

Using the Self-Braking Method when the Post-Overhaul Diagnostics of Diesel-Hydraulic Locomotives

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Abstract

A large number of diesel-hydraulic locomotives are operated at industrial enterprises. Reliability of diesel locomotives in operation directly depends on the quality of the conducted acceptance testing of the hydro-transmission after repair. Test procedures presuppose running-in and testing the hydraulic transmission in all modes of its operation. Run-in time is established by normative and technical documentation. During the running-in, the technical condition of the hydraulic transmission is determined on the base of the control of input and output parameters (shafts speed, temperature and oil pressure).

The authors propose to improve the running-in process by introduction of tools and techniques of technical diagnostics. With this aim features of post-overhaul diagnostics of diesel-hydraulic locomotive were analyzed. The article deals with the diagnostics the condition of the mechanical part of the hydraulic transmission UGP (UHT- unified hydraulic transmission) 750/120 after a major overhaul. Choosing the diagnostic parameters of the mechanical part of the hydraulic transmission was carried out. We proposed to use free path (self-braking) mode to determine the mechanical losses at bench tests.

As the criteria, determining the technical state of the mechanical part of the diesel-hydraulic locomotive during the tests in the self-braking mode, the following values are proposed: run-down time of shafts; change in the braking torque and the power of mechanical losses depending on the angular velocity. Diagnostics of the hydraulic transmission according to the above criteria allows reducing the time of receive/running-in tests and significantly increasing the technical condition accuracy and characteristics of the technical condition.

KEY WORDS *diesel locomotive, hydrodynamic power transmission, diagnostics, technical condition, mechanical losses, self-braking mode, run-down mode*

1. Introduction

A large number of diesel-hydraulic locomotives are operated at industrial enterprises. Also the railways use a rolling stock, in which the hydraulic transmission is used as the main power transmission. They are diesel trains, rail buses, rail trolleys and railcars. Operational reliability of traction rolling stock directly depends on the quality of the conducted hydro-transmission receive/running-in tests of hydraulic transmission after repair. The test procedure for hydraulic transmission is established by normative documents [16]. Condition monitoring of hydraulic transmission after major overhaul presuppose running-in and testing of hydraulic transmission in all modes of its operation. Post-repair tests are carried out with the aim of running-in the hydraulic transmission nodes and verifying the compliance of technical characteristics that correspond to the values regulated by normative and technical documentation.

2. Analysis of Research and Publications

The papers of both Ukrainian and foreign scientists are devoted to improving the tests of diesel locomotives with hydraulic transmission. Almost all of them are related to optimization of diagnostic features and are aimed at increasing the level of automation of the diagnosing hydraulic transmissions, the accuracy of measuring parameters, the possibility of their analysis and long-term storage.

Typical benches are used for testing hydraulic transmissions. Principles of constructing test benches were developed in the late 70's and early 80's [7-9, 16]. At present, bench modernization provides the following directions: improving the system of drive and loading machines and mechanisms [5 - 6], increasing the energy efficiency of the testing process [2], introduction of information-measuring systems and diagnostic devices into the testing process [1, 3-4, 15].

One of the problems, which arise when testing hydraulic transmissions of diesel locomotives and other heavy vehicles in the entire range of passport loads, is the need to use special high-power equipment for the drive of input shaft. This leads to high energy consumption and increased costs for testing. The problem can be solved using energy recovery means [2]. Another way is to use mathematical and simulation models to determine the parameters of hydraulic transmissions when it operates in a range of small loads. The results of theoretical and experimental studies of determining the technical condition of hydraulic transmissions in the process of testing are presented in the works

On the basis of inertia moment values obtained as a result of investigations [7], the expression for determining the braking torque in accordance with formulas (6) and (7) can be represented in the form:

$$M_r = 11,832 \frac{dn_{21}}{dt}. \quad (9)$$

After curve transformation in Fig. 2 and expressions (8) and (9) using the chord method, the dependence of the braking torque value on the angular velocity shown in Fig. 3, and the curve of change in the power of mechanical losses – Fig. 4 were obtained.

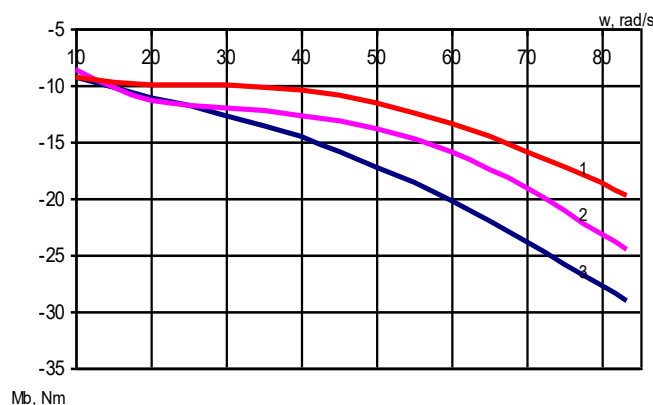


Fig. 3 Dependence graph of braking torque M_b on the angular velocity of the turbine shaft rotation: 1 - at the oil temperature of 51°C; 2 - at the oil temperature of 68°C; 3 - at the oil temperature of 80°C

