking into account limiting factors such as duration and cost. A number of papers [1, 2, 3] give recommendations (mainly general in character) for the selection of an optimal preventive servicing period, based on the maximal readiness coefficient. However, these papers do not give recommendations for the selection of the optimal preventive servicing period, taking into account certain distribution laws for the operation time without failures, which is essential for the solution of given practical tasks.

Relative operational losses depending on the idle time in preventive and unplanned servicing can serve as the criteria for efficient use of the equipment. In the present paper a general solution is presented for the determination of the optimal period for preventive equipment servicing, based on minimal operational losses, and also for the case where the distribution of operation time without failure follows Waybull's law. Losses due to incomplete utilization of parts, arising from their replacement in preventive servicing, have not been taken into account, since they are for several orders of magnitude smaller than the losses incurred through idle time of equipment due to its unreliability.

The optimal period for the preventive servicing of equipment is derived for a certain system of rules (strategy) concerning the procedure [3].

The first strategy (Fig. 1a) foresees preventive servicing in the time $t_{01}$, whereby the incidental time $\eta$ is spent for the servicing itself. If the object fails in the incidental moment $\xi < t_{01}$, an unplanned (emergency) repair is carried out in the incidental time $\eta$. The following preventive servicing is carried out in the time $t_{01}$ if during this period the object does not break down, or in the time $\xi$ if it breaks down, etc.

The second strategy (Fig. 1b) foresees preventive servicing in the fixed time $t_{02}$ regardless of the number of object breakdowns observed in this time. After expiration of time $t_{02}$ preventive servicing of incidental duration is carried out. Emergency breakdowns occurring during the period between alternate preventive servicings in the incidental time $\xi < t_{02}$ are eliminated in the incidental time $\mu$.

It is assumed in the case of both strategies that the object is fully reconditioned, i.e., returned to the state in the moment $t = 0$, after preventive as well as after emergency repairs.

The determination of the optimal period for the preventive servicing of equipment, using any given strategy, can be formulated in a general form as follows. The period for the preventive servicing $t_{0}$ of an unreserved object with a given distribution function of operation time without breakdown $F(t)$ must be selected so that in the system to be established the operational losses are at a minimum, at given mean times for the
Fig. 2. Nomogram for the determination of parameter $x^2/2$. a) First strategy, b) second strategy.