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UNDERWATER VEHICLE THRUSTER PARAMETERS EVALUATION BASED ON MOTOR LOAD TESTS

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The article considers the simulation dynamic model of an underwater vehicle thruster. The model is designed to determine thruster operational characteristics based on the results of load tests, a given control code, and the measured rotational speed of the propeller shaft. It is based on the calculation of the torque by a known motor shaft rotation frequency in the steady-state mode of a vehicle movement at a constant speed. Thruster torque and force are calculated using a mathematical model. It is based on the results of load tests of electric motor and analytical expressions for the propeller efficiency curves. The results of the parameters identification of the motor mathematical model are presented. They are obtained by analyzing the family of experimental mechanical characteristics, taking into account the control codes range and the dependence of the propeller torque on the rotational and incoming flow speed. An error estimation of the model calculation in comparison with the results of load tests is given. The results of computational experiments are used to determine the parameters of the AUV MMT-300 propulsion system developed by the IMTP FEB RAS. In the future, the proposed model allows relative pitch, the speed of the oncoming flow, and the positional hydrodynamic characteristics of the underwater vehicle to be determined.

Keywords: thrust, thruster torque, motor load tests, propeller advance ratio, propeller efficiency curves, incoming flow velocity

References

1. Ageev M.D., Kasatkin B.A., Kiselev L.V. et al. Avtomaticheskie podvodnye apparaty. L.: Sudostroenie, 1981. 223 p.

2. Bozhenov Ju.A., Borkov A.P., Gavrilov V.M.et al. Samohodnye neobitaemye podvodnye apparaty ed. I.B. Ikonnikova. L.: Sudostroenie, 1986. 264 p.

3. Blidberg D. R. The development of autonomous underwater vehicles (AUV); a brief summary. Ieee Icra. 2001. Vol. 4. P. 1–12.

4. The technology and applications of autonomous underwater vehicles (Ocean Science and Technology, 2). Vol. 2. / Griffiths G. (ed.) Abingdon, UK: Taylor & Francis, 2003. 360 p.

5. Ageev M.D., Kiselev L.V., Matvienko Ju.V. et al. Avtonomnye podvodnye roboty: sistemy i tehnologii ed. M.D. Ageeva. M.: Nauka, 2005. 223 p.

6. Vojtov D.V. Avtonomnye neobitaemye podvodnye apparaty. M.: Morkniga, 2015. 332 p.

7. Inzartsev A.V., Kiselev L.V., Kostenko V.V., Matvienko Yu.V., Pavin A.M., Shcherbatyuk A.F. Underwater robotic systems: systems, technologies, applications ed. L.V. Kiselev; IMTP FEB RAS. Vladivostok, 2018. 368 p.

8. Kostenko V.V., Tolstonogov A.Yu. AUV Thrust Allocation with Variable Constraints. ADV. Syst. SciAppl. 2017. No. 3. P. 1–8. – http://ijassa.ipu.ru/ojs/ijassa/article/view/502.

9. Kostenko V.V., Tolstonogov A.Ju. Zadacha dekompozicii upravlenija dvizheniem ANPA s uchetom izmenjajushhihsja ogranichenij marshevyh dvizhitelej. Izvestija JuFU. Tehnicheskie nauki. 2019. No. 1 (203). P. 199–211.

10. Vojtkunskij Ja.I., Pershic R.Ja., Titov I.A. Spravochnik po teorii korablja. L.: Sudpromgiz, 1960. 688 p.

11. Basin A.M., Miniovich I.Ja. Teorija i raschet grebnyh vintov. L.: Sudostroenie, 1963. 766 p.

12. Gofman A.D. Dvizhitel'no-rulevoj kompleks i manevrirovanie sudna: spravochnik. L.: Sudostroenie, 1988. 360 p.

13. Slizhevskij N.B., Korol' Ju.M., Sokolik M.G. Gidrodinamicheskij raschet samohodnyh podvodnyh apparatov: ucheb. posobie. Nikolaev: UGMTU, 2000. 93 p.

14. Kostenko V.V., Mokeeva I.G., Najdenko N.A., Tolstonogov A.Ju. Issledovanie metodov upravlenija tjagoj marshevyh dvizhitelej NPA. Izvestija JuFU. Tehnicheskie nauki. – 2020. No. 1(211). P. 108–118.

15. Tehnicheskie harakteristiki beskollektornyh dvigatelej beskorpusnogo ispolnenija. – URL: https://npo-at.com/production/beskollektornyj-dvigatel-2/ (Last request:18.04.2022).

16. Daidola J.C, Johnson F.M. Propeller Selection and Optimization Program. Manual for the Society of Naval Architects and Marine. NY.: Society of Naval Architects and Marine, 1992. 258 p.

17. Evstegneeva A.S. Ispol'zovanie komp'juternoj programmy Advanced Grapher kak sredstvo realizacii principa nagljadnosti v processe obuchenija matematike. Molodoj uchenyj. 2018. No. 2. P. 108–112.

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