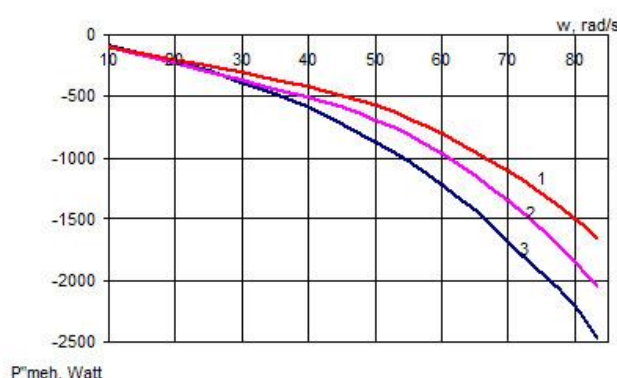


Fig. 4 Dependence graph of mechanical losses power for hydraulic transmission on the angular speed of turbine wheels: 1 - at the oil temperature of 51°C; 2 - at the oil temperature of 68°C; 3 - at the oil temperature of 80°C

6. Originality and Practical Value

As diagnostic parameters determining technical condition of mechanical part for hydraulic transmission of the locomotive when testing in the self-braking mode, we propose such parameters as the time of shaft running-out, dependence of braking torque and power of mechanical losses on the angular velocity. Diagnosis of hydraulic transmission according to the above criteria makes it possible to reduce the time of acceptance tests. The accuracy of determining the technical state of hydraulic transmission under conditions of limited or insufficient power of drive motor is also significantly improved. The obtained experimental curves can be used to estimate the value of mechanical losses in hydraulic transmission in further studies.

7. Conclusions

The methodology, which allows estimating general technical condition of mechanical part for hydraulic transmission after major repair is offered. To determine certain location and type of failure and evaluate the failures impact in hydraulic transmission units for the time of main shaft running-out, change in braking torque and the power of mechanical losses, it is necessary to carry out further experimental and theoretical studies.

References

1. Bodnar, B.; Ochkasov, A.; Bobyr D. 2016. Improving Operation and Maintenance of Locomotives of Ukrainian Railways, Technologijos ir Menas = Technology and Art 7: 109-114.
2. Bodnar, B.E.; Kapitsa, M.I.; Ochkasov, O.B.; Korenyuk, R.O. 2015. Energy efficiency of diesel locomotive hydraulic transmission tests at locomotive repair plant, Science and Transport Progress 6(60): 16-24. doi: 10.15802/stp2015/57000
3. Zhukovytsky, I.; Kliushnyk, I. 2017. Choice of the Optimal Parameters of Measuring the Shaft Rotation Frequency of the Hydraulic Transmission of the Locomotive Using Microcontroller, Science and Transport Progress 2(68): 36-45. doi: 10.15802/stp2017/99945
4. Zhukovytsky, I.V.; Kliushnyk, I.A.; Ochkasov, O.B.; Korenyuk, R.O. 2015. Information-measuring test system of diesel locomotive hydraulic transmissions, Science and Transport Progress 5(59): 53-65. doi: 10.15802/stp2015/53159
5. Stand for testing of unified hydro transmission UHT 230 [online cit.: 2018-06-22]. Available at: <http://inovcom.ru/catalog/stendy/stend-dlya-ispytaniya-unifitsirovannoy-gidroperedachi-ugp-230> (in Russian)
6. Stand for testing and running-in of hydrotransmission. Ltd. Scientific and Technical Center "Technical Diagnostics

- and Precision Measurements". [online cit.: 2018-06-22]. Available at: <http://www.diag-meas.ru/stendgt.html> (in Russian).
7. **Bodnar, B.E.** 1987. Perfection of methods for testing and diagnostics of diesel locomotives with hydrodynamic transmission: Ph.D. thesis in Engineering Science. Dnepropetrovsk, 213 p. (in Russian).
 8. **Ovchinnikov, V.M.; Halimanchik, V.A.; Nevzorov, V.V.** 2006. Hydraulic transmission of diesel locomotives: Textbook. Ministry of Education of the Republic of Belarus, "BelGUT". Gomel, 155 p. (in Russian).
 9. **Bodnar, B.E.; Nechaev, Ye.G.; Bobir, D.V.** 2010. Theory and construction of locomotives. Fundamentals of designing. Dnipropetrovsk: PE "Lira LTD", 358 p. (in Ukrainian).
 10. **Soloviev, V.M.** 2013. Experimental determination of torque converter parameters in conditions of low-power drive motor, Eastern European Journal of Enterprise Technologies 5(8): 39-45. (in Russian).
 11. **Veretennikov, A.I. [et al.]** 2010. The mathematical model of the operating process of the torque convertor, Integrated Technologies and Energy Saving 3: 50-56. (in Russian).
 12. **Osipov, A.V.; Kruchek, V.A.; Kurilkin D.N.** 2012. Torque convertor operation of hydraulic transmission of an industrial locomotive in transient processes and unsteady operating modes, Proceedings of Petersburg Transport University 2: 37-46. (in Russian).
 13. **Timukhin, S.A.; Molchanov, M.V.; Dolgikh, D.S.** 2015. The method of pressure loss indirect detection in turbine setting of design turbomachine, Mining Informational and Analytical Bulletin 6: 164-168. (in Russian).
 14. **Osipov, A.V.** 2011. Calculation of energy losses in the traction drive elements of a diesel locomotive with hydrotransmission, Proceedings of Petersburg Transport University 3: 211-217. (in Russian).
 15. **Zhukovyts'kyi, I.; Kliushnyk, I.** 2018. Development of a Self-Diagnostics Subsystem of the Information-Measuring System Using Anfis Controllers. Eastern European Journal of Enterprise Technologies 1/9(91): 11-19. doi: 10.15587/1729-4061.2018.123591
 16. GOST 25941-83. (2003). Electric rotating machines. Methods for determining the loss and efficiency. Moscow: Publishing House of Standards, 29 p. (in Russian).
 17. GOST 17069-71. 1971. The hydrodynamic transmissions. Methods of bench tests. Moscow: Publishing House of Standards, 13 p. (in Russian).