FEATURES OF ALGORITHMS OF DIAGNOSING AND MAINTENANCE OF RELIABILITY OF HYDRAULIC DRIVES OF MACHINES

Vasily SHEVCHENKO, Michael ZHILEVICH, Alexander KOROLKEVICH

The Incorporated Institute Of Mechanical Engineering The National Academy Of Sciences Of Belarus
Street Academic, 12, Minsk, ph. + 375 17 284 24 46; a fax + 375 17 284 02 41
e-mail: sv2007@tut.by

Summary

The paper discusses the possibilities of applying some algorithms of diagnosing and maintenance of reliability of hydraulic drives of machines. Some typical algorithms of diagnosing are considered. The conceptual positions of structural maintenance of reliability of hydraulic drives have been proposed.

Keywords: technical diagnosing, reliability, hydraulic drive.

1. INTRODUCTION

One of the basic functions of the test system of a hydraulic drive is the establishment of conformity of its technical condition to normative requirements. The properties of hydraulic systems, defining their technical condition, are subject to the certain changes while in service machines.
Experience is confirmed, that with a significant part of technogenic failures are tie up with the mistakes admitted at designing and operation of machines, and that the price of such mistakes is exclusively great [1]. Therefore it is necessary to pay the big attention to working off of algorithms of technical diagnosing of hydraulic systems, increase of their efficiency and reliability.

2. FEATURES OF TECHNICAL DIAGNOSING OF HYDRAULIC DRIVES

For machines that are complex, power-intensive and potentially dangerous to the person, environment and economy of technical devices especially important requirement is maintenance of trouble-free operation. Admissible values of parameters and attributes, preemergency and emergency conditions of system are defined with the obligatory account of features inherent in actually hydraulic systems. First of all is a centralization of functions and the mass distribution of influences which are carried out by a uniform working body (liquid).

Depth of troubleshooting and reliability of results of diagnosing define a degree of safe operation of the machine, and also reliability of the forecast of the technical condition of the system during the future moments of time.

While in service hydraulic drives of machines the complex of methods of diagnosing (fig. 1) is applied.

At functional diagnosing of the condition of a hydraulic drive is defined by results of the current control of parameters (constructive, regime, operational, etc.)

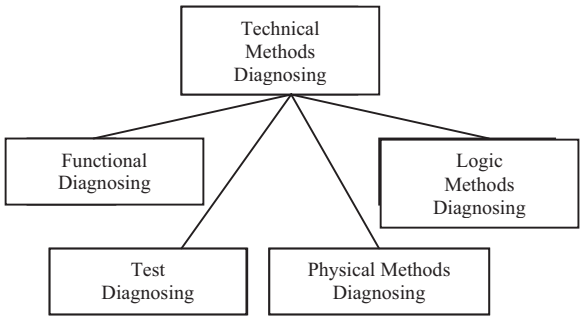

Fig. 1. Methods of technical diagnosing

The basic lacks of the specified methods are increased requirements to a memory size of the monitoring system of parameters and low efficiency of such systems. Especially it concerns to cases of the control of realization of signals or their statistical characteristics for all conditions of functioning.

3. REQUIREMENTS TO ALGORITHMS OF DETECTION OF MALFUNCTIONS

Maintenance service of hydraulic systems of machines demands participation of highly skilled experts on which arms there are the modern precision diagnostic devices having an output on a computer, allowing to define methods of elimination of malfunctions and maintenance of reliability of diagnosed devices. Such method of diagnostics is modern, but, unfortunately, yet has not received enough wide circulation basically for the reason that in operation often there are machines manufactured long time ago and not equipped by such complex diagnostic systems. However even in this case at presence of the skilled expert it is possible to define quickly enough and authentically the reasons of malfunction of hydraulic system, using a so-called logic method [2].

