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UZTE16M LOCOMOTIVE OIL SYSTEM AND REQUIREMENTS FOR DIESEL LOCOMOTIVE RELIABILITY AND OPERATING CONDITIONS

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Abstract: The crankshaft group (crankshaft, main and connecting rod bearings) is one of the most critical units of a diesel locomotive, which largely determines its service life, as well as reliability, timing, volume and cost of maintenance of the locomotive. During operation, diesel locomotives are subjected to traction-operational tests to identify the values of the main parameters and determine the optimum loading modes on different road sections. During the tests, a number of mechanical, electrical and other values are determined to judge the parameters of the locomotive, its assemblies and units, their operability and performance. It is important to determine the nature of changes in parameters and their scatter, as well as the error of measurements.

Keywords: Crankshaft group, during operation, oil system, thermal state, oil temperature, modernization, defect.

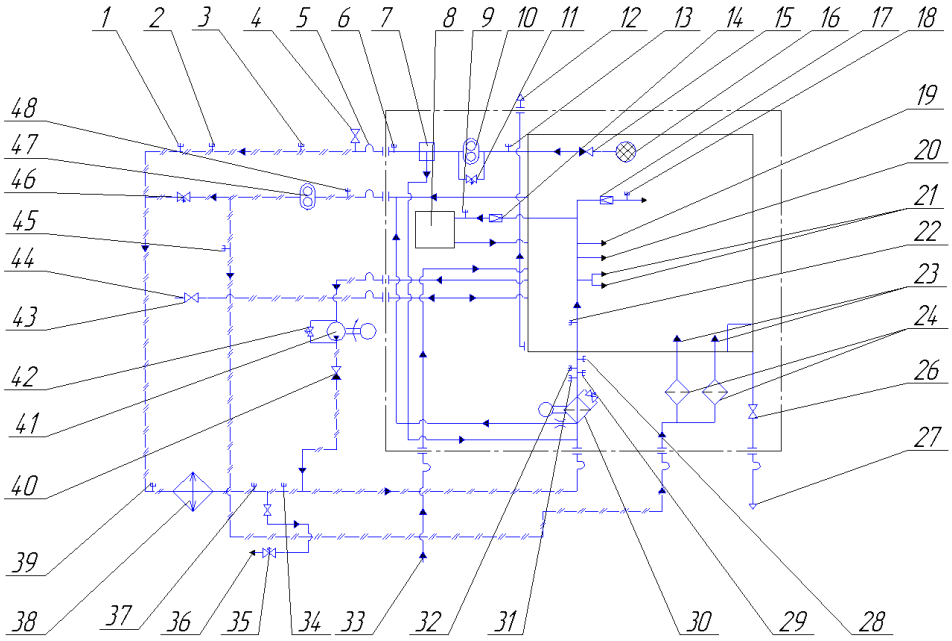
Introduction. The reliability level of diesel locomotives in operation directly affects the performance indicators of locomotive operations. To ensure train service in freight and passenger traffic on sections served by diesel locomotive traction, the locomotive department is entitled to maintain a specific optimal inventory of diesel locomotives. This inventory is determined by their turnover, calculated for the maximum number of days in the month with peak transportation volumes. The oil system ensures that oil is supplied in the right quantity and at the right temperature to lubricate and cool bearings, pistons and other rubbing parts. Oil system serves for cooling of diesel engine pistons and removal of heat generated by friction from lubricated units of the diesel engine and its units, as well as for removal of wear products from the working surfaces of rubbing units of the diesel engine. Let's consider the general device of the system on the example of diesel engine 1A-9DG (Fig. 1).

The efficiency of oil cooling of parts, which in turn depends on the specific heat flow through the crankshaft, the design features of the crankshaft, the temperature of the oil-cooled surface, and other factors, has a significant impact on the processes of formation and prevention of carbon deposits on the inner surface. Lowering the temperature of the inner surface of the crankshaft is, first and foremost, a reduction in the sensitivity of the engine to the anti-carbon deposit properties of the oil.

In the process of operation there is a constant replacement of defective parts of diesel engines with new or reconditioned ones due to increased wear of parts beyond tolerance. Thermal methods of diagnostics of crankshaft bearings of diesel engines without disassembly, in particular connecting rod liners, become especially important, as

the clearance in the connecting rod bearing without disassembly can be measured only by indirect signals. When the clearance increases, the impulse of bearing impact on the shaft journal increases, resulting in an increase in the energy of shaft vibrations, with these vibrations occurring at the natural frequencies of the impacting parts [1].

