METHOD FOR FORMING REPLACEABLE ASSEMBLY AND UNITS

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Annotation:
The article discusses the methodology for the formation of replaceable units and assemblies of vehicles during their repair. Theoretical prerequisites are given to determine the magnitude and cost of underused resources of parts and interfaces of units and assemblies

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Depending on the design of the machine , the nature and type of failure, the nomenclature of the size of the replaceable unit can vary widely from one part to the unit.

Depending on the design, cost, size and location on the machine, the performance of the replaceable unit (unit) can be restored by eliminating the failure (without restoring resources) or repairing (with restoring the overhaul life). [one]

The methodology for the formation of replaceable units and assemblies is based on the following basic conditions.

1. The size and design of the replaceable unit (unit) should be such that the time spent on its replacement (removal and installation) is minimal.
2. The resources of parts and mates combined in a replaceable assembly should be (if possible) close or a multiple of each other. This requirement is important for the most complete use of the resource of the main parts and mates.

As mentioned above, during current repairs, it is possible to make fuller use of the resources of parts and interfaces and achieve a minimum consumption of spare parts. However, this will reduce the time between failures of the machine, which, even if there is an exchange fund, will lead to an increase in the total time of the machines.[2]

Therefore, in the process of repairing an assembly, it is necessary not only to replace a faulty part (coupling), but also to assess the technical condition of adjacent parts and mates, replacing them in case of insufficient residual life.

The most favorable in this sense are such interchangeable units, the parts and interfaces of which have resources that are close or multiple in size. The repair or elimination of the failure of such interchangeable units provides, along with a good use of parts resources, high reliability of the machine during the subsequent operation of the replaceable unit.

But even in those cases when the parts and interfaces have different resources, it is possible, thanks to the correct choice of the size of the replaceable unit (unit), to use the resources of

the parts more fully than with a complete repair of a large unit, or even more so, the machine as a whole. [3]

3.The difference between the overhaul resources of replaceable units should be large enough to ensure an economically sustainable reliability of the machines.

With an increase in the number of replaceable units of aggregates, the use of resources of parts and interfaces improves, but the average time for one resource failure of the machine and, consequently, the probability of its trouble-free operation decreases. This must be taken into account when compiling the range of replaceable units and assemblies, achieving such a combination of their average overhaul resources that will ensure trouble-free operation of machines for a sufficiently long operating time, without resource failures.

However, the restoration of the overhaul life of the machine is associated with the replacement of parts or mates with an incompletely used resource.

The total value and cost of the unused resource will depend on the parts in the seed node and the value of their residual resource.

The fewer parts and interfaces in the machine (assembly, unit) and the lower the total residual resource they have at the time of replacement, the lower will be the specific consumption of spare parts and the specific cost of repairs (referred to overhaul life).

At the same time, with an increase in the number of replaceable nodes on one machine, its reliability indicators deteriorate and the costs of creating and maintaining the exchange fund increase. Thus, the determination of the optimal number of replaceable units and assemblies for each brand of machines on the one hand. And the determination of the number of replaceable units and assemblies in the exchange fund, on the other hand, seems to be an important technical and economic task, the correct solution of which depends on the unit cost of maintenance and repair of machines.

When developing a range of replaceable units and assemblies, it is necessary to take into account the value and cost of the total unused resource of interface parts. The total unused resource of all parts and mates of a node or assembly is determined by the equation

$$\sum_{1}^{N} T_{\text{îñò}} = \sum_{1}^{N} T_{gi}(n_{3i}+1) - T_n N \quad (1)$$

where: $\sum_{1}^{N} T_{\text{îñò}}$ - residual (unused) resource of all parts of the assembly (unit);

T_{gi} - full (average) resource of the i -th part, determined as a result of information processing:

$$T_{gi} = \frac{1}{N}\sum_{1}^{N} T_{gi} \quad (2)$$

where: T_p - full (average) resource of the node (unit) before decommissioning;

n_{3i} - the average number of replacements of the i - th part for the full resource of the unit or unit, determined by the equation

$$n_{3i} = \frac{1}{K}\left(\frac{T_i}{T_{mp}} - 1\right) \quad (3)$$

where: K= T $_{gi}$ / Tmp _

When calculating the obtained value of the coefficient K, and then the number of replacements n $_{3\,i}$ rounded down to the nearest whole number.