All malfunctions of the hydraulic system can be divided into two greater groups:

- The malfunctions which at present are not influencing functioning of the machine (the outflow, the raised noise, the raised temperature, etc.);
- Functional malfunctions (jamming, decline of productivity, ignitions, etc.);

Searching of malfunctions is carried out by different algorithms. Experience of the experts and their practical skills, as well as common sense, thus have crucial importance. The operational documentation, as a rule, contains a lot of the valuable information on background of the arisen problem (whether there were earlier the similar malfunctions, what works were spent on maintenance service and adjustment of those or other units and systems). The logical analysis of such information allows to save a lot of time at diagnosing and prevents failures in due time.

Revealing the elementary malfunctions of type of outflow, foaming or overheat of the working liquid, insufficient speed of the agencies, the raised noise in separate devices, etc. by means of sense organs and on the basis of experience allows to avoid excessive complications of test systems. It promotes increase of their own reliability and certain concentration of functionalities on search and the analysis of more complex malfunctions.

Experience of diagnosing and good knowledge of the device of hydraulic system allow to define the priority procedure for test of units. If at once at preliminary check the faulty unit is not found, spend deeper check of each unit by means of special control devices and stands.

After finding of the faulty unit the reasons and possible consequences of malfunction (clearing or replacement of a working liquid, adjustment of safety and conditioning devices, etc.) are defined and eliminated.

Algorithms of preliminary logic diagnosing of hydraulic systems usually include a number of consecutive checks of conformity of marks and installations of units, correctness of their adjustments and signals of management [2].

With the purpose of increasing of efficiency of built-in diagnosing systems of mobile machines base diagnostic models and schemes (base algorithms) automatically in search of possible malfunctions of hydraulic drives [3] are developed. Thus in schemes of recognition transients in hydraulic system are considered.

Adequate work of system of diagnosing is possible only under condition of the coordination of character and parameters of transients in a hydraulic drive with parameters of the measuring equipment.

For formation of a diagnostic model of the hydraulic drive the special technique in which basis the analysis of the basic scheme of a hydraulic drive and an establishment of communications between elements is put is offered. Synthesis of the general algorithm of search of malfunctions is carried out by means of connection of base algorithms according to graphic model. If necessary the algorithm can be supplemented with heuristic algorithms of search of the possible defects caused by features of connection of elements in a uniform system (structure of the system).

The mathematical model is developed for the formalized modeling hydraulic drives of any structure in an automatic mode

$$\begin{cases} \dfrac{d^2x_i}{dt^2}=\dfrac{1}{A1_i}\left[p_{i-1}-p_i-\left(A2_i+B2_i\right)\left(\dfrac{dx_i}{dt}\right)^2\operatorname{sgn}\dfrac{dx_i}{dt}-\right. \\ \qquad\qquad \left.-A3_i\dfrac{dx_i}{dt}\right],\ i=1...NU,\ i\neq i_{\mathrm{c}}; \\ \dfrac{d^2x_i}{dt^2}=\dfrac{1}{A1_i}\left[p_{i-1}-\chi p_i-\dfrac{P_z+P_0+P_T}{f_i}-\right. \\ \qquad\qquad \left.-\left(A2_i+B2_i\right)\left(\dfrac{dx_i}{dt}\right)^2\operatorname{sgn}\dfrac{dx_i}{dt}-A3_i\dfrac{dx_i}{dt}\right],\ i=i_{\mathrm{c}}; \\ \dfrac{dp_i}{dt}=\dfrac{E_{a0}+a_p p_i}{V_i}\left(f_i\dfrac{dx_i}{dt}-f_{i+1}\dfrac{dx_{i+1}}{dt}\right),\ i=1...NU,\ i\neq i_{\mathrm{p}}; \\ \dfrac{dp_i}{dt}=\dfrac{E_{a0}+a_p p_i}{V_i}\left(f_i\dfrac{dx_i}{dt}-f_{i+1}\dfrac{dx_{i+1}}{dt}-f_{i+k}\dfrac{dx_{i+k}}{dt}\right),\ i=i_{\mathrm{p}}. \end{cases}$$

Here: NU – quantity of sites; i – number of a site; p_i – pressure; x_i – moving; V_i – volume of a liquid on *i-th* site; E_a – the module of elasticity of a liquid; a_{PA} – the factor considering influence of pressure on E_a; f_i – the area of section *i-th* site; P_T – force of friction; P_0, P_Z – constant and item loadings; i_c – a site with the hydraulic cylinder; i_p – unit of a branching; $A1_i$, $A2_i$, $A3_i$, $B2_i$ – the factors considering various kinds of losses of pressure.

