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RELIABILITY ANALYSIS OF THE MAIN COMPONENTS OF HYDRAULIC SYSTEMS OF MINING MACHINES

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Analysis of conditions and operating modes of hydraulic systems of mining machines shows that hydraulic units operate under stressful conditions characterized by constantly changing operating pressure, temperature conditions, pressure build-up rate, occurrence of hydraulic shocks and cyclic loads. This increases the probability of failure of hydraulic system components and can lead to failures, causing loss of working fluid. These circumstances make the task of developing effective schemes for protecting the hydraulic system from the release of working fluid when destroying high-pressure hoses and the problem of environmental protection urgent. **[1,3-7]**

On the basis of the analysis of previously made researches it is established that the greatest number of failures of units of hydraulic system of mining machines falls on a hose of high pressure - to 44 % (fig. 1).

Using the methods of probability theory, it is found that the lifetime of high-pressure

hoses before maintenance is about 1000 motor-hours. Consequently, maintenance of high-pressure hoses should be carried out at MOT-3.

At such periodicity of maintenance of hydraulic system, 85 % of hoses will be serviced in time (before the limit state), and about 15 % will fail before

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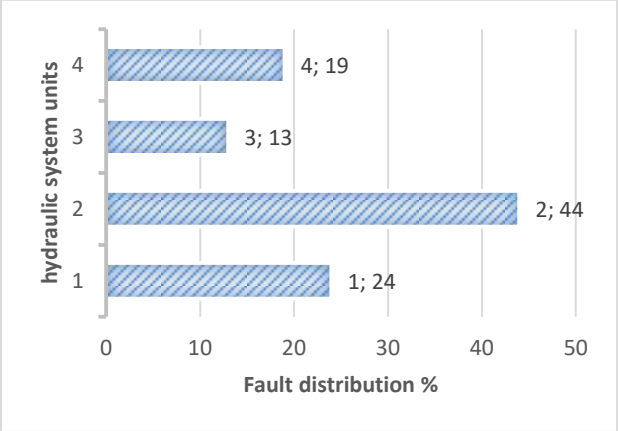
maintenance, which provides observance of the main requirement of modern maintenance system about preventive maintenance.



1-pump, 2-high pressure hose,3-hydraulic cylinder, 4-distributor
fig 1. Distribution of faults by hydraulic system units.

The studies conducted earlier show that the main share of working fluid losses during operation of construction machines is accounted for by losses caused by destruction of high-pressure hoses of hydraulic system and violation of tightness in joints (about 50% of total losses).

Consequently, to improve the efficiency of hydraulic systems of mining machines, it is necessary to improve devices for protecting hydraulic systems from emergency losses of working fluid during depressurization of the pressure line.

To protect hydraulic systems of mining machines from accidental loss of working fluid in the work an improved device is proposed, based on the principle of double overlapping of the pressure line with a plunger and spring-loaded valve and the use of hermetic shell, located on the high-pressure hoses (Fig. 1). The proposed device differs from the known prototypes by the presence of an elastic element of variable stiffness and a protective casing. Its important advantage is that it allows to fully exclude escape of working liquid into the atmosphere in case of emergency situations in the hydraulic system. Application of the offered protective device in a design of machines will allow to raise considerably operational properties of a hydraulic system of machines that is reached by presence in a design of a hydraulic system of the locking device and strong on break hermetic cover for gathering of a working liquid thrown out during operation of the protective device [1].

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The advantage of the proposed technical solution is also in the fact that in an emergency mode, the liquid ejected at the time of operation of the protection device is collected in the containment, which excludes pollution of the environment.

In contrast to the known designs of protection, the proposed protective device is equipped with a spring of variable stiffness, made in the form of two springs, which allows to increase the speed of the valve in the initial period of its closure and reduce the speed at the time of the end of the closure. This maintains the rapidity of the device, but reduces the force of the valve hitting the socket and reduces wear. [2]

The protection device of the hydraulic system is shown in Fig. 2. The device contains a hydromechanical unit 1, a tear-resistant protective hermetic shell 2. The hydromechanical unit includes a body 1, a spring-loaded plunger 6 with axial 7 and radial 8 holes and a spring-loaded valve 9 located in the body of the unit. Unlike the known ones, the proposed device has an additional valve spring in the hydro-mechanical unit, which is necessary for stable and reliable operation of the protective device and reduction of valve and seat wear. The use of an additional spring increases the total stiffness of the valve springs in its initial position and decreases - at the time of closing, compared with the device, where a single spring is installed.

The device works as follows. The working liquid with the hydraulic pump 4 through the high-pressure pressure hydraulic line 3 is supplied through the cavity A and B of the hydro-mechanical unit 1 to the hydraulic valve 5 and further to the hydraulic cylinder. When the pressure line fails, the pressure difference in cavities A and B increases and the plunger 6 is out of equilibrium. The valve 9 and plunger 6, moving towards each other, block the hole 7 and further, moving as one unit, overcoming the force of springs, block the cavity B of the pressure line, directing the working fluid through radial holes 8 from the cavity A through the drainage hydraulic line 10 into the hydraulic tank.

Introduction of a tear-resistant hermetic shell 2 provides collection of the ejected working liquid in case of damage to the high-pressure pipeline during the time of operation of the shut-off device and completely prevents contamination of the environment.

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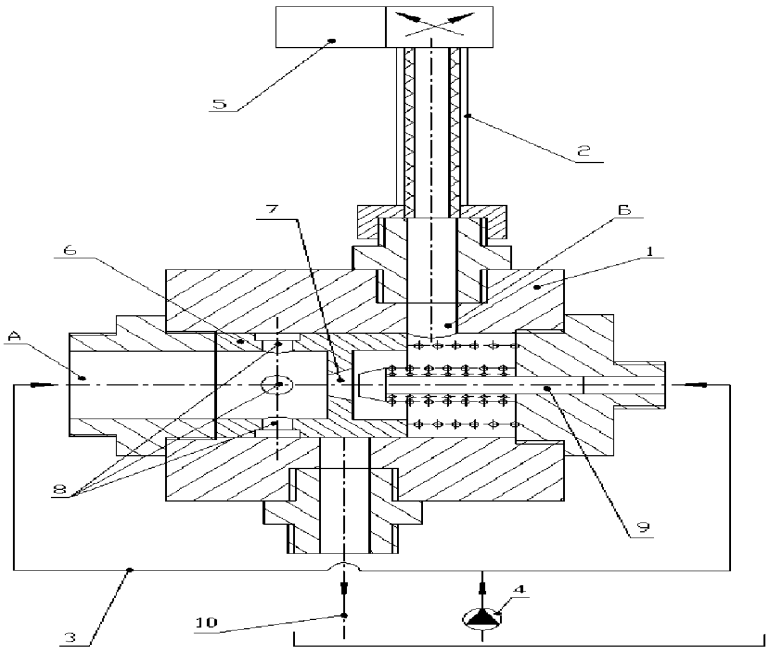

Fig. 2. Hydraulic system protection device with two springs and sealed shell.

The proposed device allows you to turn off the hydraulic actuator when the leak tightness of the high-pressure line on any of its sections, as well as to collect the working fluid ejected from the damaged section.

As follows from the given description [2] the device consists of two main parts with different purposes. The first part - the hydromechanical one - is designed for automatic shutting off of working liquid supply to the hydraulic system in case of depressurization of the discharge line. And the second part - the shell part - is designed to collect working liquid and prevent its release into the environment in case of emergency situations.

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