In turn, the units on which diesel engine reliability depends are: crankshaft, turbocharger, fuel equipment, air coolers, cylinder piston group and cooling system. In order to reduce the costs of inspections with fault finding it is necessary to use automated complex systems of inspections with the help of objective methods and modern technical means providing reduction of labour intensity and locomotive downtime for maintenance and repair. To increase the reliability of control, individual control over the condition of each locomotive should be established using objective methods and modern technical means to ensure that sufficient information is obtained.



1, 2 - fittings for sensors of electro thermometers; 3 - fittings for temperature sensor; 4 - valve for oil sampling; 5 - flexible connection; 6, 18, 22, 34, 45 - fittings for manometers; 7 - thermoregulator; 8 - turbocharger; 9, 13, 48 - fittings for manovacuummeters; 10 - oil pump; 11, 35, 46 - safety valves; 12 - drain pipe of leaked fuel and oil from the shelves of the block; 14, 17 - reducing valves; 15, 40 - check valves; 16 - oil intake with check valve; 19 - oil outlet for crankcase rarefaction control; 20 - oil outlet to limit boost regulator; 21 - oil outlet to air slam; 23 - oil drain from centrifugal filters; 24 - centrifugal filters; 26, 43 - valves; 27 - drainage of sludge from the tank in the frame (receiver blowing); 28, 29 - fittings for pressure sensors; 30 - fine oil filter (self-cleaning); 31, 32 - fittings for electro manometers; 33 - oil drainage from the hydraulic drive and gearbox; 36 - oil outlet on the hydraulic drive and gearbox; 37, 39 - fittings for mercury thermometers; 38 - water-oil cooler; 41 - oil pumping pump with electric drive; 44 - oil filling in the crankcase and oil drain from the diesel engine; 47 - pump for oil supply to centrifugal filters.

Figure 1. Oil system diagram

The requirements to the diesel engine oil system are in some cases mutually exclusive. For example, to improve the operation of bearings it is necessary to increase the oil pressure, but this leads to a sharp increase in resistance in the cooler, causes the need to strengthen its elements (tubes, partitions, etc.). To meet these requirements oil circulation circuits are separated. Each circuit is equipped with its own pump.

The diesel engine oil system consists of an internal and an external system. The internal lubrication system of diesel engines is a set of channels and tubes in the parts, providing oil supply to all rubbing parts. External systems provide circulation, cleaning and cooling of oil taken from the sump (crankcase) of the diesel engine and brought to the oil manifold. The external oil system consists of pumps, oil coolers, filters, control and safety devices. After passing through the external system, cleaned and cooled oil is fed to the oil manifold of the diesel engine, from which it goes through channels to the main and connecting rod bearings of the crankshaft. From the crank journals of the crankshaft oil through channels in the connecting rods is fed to lubricate the rubbing parts of the cylinder-bearing group and cooling of the pistons, as well as for lubrication of the bearings of the camshaft to the levers of the tappets of the timing mechanism, to the bearings of the turbocharger. After lubrication of parts and mechanisms, the oil is drained into the diesel sump. To reduce the oil pressure in the external system, two pumps can be used in series. In this way, a higher oil pressure is maintained in the diesel engine bearings without increasing it in the cooling devices and filters [2].

Methods. The objective parameter of bearing unit condition is temperature. Experiments have shown a sharp increase in temperature when liquid friction is disturbed. Deflections and displacements of shaft journals are also a factor reducing bearing capacity. The work of friction at mutual displacement of oil layers, transformed into heat, determines the temperature regime. The oil temperature can be determined directly in the oil layer. However, it is more often measured near the surface of the liner, taking into account that the temperature varies by 1...1.3°C/mm along its thickness. The crankshaft group (crankshaft, main and connecting rod bearings) is one of the most responsible units of diesel locomotive diesel engine, largely determining its resource, as well as reliability indicators, terms, volumes and cost of diesel locomotive maintenance. At the same time, despite intensive development of means and methods of non-disassembled diagnostics (including built-in and on-board), it is impossible to solve the problem of direct operational control of crankshaft bearings condition during locomotive operation. Sliding bearings operating in aggressive environment and located far from possible places of installation of vibration sensors exclude the possibility of using means and methods of vibration diagnostics. So far, the great expectations placed on the methods related to the control of the content of wear products of rubbing parts in the lubricating oil are not justified. The methods used on powerful marine diesel engines, based on direct control of oil flow through each bearing and its heating temperature, do not find application on diesel engines of land vehicles due to unacceptably high cost of diagnosis.