Adequacy of the mathematical model and algorithm is confirmed by computer experiment. In fig. 2 results of dynamic calculation of a brake drive and a drive of the elevating mechanism of the car-dumper are presented.

Transients at functioning hydraulic drives are speedy and are accompanied by high-frequency pulsations of pressure and significant control over, and instant value of pressure exceeds a threshold of adjustment of a safety valve. If not to consider dynamics of internal processes in a hydraulic drive it can lead to the false conclusion about a technical condition of a hydraulic drive. Not to admit possible wrong of diagnoses, transfer of characteristics of quality of transient to the system of automatic search of defects for updating of actions in case of discrepancy of entrance and target signals is stipulated.

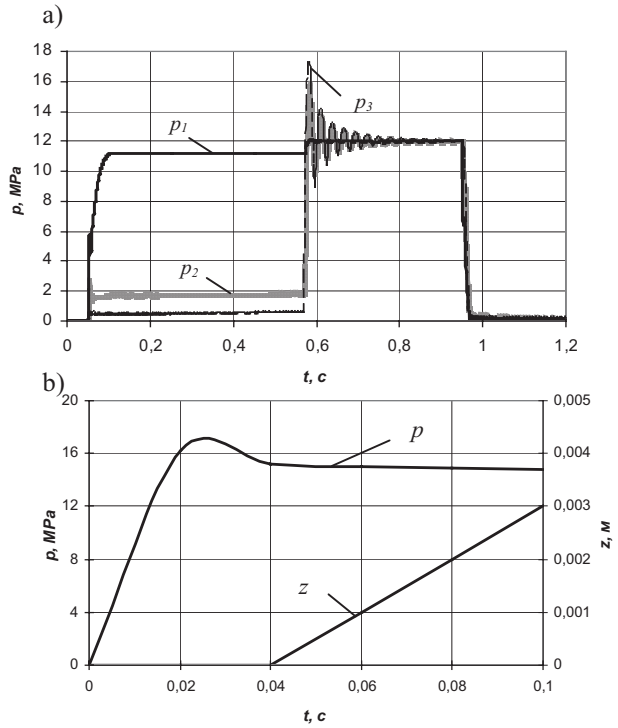

Fig. 2. Results of dynamic calculation:
a – a brake drive (p_1,p_2,p_3 – pressure accordingly on input of a contour, in a branching and in the actuating cylinders),b – the elevating mechanism (p – pressure ,z–moving platforms, t– time).

4. DIAGNOSING AND MAINTENANCE OF RELIABILITY OF HYDRAULIC DRIVES

Diagnosing of a hydraulic drive assumes obligatory check of conformity of pressure and of liquid consumption to demanded values for corresponding modes. Thus adjusting installations of units of system, streams of a working liquid through a safety valve and drainage system, and also vacuum an input of the pump are supervised.

Well-known, that results of diagnosing, the information received at this stage, should be used in the further for maintenance of working capacity and reliability of the system of the hydraulic drive. Experience has shown, that traditional use of progressive technological processes and high-quality materials by manufacturing the hydraulic devices, already given a new push to development in this area, has allowed at the same time to reveal the certain restrictions which cannot be overcome by only one improvement of technology and material resources. Prospects of overcoming of difficulties and the further development of hydraulic drives of machines are connected with the application of new approaches of structural maintenance of their reliability.

Structural maintenance of reliability of hydraulic drives of machines is carried out due to purposeful development or change of the block diagram of a hydraulic drive at a stage of its designing [4]. Its basic essence says that, so-called subsystems of maintenance of reliability, entered into structure of a hydraulic drive, carry out active influence on the parameters defining reliability.

