Karlsruhe Institute of Technology

KIT - Mobility Systems Center

Elektrotechnisches Institut (ETI)

Electromagnetic Design of Electrical Machines as Traction Motors

Requirements for electrical traction machines

The electrical machine is one of the key components in electrical traction technology. Although the motor is less expensive than the battery, its production cost must be further reduced. Additional improvements must be made to reach development goals like efficiency, noise and reliability.

Our HEV Electromagnetic Design group analyses and optimises the performance of the electrical machines. A number of concepts and machine types, (e.g. asynchronous machines, synchronous machines and transverse flux machines) are examined and improved to meet the above mentioned requirements and desired dynamics for different vehicles.

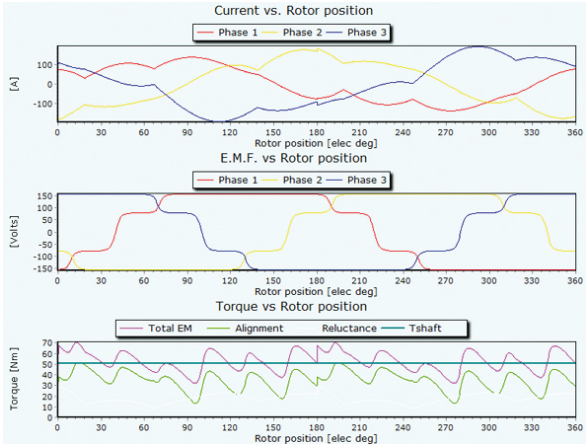
Calculation of electrical machines

During the design process, the electrical machines are modeled and their performances are then analyzed using a series of methodologies.

Analytical calculation using SPEED

Using formulas of machine theory, the performance of electrical machines can be analyzed quickly.

Although this method lacks of accuracy, it delivers acceptable results almost simultaneously. These results can be used during the first design process phase to determine the correlation between the performance of the machine and certain design parameters.

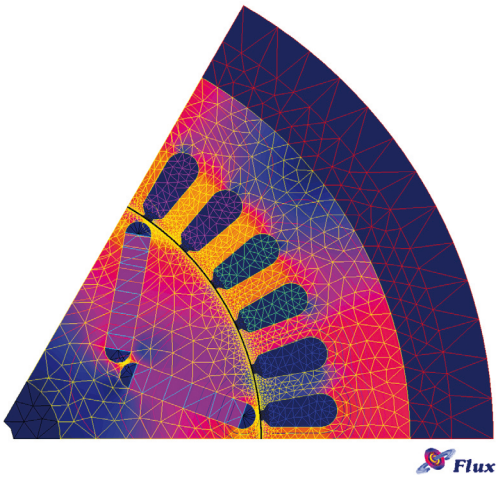


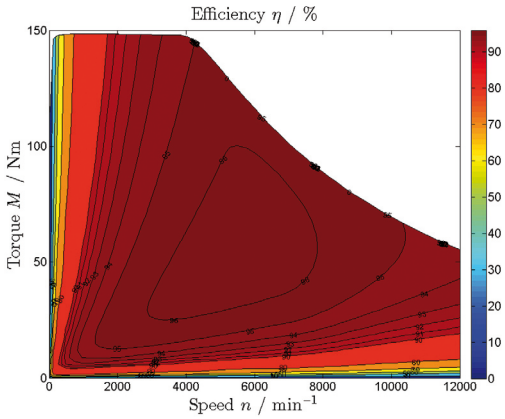
Finite element simulation using Flux2D

Using the finite element method (FEM), the machine can be analyzed in greater detail and with a high accuracy.

Effects like saturation, non-linear iron losses, harmonic waves, demagnetization of the permanent magnet etc. can be taken into account.

By means of this method, the geometric design can be optimized and the proper materials can be chosen to reach the design goals.





Analysis using self-developed tools

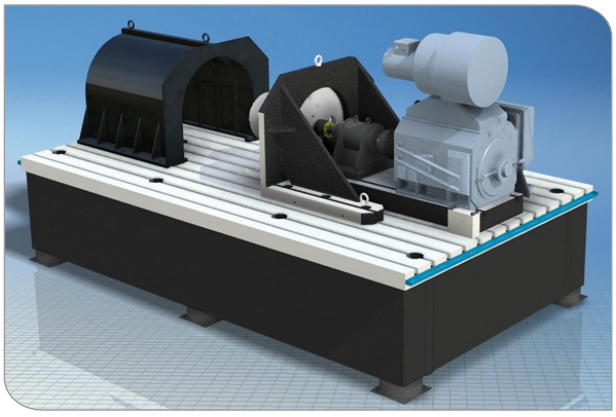
Using the results of the FEM analysis, our in-house developed Matlab programs can visualize machine behavior like efficiency and determine the optimal machine control.

Beyond that, the precision of the finite element method and the quickness of the analytical calculation can be combined to optimize the machine geometry numerically.

Examining the electrical machines on test bench (Campus Ost)

To validate the simulated electrical machines, prototypes will be built and measured on test benches. Test sequences (steady-state, driving cycles etc.) can be programmed without restrictions thanks to our self-developed power and control electronics.

Furthermore, new materials like SMC (soft magnetic composites) will be examined and evaluated for application in electrical machines.



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Elektrotechnisches Institut (ETI) - Hybrid Electric Vehicles

HEV Hybrid Electric Vehicles

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