To increase the level of reliability of technical means it is necessary both to improve the design and to improve the system of their maintenance and repair. Locomotive facilities have a planned preventive maintenance and repair system. The system provides for types of maintenance and repair of locomotives and regulates volumes and inter-repair runs.

To determine crankshaft life, data on their failure was analyzed. The analysis showed that more than 80% of crankshafts are discarded due to cracks, fractures and cooling medium closure. The analysis of the research shows that the serviceability of connecting rod and main bearings depends on the quality of applied oil products, and the suitability of antifriction babbitt layer of bearing shells largely depend on the physical and chemical properties of applied oils. Operation of diesel locomotive diesel engines shows that almost 70 per cent of all liners on diesel locomotives fail due to fatigue damage (pitting) of babbitt casting caused by cyclic loading [3, 4].

And (&) Discussion fatigue resistance assessment.

In 2009, the diesel locomotive was modernized on the basis of the 2TE10M diesel locomotive with diesel engine replacement. During modernization, a D49 diesel engine was installed instead of the 10D100 diesel engine, and the locomotive was named UzTE16M. As a result, more than 100 diesel engines of UzTE16M diesel locomotives were modernized. In recent years, UzTE16M diesel locomotives had a number of crankshaft malfunctions during operation. The crankshaft failures are micro-cracks, cracks, nitride layer scoring and crank mechanism failure. During the research, a number of crankshaft problems are studied, and as a result, a new methodology for assessing the technical condition of diesel locomotives was introduced, after which the condition of the locomotive can be analyzed.

The operational efficiency of diesel locomotives is in no small measure determined by their reliability. Diesel generator set units require regular monitoring during operation to avoid unscheduled repairs and failures in the diesel locomotive diesel engine system. In the process of diesel locomotives operation there were repeated failures of diesel crankshaft, which resulted in high costs. According to the technological processes, surfacing and welding of the crankshaft is prohibited. As a result, the crankshaft is rejected. To preserve the reliability of diesel locomotives is the most important task of locomotive engineering. The study belongs to the field of temperature readings technology and can be used in the testing and diagnosis of the crankshaft of diesel locomotives. After carrying out these works on diagnostics it is possible to give a prognosis on separate assemblies and units of diesel generator set.

In railway transport, operation of locomotive diesel engines of locomotive devices in technically defective condition causes fuel overconsumption. The use of diagnostic methods in this process allows to determine the changes in the technical condition of thermal power units and fix them when planning the volume of repairs. Today's problems of the crankshaft of diesel engines D49, a number of diagnostic works have been carried out in the process of operation was found cracks in the area of crankshaft journals. According to the results of research observed problems in the crankshafts of

diesel engines D49 in the process of operation. During repair CR-3, OR-1, OR-2, ORP crankshafts of diesels are ground, as a result of which the thickness of connecting rod or main joints (gradation) is increased.

Once the levelling is complete, an insert suitable for the neck grading is selected. Modern locomotives are fitted with various protection systems, relays and contactors. D49 diesels have crankshaft protection: oil pressure and vibration protection. Oil pressure protection devices OPS-1, if the oil pressure is lower than 0,6-0,7 atm on the D49 diesel engine, it switches off the diesel engine. If the oil pressure drops by 1.1-1.2 atm OPS-2.

In positions 11-12 the diesel engine is unloaded, i.e. it is protected. If the oil temperature exceeds 85 degrees Celsius, the OTR removes the load. The diesel has a thermostat and if the oil temperature exceeds 60 degrees the thermostat opens a channel with the oil heat exchanger causing the oil to cool. Despite having guard's diesels have crankshaft problems.

Technology of problem solving. At both stages, the technology of problem solving is the same. The information received on the display from all sources for the period of locomotive operation between maintenance CR -3 is processed at least a day before the locomotive is scheduled for the next maintenance CR -3. The results of solving the task by subtasks of diagnosis and prognosis are transmitted to the driver's cab.