The protection devices warning of possible failures are known. More often they switch off the system before elimination of the reasons of possible refusals. Such a way is the most comprehensive at operation concerning simple systems.

Generally management of the processes defining reliability of a hydraulic drive of machines and their elements can be realized on principles of indemnification of indignations or deviations of the parameters defining reliability. For such management it is necessary to have an opportunity of registration of deviations, the nobility of the characteristic of indignations and to compensate them (fig. 3).

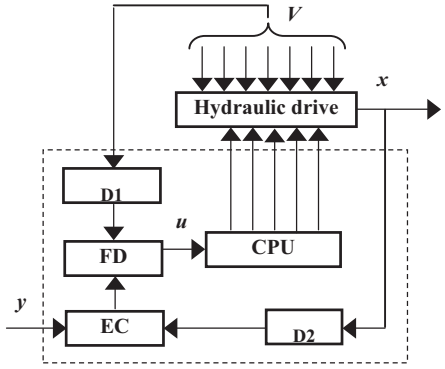

Fig. 3. The scheme of management of the processes defining reliability of a hydraulic drive

Indignations *V* influencing on a hydraulic drive are registered by sensitive element D_1 and act in formation device *FD.* The signal of a mismatch from an element of comparison *EC,* formed as a result of comparison of a deviation of adjustable size *x* (it is registered by sensitive element D_2) and the set coordinate *y* also come in FD. In *FD* operating influence *u*, getting in a power drive of control system *CPU* is developed. According to the acted signals the drive of a control system influences the certain element of a hydraulic drive, providing its normal functioning. Thus, in the given general scheme the complex of devices D_1, D_2, *EC, FD, CPU* represents providing subsystem which changes character of influence of indignations in the necessary direction and influences a course of processes in a hydraulic drive as a result of change of cycling of loadings, a mode of greasing, air-conditioning, inclusion of correcting parts, etc.

Antifriction functions of subsystems of maintenance of reliability are characteristic for all types of hydraulic drives. The cores from them – exception of hit of aggressive impurity in system of a hydraulic drive, creation of a greasing layer between cooperating elements, indemnification of deterioration and deformation, maintenance of demanded properties of a greasing liquid, reduction of specific pressure and speeds of influence.

For severe loading hydraulic drives the most typical functions of subsystems of maintenance of

reliability are unloading (indemnification of deformations, decrease in specific pressure, reduction of vibrations, etc.), and also maintenance of tightness of systems.

THE CONCLUSION

Technique and the algorithms of simulation of a hydraulic drive are applied as the software product for engineering calculations on mechanical engineering firms.

The offered conceptual positions and schemes of structural maintenance of reliability of hydraulic drives of machines are based on characteristic properties of hydraulic systems, results of diagnosing of their conditions and introduction of subsystems of active maintenance of reliability. Distinctive property of the specified subsystems is their ability automatically to support and if necessary to restore working functions of hydraulic drives during their long operation.

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D. Sc., **professor Vasily SHEVCHENKO** works as the main scientific employee managing sector of hydraulic drives of machines of Incorporated institute of mechanical engineering of the National Academy of sciences of Belarus. Area of scientific interests: mechanics, systems of drives, reliability of machines. The winner of the State premium in the field of a science and technic. Are the author more than 200 scientific works and inventions, including 7 monographies and manuals.

Prof., senior lecturer **Michael THILEVICH** works as the leading scientific employee of the Incorporated institute of mechanical engineering of the National Academy of sciences of Belarus. Area of scientific interests: diagnostics of hydraulic drives of machines, simulation of dynamic processes of hydraulic drives. He is the author more than 70 proceedings and inventions.

Prof., senior lecturer **Alexander KOROLKEVICH** works as the leading scientific employee of the Incorporated institute of mechanical engineering of the National Academy of sciences of Belarus. Area of scientific interests: methods of designing of hydraulic drives of machines. He is the author more than 100 proceedings and inventions.