Monitoring of the technical condition of individual resource units and units of utilized agricultural machinery

Yuri Kataev, Margarita Mordasova, Igor Tishaninov, Evgeniy Gradov

Abstract. The article presents the use of machine monitoring as an information basis for a control system for maintenance and repair processes, which improves the use of agricultural machinery and reduces the costs of its operation. Improving the planning and management of maintenance and repair of agricultural machinery based on modern technical means plays an important role in increasing its efficiency of use. It is noted that the use of diagnostic tools allows optimizing maintenance and repair processes. The main methods and means of determining the technical condition of the main units of agricultural machinery were used, such as: instrumental method, visual method, organoleptic methods, resource parameter, limit value of the parameter, structural parameters, technical condition parameters. The advantage of monitoring the technical condition of discarded agricultural machinery using a random check method is the determination of the residual life of individual components and assemblies of the machines.

Keywords: monitoring, recycling, agricultural machinery, residual resource, recycling, technical condition.

1 Introduction

The equipment used in the production of agricultural products wears out and becomes susceptible to physical and moral aging processes. A reduction in the fleet of agricultural machinery leads to an increase in the load on the remaining machines, which, in turn, leads to a significant deterioration in the safety indicators and economic efficiency of its operation [1–4]. The tendency to increase the load on equipment entails an increase in the costs of maintaining it in good working order. Based on this, issues with highly efficient use of equipment throughout the entire life cycle, where technical problems associated with effectively increasing its operational reliability, including technical condition monitoring, are among the main ones in building the engineering and technical sphere of the agro-industrial complex [5–9].

Purpose of research — The research aimed at determining the technical condition of the main components and assemblies of agricultural machinery sent for disposal.

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2 Materials and methods

The methodology is based on the current technical state of equipment, technologies and existing regulatory requirements for the disposal of agricultural machinery. When forming scenarios for the development of engineering services, trends in technology development and improvement of the regulatory framework for this type of activity are taken into account.

For 2017-2022 monitoring of the technical condition of tractor and combine harvester units sent for disposal in certain agricultural complexes of the Russian Federation was carried out: Krasnodar Territory, Republic of Tatarstan, Republic of Mari El, Tambov, Tver, Irkutsk, Sakhalin, Penza, Ryazan and Kurgan regions.

Research was carried out on the technical condition of discarded equipment, and survey data from agricultural enterprises in the regions indicated above were also used. The spot check affected batches of agricultural machines in the amount of 35-50 units.

The general provisions of the concept of monitoring and checking the technical condition of recycled agricultural machinery, which the experts adhered to, included: measurements, analysis of measurement results, preparation of general conclusions about the technical condition of machines and resource units during recycling.

Depending on the nature of the tasks, the monographic research method, methods of mathematical analysis using a PC, methods of system and statistical analysis using Microsoft Office Excel 2020 packages, etc. were used.

3 Results and discussion

For each recycled equipment, the technical condition of the product and its main testing units was determined using basic methods and means, including:

- technical condition parameters - physical quantities characterizing the performance of a machine, component, unit;
- structural parameters - wear size, gaps, power, surface hardness of the part, etc.;
- limit value of the parameter - determines the performance of the machine and its components;
- resource parameter - determines the limit value leading to loss of machine functionality;
- organoleptic methods - methods for assessing the technical condition of machines using human senses (subjective method);
- visual method - determines functional violations of the technical condition of the machine by the presence of fuel, water, oil leaks; exhaust colors, etc.;
- instrumental method - is based on the use of special measuring control tools that make it possible to effectively and quickly determine the technical condition of a recycled machine.

The results of studies of the technical condition of resource units of tractors and combines sent for disposal by agricultural enterprises in the regions indicated above are presented in Table 1 and Figures 1 and 2.
**Table 1.** The results of monitoring the technical condition of the resource units of tractors and combines sent for recycling in certain agricultural complexes of the Russian Federation