When using the diagnostic complex, the task is divided into the following subtasks:

Preliminary processing of input information. The subtask is designed to control critical values of parameters and prepare data for solving other subtasks. Control of critical values is performed to identify faulty locomotive assemblies. The control is performed according to the logical algorithm of state estimation.

Collection and accounting of initial data. The subtask is necessary to accumulate information for training of the diagnostic control system.

The information is collected and recorded in the accumulating matrix. The diagnostic matrix of initial parameters is a table built on the basis of lists of controlled assemblies and parameters. The list of controlled assemblies is made on the basis of repair rules, operating instructions and locomotive operating experience. The lists of controlled parameters are made in accordance with the capabilities of technical means of information-measuring systems and information on locomotive mileage and on the work performed on a given locomotive during previous maintenance and repairs on the controlled assemblies.

Technical diagnostics aimed at ensuring the required level of reliability and strength of such a complex object as a diesel locomotive engine involves conducting comprehensive analytical and numerical studies on the mathematical modeling of its components and parts. This comprehensive approach entails solving tasks related to assessing the stress-strain state, as well as investigating the operating modes of the diesel locomotive's crankshaft systems, while determining optimal operational regimes.

Conclusion. Diagnosis of technical condition. Recently, the method of thermal control and technical diagnostics of objects has become popular worldwide. The thermal

control diagnostics of locomotives provide the following parameters: values at specific points, various temperature indicators, temperature increases, and determination of malfunctions in diesel locomotive units. The subtask solves the issue of diagnosis of controlled assemblies for issuing recommendations on the scope of work for the upcoming maintenance or repair of the locomotive [5].

To solve the task of diagnosing the object of control means to establish the state of the object at the moment and, depending on the diagnosis, to give a conclusion. If faults are detected, indicate their addresses and determine the scope of work for the upcoming maintenance or repair depending on the level of failure, if there are no faults - give a forecast of failure-free operation until the next scheduled maintenance or repair. When making a diagnosis, a working matrix, identical to the accumulating matrix of outcomes, and input information are used. The working matrix, unlike the accumulating matrix of outcomes, is periodically adjusted.

Residual life forecast. The subtask allows to determine the residual life before repair of an assembly unit to establish the order of locomotive repair. The task of residual life determination is reduced to the usual task of function prediction by the extrapolation method using known parameter realizations. The forecasting uses a forecasting matrix and input information. The forecasting matrix is a table containing variable information for each locomotive.

When ensuring the required level of reliability and thermal strength of assemblies and parts of diesel locomotive diesel crankshaft, it is necessary to solve the following tasks:

- to determine the thermal state of the diesel engine crankshaft nodes and parts;
- determine their stress-strain state;
- to determine the durability of units and parts of the crankshaft of diesel locomotive diesel engine under repeated thermal loading.

In the processes of control and decision-making to ensure the required level of reliability and thermal durability of assemblies and parts of diesel locomotive diesel locomotive is of great importance various kinds of information about the state of the controlled system.

References

1. Chetvergov, V.A. Reliability of locomotives / V.A. Chetvergov, V.D. Puzankov. - Moscow: Marshrut, 2003. - 415 p.

2. Khamidov O. R., Kudratov, S. I., Turdimurodov, B. C. U., & Norbotayeva, M. C. Q. (2024, March). Improvement of diagnostics and analysis of malfunction of the crankshaft of locomotive power plants. In AIP Conference Proceedings (Vol. 3045, No. 1). AIP Publishing. https://doi.org/10.1063/5.0197416

3. Krivorudchenko V.F. Modern methods of technical diagnostics and non-destructive testing of parts and units of railway rolling stock: Textbook for universities of railway transport / R.A. Akhmedjanov, V.F. Krivorudchenko. - Moscow: Marshrut, 2005. - 436 p.

4. Roizenblit, G.B. Heat transfer in diesel engines. / G.B. Roizenblit. - Moscow: Mashinostroenie, 1977. - 216 p.

5. Nesteruk D.A. Thermal control and diagnostics. Textbook for training of specialists of I, II, III level. / D.A. Nesteruk, V.P. Vavilov. - Tomsk: 2007. - 104 p.

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