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Interactions of Structural and Technological Systems of Single Bucket Excavators

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Abstract: *The solution to the issue of increasing the efficiency of the hydraulic drive of road earthmoving machines should be based to a large extent on the study of the balance of acting forces and the distribution of power for each cycle in real operating conditions of road construction machines, as well as generalizing the experience of their use. This article is about it.*

Keywords: *road construction machines, increasing the efficiency of the hydraulic drive, road earthmoving machines.*

Introduction

The development of the road industry - one of the important components of the economy of Uzbekistan - largely depends on an efficiently functioning system of operation and repair, which ensures the maintenance of mechanization facilities at a high level of performance throughout the entire period of their operation. Among the various types of construction work, a significant amount falls on the development of soils. The peculiarity of the operation of a set of machines at facilities in aggressive environments is aggravated by the fact that the quality criteria of the entire technological process depend on the efficiency and reliability of each unit. The effectiveness of the interaction of structural and technological systems of road vehicles is evaluated by the main parameters, such as performance, efficiency and energy intensity.

Main Part

The results of studies on the assessment of the energy consumption of mining and loading machines when moving the rock mass, depending on the geomechanical state of the massif, carried out by previous researchers A.M. Zavyalov, D.B. Solovyov, V.N. Tarasov and others, indicate that excavators occupy a leading position in performing energy-intensive operations [1, 2,3,4,5,6,7,8].

Currently, hydroficated vehicles make up 80% of the total number of SDM fleet. When excavating the soil environment, the operation of hydraulic drives during the entire life cycle is 85%. From 50 to 70% of the main functional operations are performed under heavy loading conditions. Earth-moving machines are characterized by a large number of inclusions of power hydraulic motors and elements that affect the load of the hydraulic drive and the dynamics of its change. Thus, the modes of operation of the actuators are very intense [9,10,11,12].

Among the universal construction and road machines, a wide range of functionalities is found by single-bucket excavators of the 3rd and 4th groups on caterpillar tracks. In the technological processes of road construction works, they occupy leading positions in the sets of machines. The working equipment of excavators, which acquires large values of moments of inertia during cyclic movement, is a source of dynamic loads. Operations of the working cycle of the excavator are provided by the

high power of the power plant and high values of the specific fuel consumption. The operation of filling the bucket is accompanied by alternating dynamic loading and low efficiency of the hydraulic drive. Incomplete loading of the bucket leads to a decrease in the productivity and efficiency of the excavator. The effect of increasing loads on the units and assemblies of machines tightens the requirements for its efficient operation with minimization of energy consumption for technological operations of the hydraulic drive [13,14,15,16].

To study the operation of hydraulic drive mechanisms, consider its classification. There is an energy source in the structure of the volumetric hydraulic drive. According to the type of energy source, hydraulic actuators are divided into three types [17]:

- pump hydraulic drive - a hydraulic drive in which the working fluid is supplied to the hydraulic motor by a positive displacement pump;
- battery hydraulic drive - the working fluid is supplied to the hydraulic motor from a pre-charged hydraulic accumulator;
- main hydraulic drive - the working fluid enters the hydraulic motor from the hydraulic line.
- According to the nature of the movement of the output link, volumetric hydraulic drives are divided into:
- progressive movement;
- rotary movement - with rotary movement of the output link of the hydraulic motor at an angle less than 3600;
- rotational movement.

In an adjustable hydraulic drive, the speed of the output link of the hydraulic motor can change according to a given law. In an unregulated hydraulic drive, there are no devices for changing the speed.

The improvement of existing and the creation of new, more efficient hydraulic drive mechanisms require a complex of theoretical and experimental studies with testing of both the hydraulic drive itself and earth-moving machines as a whole.

Earth-moving machines are complex mechanical systems consisting of working bodies, working, power and running equipment, various types of working mechanisms, hydraulic drives and metal structures, which is why their research and testing is a multifaceted task that requires the use of modern methods and tools.

Extensive experience in the studies of the interaction of the main systems of a shovel excavator during testing of earth-moving machines makes it possible to unify and typify research and testing methods using modern information-measuring systems or their elements, processing and analyzing equipment and computers. This raises the scientific level of research, speeds up its implementation, and makes it possible to obtain uniform information with the same degree of reliability.

It should also be noted that, despite the variety of structural forms and types of earth-moving machines and their drives, when testing and researching them, it is possible to determine the necessary and sufficient amount of information of the same type for all machines. When conducting experiments and tests, methods of similarity and physical modeling of the working processes of hydraulic drive elements, the theory of experiment planning, strain gauges, magnetography, etc. should be widely used. For semi-automatic and automatic processing and analysis of experimental data according to the methods and programs developed at TsNIIS, modern reading equipment, computers, as well as the mathematical apparatus of probability theory and the theory of random processes are used.

The use of methods of similarity theory and physical modeling makes it possible to study the interaction of interfaces of hydraulic drive elements, such as a hydraulic cylinder, before manufacturing prototypes of machines. For this, systems of differential equations and uniqueness conditions are used that determine the essence of the process under study, which makes it possible to obtain experimental dependences on the basis of a direct experiment and test the hypotheses put forward.

To improve the scientific level of experimental research, unify the methods of processing and analyzing the results, reduce the cost and labor costs, reduce the time for performing work and increase the reliability of the results obtained, it is necessary to apply mathematical methods of the theory of experiment planning, which are widely used in research in the field of chemistry and technology, black and color metallurgy, automatic control, metal processing, mechanical engineering.

These methods include:

- the choice of a quantitative characteristic of the research goal and the factors characterizing it, as well as the combination of random noise into noise, the statistical characteristics of which are to be determined;
- assessment of the significance of factors (selection of the most significant factors and ranking them according to the degree of significance in order to reduce the size, factor space, and the amount of experimental computational work);
- development of a mathematical model of the object in the form of a regression equation with unknown coefficients;
- building a plan for conducting an experimental study that determines the number of experiments, random order, their conduct and the choice of combinations of factor values in each experiment, which ensures the averaging of all the effects of uncontrolled factors;
- statistical processing of experimental data (leveling of observation errors, determination of numerical characteristics and the law of distribution of random components in experimental data, verification of the reproducibility of experiments and basic statistical hypotheses, finding the coefficients of the regression equation, verification of the adequacy of the mathematical model to experimental data);
- analysis of the results of the experiment.

The use of mathematical planning methods allows optimizing the process of conducting an experiment, processing and analyzing the information received, standardizing the estimates of the studied parameters, setting confidence intervals and obtaining comparable results from various studies.

Conclusion

The measuring tensometric and magnetographic equipment used, selected in accordance with the requirements of metrology, must ensure the registration of measurement results in a form convenient for subsequent automated processing using modern processing, computing and analyzing technology. The complex of equipment must ensure the conversion of measurement results to the form corresponding to the selected computing, analog or specialized analyzing technology, as well as ensure the necessary statistical processing and appropriate mathematical analysis. The resulting automated information-measuring systems make it possible to obtain all the necessary information from measurements, carry out all calculations for the processing of this information and present the results in the most convenient form for analysis.

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