<table>
<thead>
<tr>
<th>№</th>
<th>Make of tractor, combine</th>
<th>Residual resource in % of new machines for individual components and assemblies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Engine</td>
</tr>
<tr>
<td>1</td>
<td>VTZ-90</td>
<td>25,0</td>
</tr>
<tr>
<td>2</td>
<td>MTZ-80/82</td>
<td>30,0</td>
</tr>
<tr>
<td>3</td>
<td>К-744</td>
<td>27,5</td>
</tr>
<tr>
<td>4</td>
<td>BTZ-150K</td>
<td>26,0</td>
</tr>
<tr>
<td></td>
<td><strong>Total for tractors</strong></td>
<td><strong>27.1</strong></td>
</tr>
<tr>
<td>1</td>
<td>Acros-530</td>
<td>25,0</td>
</tr>
<tr>
<td>2</td>
<td>Palesse GS-12</td>
<td>25,0</td>
</tr>
<tr>
<td>3</td>
<td>KSK 600 Polesie</td>
<td>32,5</td>
</tr>
<tr>
<td>4</td>
<td>Don-680M</td>
<td>25,0</td>
</tr>
<tr>
<td></td>
<td><strong>Total for combines</strong></td>
<td><strong>26.8</strong></td>
</tr>
</tbody>
</table>

**Fig. 1.** The technical condition of the resource units of tractors sent for recycling
Fig. 2. The technical condition of the resource units of combines sent for recycling
Based on the information provided (Figure 3), you can get an idea of the main components and working parts of the tractor, which are subject to recycling with secondary resources in percentage terms.

Steel: 71.95%
Cast iron: 24.39%
Rolling bearings: 1.36%
Copper, brass, bronze, aluminum: 1.12%
Rubber and plastics: 0.82%
Asbestos, metal ceramics: 0.28%

**Fig. 3.** Composition (a) and structure (b) of recycled materials
Based on the goals of developing the process of recycling agricultural machinery in the agro-industrial complex of the Russian Federation and taking into account world experience \[17, 18\], it seems necessary to solve the following problems:

1. Determine and justify the principles and instruments of regulation in the field of use of secondary resources in the country’s agro-industrial complex.
2. Implement measures to support the use and development of advanced technologies and equipment for the collection and restoration of used agricultural machinery, equipment and other resources.
3. Carry out the selection of parts and assemblies of recycled agricultural machinery that have a residual life of 55-60% at repair enterprises of the agro-industrial complex.
4. Prepare proposals for improving the regulatory framework for the development of the organizational and production infrastructure of technological processes for recycling agricultural machinery.
5. Attract small and medium-sized agro-industrial enterprises to this area with the prospect of creating on its basis a sub-industry for collecting recyclable used agricultural machinery and restoring usable parts and assemblies with their sale as marketable products.
6. Determine the range of waste from recycled agricultural machinery to be used as a matter of priority as secondary material resources in the agro-industrial complex.
7. Create a program for the development of enterprises for the recycling of agricultural machinery and monitoring of regional markets for secondary resources.

The implementation of these provisions will allow:

1. Attract investments in the areas of waste management after disposal of agricultural machinery.
2. Increase the volume of production of products made from waste or using it.
3. Reduce losses of raw materials, material and fuel and energy resources currently being withdrawn from economic circulation and consumption, and thereby increase the efficiency of use of secondary resources.
4. Create more favorable conditions for expanding the material base of the agro-industrial complex economy, namely reducing the volume of supplies of new parts and components of agricultural machinery and equipment due to equipment restored during selection during the recycling process, which have a high resource and prices 50-60% of new ones.
5. Reduce the level of environmental waste pollution.
6. Create new jobs, primarily in small and medium-sized businesses involved in the recycling of agricultural machinery.
7. Expand interaction with foreign countries in the field of improving technologies for collecting and processing discarded agricultural machinery.
8. Ensure compliance with environmental requirements.

4 Conclusions

Monitoring of agricultural machinery helps to determine the technical condition of machine components and assemblies without resorting to disassembly or partial disassembly, as well as to predict the service life of components and mechanisms. In fact, it becomes possible to manage the technical condition of machines and prescribe the required preventive measures. This allows you to significantly reduce equipment downtime, while saving money on maintenance and repairs (MRO), as well as reducing the consumption of fuels and lubricants (fuels and lubricants) and spare parts. Thus, timely identification and elimination of serious malfunctions in the engine power supply and ignition systems, ...
Transmission units or chassis improves fuel and economic indicators by 5-10%, while increasing the environmental performance and safety of equipment during its operation.

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