

Improved connection of permanent magnets

Electromagnetic – structural simulation of axial flux generators for wind turbines



Fig. 1: Axial flux machine as generator integrated in a wind turbine.

Task

Direct drives, as a generator in use, are characterized by providing the electrical energy without additional mechanical transmission required. Simpler, more compact designs with fewer mechanical components and thus greater robustness are the resulting significant benefits.

DDIS's innovation lies in the development of axial flow machines. Compared to conventional generators with radial electromagnetic flux more compact systems or systems with a much higher power density are possible.

Permanent magnets are integrated in these systems as central components. Due to the present electromagnetic behavior, these elements are exposed to high structural loads. With this analysis, the electromagnetic force effect at different operating conditions was to be determined and evaluated. Different proposals of design changes designs should be investigated as well in order to improve the reliability of the electrical machine.

Contact:

Dr.-Ing. Jürgen Wibbeler
 P +49 (0) 30 – 47 59 666 - 21
 jwibbeler@cadfem.de

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Solution

The analysis of the electromagnetic fields within the axial flux generator was set up in ANSYS Maxwell. Based on the transient motion of the system, magnetic field distributions arise as a function of the angle of rotation, which are fundamental for the determination of the electromagnetic forces.

To determine the structural mechanical stresses of the rotor and stator components, a nonlinear FEM simulation with ANSYS Mechanical was performed. The load transfer from the electromagnetic analysis to the static structural analysis took place via direct coupling of the two analysis systems within ANSYS Workbench.

Various design variants and connection mechanisms have been investigated during this project. Suggestions for improving the reliability and fatigue life could be worked out.

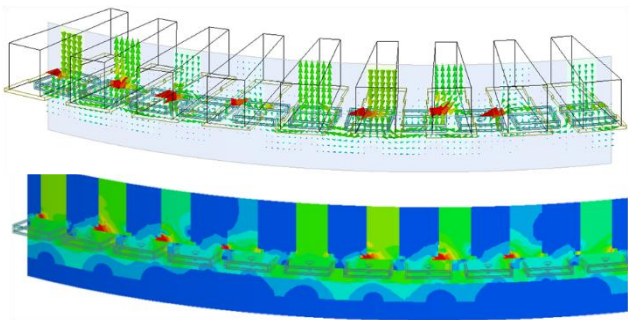


Fig. 2: exemplary electromagnetic field distributions of the axial flux generator under investigation.

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About CADFEM

Founded in 1985, CADFEM provides everything that is required for the success of the simulation from a single source:
First-class software and complete, ready-to-use systems;

Customer Benefit

The simulations provide essential insights into the interaction between electromagnetic and structural magnetic behavior for the further development of the generator:

- Insight into the implementation of mechanical power into electromagnetic power and vice versa.
- Identification of the relevant parameters with regard to reliability and fatigue life of the connection of the permanent magnets.
- Proposal of a structurally best possible design of the permanent magnets connection.

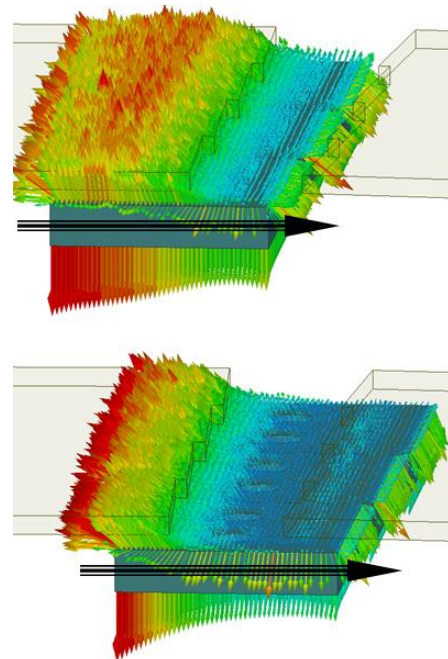


Fig. 3: Transfer of the electromagnetic forces from the electromagnetic analysis into the structural model – force densities for different rotor positions.

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