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ANALYSIS OF RESEARCH ON THE DURABILITY OF HYDRAULIC SYSTEMS OF MOBILE MACHINERY

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Problem statement. The problem of increasing the reliability of a hydraulic drive has been the subject of research by many authors. It has been found that the level of reliability of a hydraulic drive is determined by the concentration of mechanical impurities in the working fluid. Scientific and practical recommendations have been developed to ensure the industrial cleanliness of the hydraulic drive, the use of which provides a significant effect. Similarly, researchers, based on the provisions of the theory of friction and wear developed by scientists (I.V. Kragelsky, V.S. Kambatov, U.A. Ikramov, etc.), have made attempts to build analytical methods for determining the wear of hydraulic units. However, the assumptions made in this regard make these methods ineffective.

Main research materials. Nowadays, the direction of increasing the reliability of the hydraulic drive by improving the cleanliness control of components, units and systems of machines for various purposes has been developed, which is used in the operation of mobile machines and has high efficiency.

Research by the Cincinnati company (USA) shows that it is enough to increase the durability of hydraulic units by 5,5% to recoup the costs of equipping the hydraulic system with finer filters, which will extend the service life of parts by 46%, while the costs pay off in two weeks.

VNIIStroydormash conducted tests of pumps installed on EO-4121 excavators with different fixed composition of contaminants in the working

fluid.Tests have shown that the reduction in volumetric efficiency of a pump operating with a degree of contamination of the working fluid corresponding to class 17 is achieved after approximately 1000 hours, and with a fluid of class 14 – after 3350 hours [1].

VNIIHydroprivod [2] studied the dependence of wear of gear pumps of the GP-2 type on the concentration of mechanical impurities using the accelerated testing method.The pumps were tested in nominal mode with a working fluid purified by an 8–12 μm filter. This fluid was then contaminated with grinding powder. When the working fluid was contaminated with grinding powder M-20 with a concentration by weight, the volumetric efficiency decreased by 138 hours. The decrease in volumetric efficiency by this amount in purified oil occurred after 1200 hours. When the working fluid was contaminated with grinding powder M-4 with a concentration by weight, after 5,5 hours the volumetric efficiency of the pump decreased almost to zero.

Japanese experts [3] believe that the intensity of wear increases sharply with increasing concentration of contaminants to. Increasing the working pressure causes a negative impact of contaminants on the reliability of hydraulic units. The relationship between increasing the working pressure in the system and the permissible contamination of the working fluid can be represented as:

$$P_1/P_2 = e^{0,0037 \ln N_2/N_1}, \quad (1)$$

where P1 and P2 are the operating pressure in the system before and after contamination, respectively;

N1 and N2 are the number of particles of a given size in the system before and after contamination, respectively.

Experts from the UK Ministry of Defence, Whitland Helicopter Corporation, Imperial College and the US Navy Research Institute believe that a significant increase in the service life of hydraulic units is achieved in cleanliness classes not lower than 14/11. The service life doubles if the level of contamination is reduced from 21/13 to 17/14 according to the ISO 44061 classification.

The influence of working fluid contamination on the reliability of the hydraulic drive of construction and road machinery was studied in the KADI. An examination of hydraulically powered excavators, bulldozers, and truck cranes that were in real operation conditions showed that the cleanliness of working fluids on excavators and bulldozers is at the level of 16...17 classes, and truck cranes - at the level of 15...16 classes.When refueling machines with working fluid with IS class purity, the maximum operating time to the set values of working fluid purity was 240 and 480 hours, respectively. It was found that particles with a size of 5–25 microns are dangerous for excavators, and particles with a size of 10–40 microns are dangerous for bulldozers and truck cranes.

The study of the distribution of particles by size allowed us to establish that the share of hazardous particles in their total number reaches for excavators95%, and for truck cranes and bulldozers – 30…33%.When the temperature of the working fluid increases above and its contamination reaches the level of class 75, the hydraulic distributor plunger jams, which leads to unstable operation of the hydraulic system, and the pump operates with increased noise characteristics.Bench tests of hydraulic pumps 210.25 and 223.25 showed that cleaning the working fluid from mechanical impurities allows increasing the operating life of pumps for excavators by an average of 2.8 times, and for truck cranes by 1.7 times.Simultaneous cleaning of mechanical impurities and water increases the service life of excavator pumps by 3.9 times, and of truck cranes by 1.9 times [1].

In the studies [4] and other scientists it is shown that intensive wear is caused by particles whose size is commensurate with the gap in the friction pairs. If the particle size is smaller than the gap, then the fraction of contaminants in the fluid flow freely passes through it without causing damage.Particles of contamination, the size of which is much larger than the gap size, do not penetrate it, but can cause partial blockage of the gap from the outside. Large particles can be crushed into small ones. Particles of contamination, the size of which is close to the gap size, are the most dangerous, especially if their hardness exceeds the hardness of the material of the parts.Penetration of larger particles into the gap is possible only after it has increased as a result of the abrasive action of small particles or due to the skewing of parts under load. Once in the gap, the particle of contamination moves relative to the working surfaces with sliding, resulting in scratches on the surfaces of the contacting parts. The impact of particles on the surface is, as a rule, multiple.

Conclusions. The analysis of literary sources shows that the durability of the hydraulic drive of agricultural, construction and road machines is significantly influenced by both the design parameters laid down at the design stage and the properties of the working fluid maintained at the operation stage. Regarding the hydraulic drives of mobile machines, the sensitivity of the system safety indicators to changes in operational factors is represented by the identification of the nature of the intensity of wear of friction elements, in particular plunger pairs of axial-piston pumps depending on the state of the working fluid. The establishment of parameters, their qualitative and quantitative characteristics have not received a sufficiently accurate reflection in the existing scientific developments. In furtherstudies, it is planned to conduct analytical studies to identify the impact of changes in the structural parameters of the technical condition of parts in plunger pairs on volumetric and mechanical losses in an axial-piston hydraulic pump.

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ДОСЛІДЖЕННЯ РЕЖИМІВ РОБОТИ ВІДЦЕНТРОВОГО ВЕНТИЛЯТОРА ПНЕВМАТИЧНОГО ВИСІВНОГО АПАРАТУ

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Анотація: розглянуто етапи режимів роботи індивідуального відцентрового вентилятора (ІВРВ) для визначення сфери оптимальної роботи системи.

Ключові слова: повітря, лопатки, канали, вентилятор, робоча ділянка.

Завдання при проектуванні вентилятора полягає в тому, щоб досягти високої ефективності за низьких виробничих витрат. Але оскільки при роботі вентилятора частина енергії витрачається на втрати, тому не вдається досягти максимальної ефективності. Ідеальна конструкція робочого колеса – це контур із просторово вигнутими лопатками. Робоче колесо виходить як складальна одиниця, де деталі отримані за допомогою фрезерування або як лита більш економічна деталь. Лопатки робочого колеса мають постійну товщину стінки, які виконані у вигляді лез з круговою дугою, або лопатка з плоско паралельною опорою та захисним диском.

Вентилятори, що використовуються у сівалці, є частиною всієї пневматичної системи пристрою [1]. Робоча характеристика системи, що складається з ІВРВ, трубопроводів та апарата, що висіває, складається з характеристичних кривих, як показано на рисунку 1.01(а).