
Optimum vertical ascent of an electric multicopter

© S.Z. Sverdlov

Vologda State University, Vologda, 160000, Russia

We consider the problem of a vertical climb that minimises battery power consumption. We obtained equations for the velocities of optimum and quasi-optimum ascent along with an equation for computing aircraft thrust-to-weight ratio that ensures optimum ascent. We studied the effect that varying the electric motor energy conversion efficiency had on optimum ascent computations. We derived an equation for estimating the electric motor energy conversion efficiency in aircraft hover mode. The article presents propeller aerodynamic parameters required for determining the optimum ascent.

Keywords: multi-rotor unmanned electric helicopter, multicopter, optimum vertical ascent, energy conversion efficiency, specific power consumption, thrust-to-weight ratio, aircraft power plant, brushless electric motor.

REFERENCES

- [1] Landing Products Inc. *APC Propeller Performance Data*. Available at: <http://www.apcprop.com/Articles.asp?ID=270>
- [2] Brandt J.B., Selig M.S. *Propeller Performance Data at Low Reynolds Numbers. 49th AIAA Aerospace Sciences Meeting*, Orlando, 2011.
- [3] Brandt J.B., Deters R.W., Ananda G.K., Selig M.S. *UIUC Propeller Database, University of Illinois at Urbana-Champaign*. Available at: <http://m-selig.ae.illinois.edu/props/propDB.html>
- [4] Pritsker D.M., Sakharov G.I. *Aerodinamika [Aerodynamics]*. Moscow, Mashinostroenie Publ., 1968.
- [5] Obukhovskiy A.D. *Aerodinamika vozdushnogo vinta [Propeller aerodynamics]*. Novosibirsk, Novosibirsk State Technical University Publ., 2009, 80 p.
- [6] *Spravochnik aviakonstruktora [Aircraft designer handbook]. Vol. 1: Aerodinamika samoleta [Airplane aerodynamics]*. Moscow, TsAGI (Central Aerohydrodynamic Institute) Publ., 1937, 512 p.
- [7] Sverdlov S. *Kvadrolet [Quadcopter]*. Available at: <http://forum.rcdesign.ru/blogs/174358/blog18011.html>
- [8] Sverdlov S.Z. *Mekhatronika, avtomatizatsiya, upravlenie — Mechatronics, Automation, Control*, 2016, vol. 17, no. 6, pp. 425–432.
- [9] Ovchinnikov I.E. *Ventilnye elektricheskie dvigateli i privod na ikh osnove (malaya i srednyaya moshchnost) [AC converter-fed motors and drives based on them (low and medium power)]*. Saint Petersburg, Korona-Vek Publ., 2006, 336 p.

Sverdlov S.Z., Cand. Sci. (Eng.), Professor, Department of Applied Mathematics, Vologda State University. Specializes in information technology, digital photography and image processing, unmanned helicopters. e-mail: c3c@uni-vologda.ac.ru
