

HOLOGRAPHY IN THE CONTROL OF AGRICULTURAL  
MACHINERY

## ГОЛОГРАФИЯ ПРИ КОНТРОЛЕ СЕЛЬСКОХОЗЯЙСТВЕННЫХ МАШИН

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**Abstract.** *Agricultural machines and their components are manufactured with a significant measure of quality variation. They have a stochastic, probabilistic nature of loss of operability during operation. A wide range of external factors and working conditions also leads to significant changes in the loss of the work state, especially in agricultural machines, the use of which is associated with severe operating conditions. Objective evaluation of the technical condition of the machine can also give a defect (control) without disassembly. It is considered an established fact that each disassembly significantly reduces the efficiency of the machines due to the loss of the properties of the matings that are used during operation. That is why, diagnostics and non-destructive testing have priority in determining the real parameters of the technical condition and the trouble-free operation of each machine.*

**Key words.** *Detail, machine, technical condition, interferometry, holography, laser, microdeformation.*

**Introduction.** The technical state of the existing fleet of agricultural machinery and its productivity is determined by the indicators of physical and parametric reliability. Physical reliability indicators are determined by the readiness factor, and parametric ones - because of the decrease in engine power from wear and strain. Permissible reductions in the power of turbocharged engines, which are equipped with harvester, to 12-13% of. [1, 3, 4]. In the same limits, the allowable reduction of CP mechanical, hydraulic mechanisms and systems. For calculations we take the average value of parameters of parametric reliability of engines and mechanisms (5 ... 6%) in total [5]. Taking a car as a complex of diverse elements that interact with each other while working and creating a workable product, its durability must be taken into account with the determination of the value of the work or the service life of its individual elements [6].

**The aim.** Determination of the technical condition of agricultural machinery through monitoring and diagnosis, to establish the timing of timely technical maintenance, repairs and prevention of failures.

**The results of research.** Diagnosis of the parameters of the technical condition of agricultural machines using modern methods, as the practical experience has shown, is harnessed with considerable difficulties. The results, as a rule, do not allow to adequately assess the technical condition of the product (machines, tools),

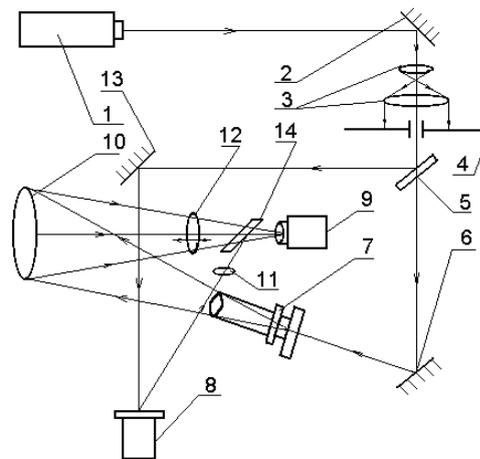


especially those that were in operation.

With the help of holography, it is possible to evaluate the state of the surface layers of the working zones of a part in a complex and integral way, and not differentially, from point to point, as by other methods of nondestructive testing. The sensitivity of the optical system makes it possible to record ultra-small changes in the surface layers, which in turn makes it possible to assess the technical condition and, accordingly, the operability in an expensive, arbitrarily chosen moment of time for the production operation of the agricultural machine.

There is established that the use of holography makes it possible to reduce the number of incorrectly rejected and serviceable parts that were in use and new, respectively:  $n_{ct} = 9,66\%$ ;  $n_n = 6,60\%$ , - rejected (incorrectly) as well as incorrectly accepted:  $m_{ct} = 10,83\%$ ;  $m_n = 6,97\%$  ( $n_{ct}$  and  $m_{ct}$  are used, and  $n_n$ ,  $m_n$  are new ones). Holography increases the reliability of agricultural machinery by reducing errors in the defect and control of machine parts.

The method is based on determining the technical state of a part, assembly, or aggregate during double-exposure observation of their surface when the physical state changes and fixing the result in computer memory as fields of microdeformation in the form of colored or black-and-white interference fringes. This method allows non-destructive testing of new parts, defects of those that were in operation, with the detection of hidden defects and damages with a high degree of reliability (up to 92%).



**Fig. 1. Optical scheme of the installation for creating holograms**

The beam of coherent laser light (1), reflected from the mirror (2), passes through the lens system 3 (the collimator) and the point diaphragm (4) and is directed to the flow divider, where it divides into an object and reference, the latter reflecting from the mirror (6) through the lens (7) illuminates the object (10). The reference beam, reflected from the mirror (13), hits the piezo-mirror (8), passes through the lens (11) and the flux divider (14), and also through the movable lens (12) illuminates the object and enters the video camera (9) which is directly connected with computer. The software creates color holographic images - holograms - interference fields of the surfaces of the deformed body.

The laser uses helium - neon, ruby or argon. Ruby laser is used, mainly, in the implementation of classical holography to study fast flowing processes associated



with the destruction of surfaces in determining the limiting parameters of the technical state of products. With the help of a video camera, the illuminated surface of a part is fixed, and the received information in the form of a digital signal through a digital adapter is recorded in the memory of a personal computer.

Control is subject to a wide range of parts of agricultural machinery and equipment of enterprises from the processing of agricultural raw materials: body parts, linings, shafts, gears, pistons, parts of complex configuration, working organs of soil cultivating, sowing and gathering machines, equipment and others. Diagnosis of the technical condition of agricultural machines using holography is based on the principle of comparative evaluation of two holograms obtained from the same object at different times or comparisons with holograms that are obtained from a reference sample.

During the process of carrying out diagnostic work of the pump sprayer OVT - 1 was obtained a series of holograms examples, which are shown in Fig. 2 and 3. In the first case, the hologram was obtained from the standard (the sprayer was not used, and in the second case - worked two seasons of field work, narobotka - 148 hectares). The interference bands are placed without anomalies in a certain order, which indicates the suitability of this unit for direct operation. Otherwise, the interference fringes have a pronounced anomalous placement on the hologram, which indicates the presence of defects or damages at the site itself, which was investigated.

**Conclusions.** Thus, the rational use of a complex of non-destructive methods of control makes it possible to increase the reliability and quality of products, to prevent accidents of complex aggregates and to give production enormous economic advantages. The main purpose of holography is to identify hidden and surface defects, damage, internal structure violations, whereby geometric dimensions, configurations, locations, their depth and other parameters are established. It is possible to determine the values of microdeformation and stresses with predicting the residual life.

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**Аннотация.** *Сельскохозяйственные машины и их компоненты изготовляют со значительной мерой вариации качества. Они имеют стохастическую, вероятностную природу потери работоспособности во время эксплуатации. Широкий диапазон внешних факторов, условий работы также приводит к значительным изменениям потери работоздатного состояния, особенно у сельскохозяйственных машин, использование которых сопряжено с тяжелыми условиями эксплуатации. Объективную оценку технического состояния машины может дать также дефектовка (контроль) без разборки. Считают установленным фактом, что каждая разборка значительно снижает работоспособность машин за счет потери свойств приработанных в процессе эксплуатации сопряжений. Вот почему, диагностирование и неразрушающий контроль имеет приоритет в определении реальных параметров технического состояния и безотказной эксплуатации каждой машины.*

**Ключовые слова.** *Деталь, машина, техническое состояния, интерферометрия, голография, лазер, микродеформация.*