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# Selected Problems of Optimization of a Switched Reluctance Motor for an Electric Vehicle using Analytical Calculations

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## Key words

Switched reluctance motor (SRM), electric vehicle, optimization, analytical model.

## 1. Introduction

There are several drawbacks when applying switched reluctance motors – torque ripples, small efficiency at high velocity and acoustic noise, which decide about its competitiveness in comparison with other types of electric motors (i.e. induction motor), especially in electric car drive applications. The great advantage is a simple construction and a high reliability. The paper describes a procedure to develop a 6/4 type SRM with the best performances. Some information related to this construction presented in an earlier paper [1] has been taken into account.
A gradient optimization procedure has been employed to improve performances of the SRM. The procedure uses a modified version of the analytical model of the SRM described in [2]. The improved model enables estimation in the steady state operation of not only efficiency and torque ripples, but also acoustic noise, and furthermore – takes into account the magnetic non-linearity. The model does not take into account mutual inductances and their influence on optimization results. A simplified solution of the problem has been proposed in the paper. Calculations were performed in MATLAB environment. The solutions were verified by means of FEM analysis.
The analytical model of the SRM is described in the first part of the paper. The problem of neglecting mutual inductances in modelling is discussed. Some results of an optimization approach are presented as well.

## 2. Optimization calculations

Two examples of scalar optimization calculations have been performed to test the analytical model. The goal of the first task was minimal value of the torque ripples. The goal of the second task was maximal value of the motor efficiency. Geometrical parameters and parameters of the winding have been assumed to be the 11 optimization variables. Some results of the first task of optimization – minimization of the torque ripples – are presented on Fig. 1.

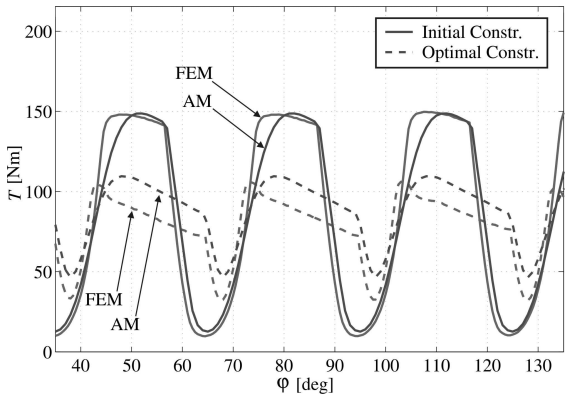


Fig. 1. Functions of the electromagnetic torque obtained with the help of an analytical model (AM), and finite element simulations (FEM), for the initial construction and the optimal one – minimization of the torque ripples.

## 3. Conclusions

The proposed analytical model enables an estimation of the functions necessary in the designing procedure, such as the electromagnetic torque, efficiency and magnetic noise. The model has a feature, which enables its application in an optimization approach with the help of a gradient optimization routine. Analytical solutions are not as accurate as those obtained with the help of FEM, but the calculation time is much lower, and the results are reasonable. It enables a more advanced investigation based on optimization results in the same time. A less accuracy is a reason that results obtained by means of the analytical model should be verified by means of FEM calculations.

## References

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