It is convenient to estimate the value of the unused resource by the technical coefficient of using the resource of the parts of the assembly K_p (the ratio of the actually used resource of the parts for the entire service life of the assembly to the theoretically possible one) and the specific cost overrun of the parts (by cost) due to the incomplete use of their resource d (rub/motto-h):

$$K_{\text{èð}} = \frac{T_n N}{\sum_i^N T_{gi}(n\acute{y}i+1)} \quad (4)$$

$$= \frac{\sum_1^N C_{ginyi}}{T_n - T_{mp}} - \sum_1^N C_{gi}/Tgi \quad (5)$$

where: C $_{d\,i}$ – cost of the i - th part, rub.

With a large-aggregate repair method (a large number of expensive parts in one unit), for example, with a complete repair of engines, the amount of incomplete use of the resource of parts can be significant.

With a decrease in the number of parts in one replaceable unit, both the total underutilization of their resource and the expenditure of funds for the purchase of spare parts are reduced.

With a decrease in the number of parts in replaceable units, all the technical and economic characteristics of using the resource of parts improve, and the total consumption of spare parts becomes less. The greatest economic efficiency is obtained if the replacement assembly consists of only one part. In such a variant, the resource of the part will be fully used and, therefore, the utilization factor $K_{p\,is}$ 100%, and the specific cost overrun for the purchase of spare parts will become equal to zero.

However, with a decrease in the number of parts in the nodes, the total number of their repairs increases, which will lead to an increase in the volume of disassembly and assembly work and increase the total downtime of the machine.

Along with this, the corruption of the machine during repairs into replaceable units only on a constructive basis does not in all cases increase the efficiency of using the resources of parts. Sometimes it is possible to detect such structural elements of the machine, the selection of which into a replaceable unit is impractical, since this worsens the use of the resource of its parts and mates.

The analysis of the resources of the parts included in the replaceable assembly allows us to draw another important conclusion.

If the resources of the parts of a replaceable unit have a significant spread, it is possible to improve their utilization factor by alternating the processes of eliminating failures (without restoring the TBO of the unit as a whole) and repair.[4]

Reducing machine downtime during repairs and eliminating operational failures can be achieved by creating and using an exchange fund of units and assemblies. By changing the nomenclature (list) of replaceable units and assemblies for each brand of machine and thereby changing their technical and economic characteristics, it is possible to determine the optimal composition of replaceable units and assemblies, which, taking into account the costs of creating and maintaining the exchange fund, will provide the lowest unit cost of maintenance and repair machines. In general, this condition can be expressed by the functional:

$$C_m = t_{np} C_{np} + \sum_1^n \frac{C_{pi} + C_{\text{ôî i}} + C_{\text{îôi}}}{T_{ni}} \rightarrow \min \ (6)$$

where: C $_m$ - the average unit cost of maintenance and repair of the machine;

C $_{pr}$ - the average cost of one hour of the car;

C $_{p\,i\,.}$ With $_{t\,oi}$ C $_{of\,i\,-}$ the average total cost, respectively, of repair of components and assemblies, maintenance of the machine (including the cost of eliminating operational failures), creating and maintaining an exchange fund of components and assemblies for a full resource T $_{ni}$.

tnp _ - the average downtime of the machine for technical reasons for its full resource.

As can be seen from the expression, the determination of the optimal list of replaceable and aggregates for each brand of machine is associated with a large amount of computational work. However, in a specific case, the solution of this problem is simplified by a number of the above restrictions (three conditions for the formation of replaceable units and assemblies).

Based on the developed nomenclature of replaceable units and assemblies, the machines calculate the range and amount of the exchange fund to replace the units of units in the event of operational and resource failures.

With the aggregate-nodal method of repair and elimination of failures, the main purpose of the exchange fund is to reduce the downtime of machines for technical reasons to the optimal value at which the unit cost of their repair and maintenance C $_m$, taking into account the creation and maintenance of the exchange fund, will become the smallest. As applied to the machine, the functional ( ) will take the form:

$$C_m = \sum_1^n C_{cki} \rightarrow \min \ (7)$$

where: - n is the number of replaceable units on the machine;

D $_{sk\,i}$ - specific cost of repair and elimination of failures of nodes with the aggregate-nodal method rub.

The nomenclature composition of the exchange fund should provide the possibility of replacing all replaceable units and assemblies, and the quantitative minimum unit cost of maintenance and repair of the machine, taking into account the cost of creating and

maintaining the exchange fund, taking into account the cost of creating and maintaining the exchange fund and the cost of machine downtime for technical reasons.

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