Maximizing the Energy Output of an Axial Flux Permanent Magnet Generator for a Small Wind Energy Application

Hendrik Vansompel

Supervisor(s): Luc Dupré, Peter Sergeant

I. Introduction

Recently, interest in small-scale wind power applications increased. Direct drive generators are usually used instead of conventional generators combined with a reduction gear, because of the reduced number of construction elements and the lower maintenance costs. These direct driven generators are characterized by high torques at low speeds. Moreover, the shaft speed is not fixed due to the variable wind speed. Therefore, when evaluating the performance of the generator, the annual year electric energy output is taken into account instead of the power output at fixed speed.

II. Axial Flux Permanent Magnet Generator

The high torques at low speeds require custom machines. The axial flux permanent magnet synchronous generator (AFPMSG) (Fig. 1) has a high torque to volume ratio and may therefore be appropriate for direct driven wind energy applications [1]. The number of pole pairs is chosen high to obtain a sufficient frequency at low speeds.

In this research, the emphasis is placed on the efficiency of the machine. Therefore, several measures are proposed and evaluated to improve efficiency of the machine i.e. concentrated windings to reduce the copper losses, grain oriented material in the stator teeth to reduce iron losses, segmented permanent magnets to reduce the eddy current losses in the magnets, obtaining a high winding factor by using a custom combination of the individual stator coils,...

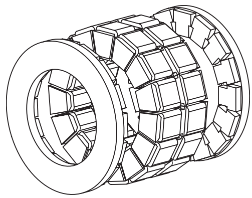

Figure 1. The axial flux permanent magnet synchronous generator (AFPMSG)

To perform simulations and parameter optimizations, analytical as well as finite elements models (FEM) are used. As the axial flux machine has a 3D structure, 3D FEM should be used. However, a good approximation is obtained by using a multilayer 2D model of which the calculation time is much shorter than a full 3D FEM. Afterwards, the simulated results are compared with measurements performed on a prototype machine.

III. Conclusion

By optimizing the geometry of the AFPMSM and introducing some measures to reduce the losses, a high efficient generator for a small-scale wind energy application is obtained with an efficiency of more than 95%.

References

[1] T. F. Chan, and L. L. Lai, “An Axial-Flux Permanent-Magnet Synchronous Generator for a Direct-Coupled Wind-Turbine System,” *IEEE Trans. Energy Convers.*, Vol. 22, No. 1, pp. 86-94, Mar. 2007.

H. Vansompel is with the Department of Electrical Energy, Systems & Automation (EESA). E-mail: Hendrik.Vansompel@UGent.be .