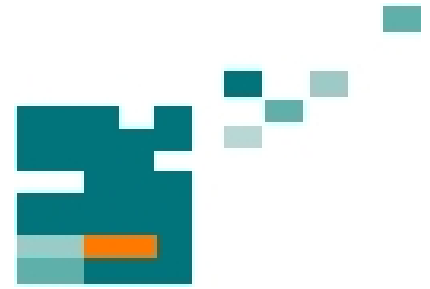


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Transient FEM simulation of commutator motors

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ABSTRACT

Modern numerical field computation software are useful tools for the development and optimisation of electrical machines. The magnetostatic calculation of the magnetic circuit with the finite element method (FEM) is today state of the art. Apart from this the transient FEM is a relatively new method for the simulation of electrical drives.

The following article is concerned with the application of the transient FEM to commutator motors. Therefore an existing permanent-magnet DC motor and a commutator series AC motor were modelled. A further aspect in the presentation is the realistic simulation of the mechanical commutation system. The computed motor characteristics are finally evaluated with the aid of measurement results.

1. INTRODUCTION

For the design and optimization of electrical machines numerical field computation programs based on the finite element method are useful and proved tools. The magneto-static calculation of the magnetic circuit is today state of the art. Thanks to the development of software and advances in computing technology a new method for simulation of electrical drives is available. The present article deals with the working principle and application of the transient FEM for the calculation of commutator motors. During the lecture, the possibilities and current limitations of the method are analyzed.

2. ANALYSED COMMUTATOR MOTORS

Two fractional horse power drives were modeled and calculated to assess the applicability and accuracy of the transient FEM. The first example in Figure 1 is a permanent magnet DC motor for the low voltages. In the second model (see Figure 2) a commutator series AC motor is simulated.

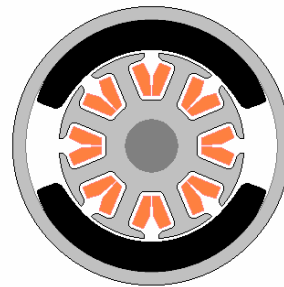
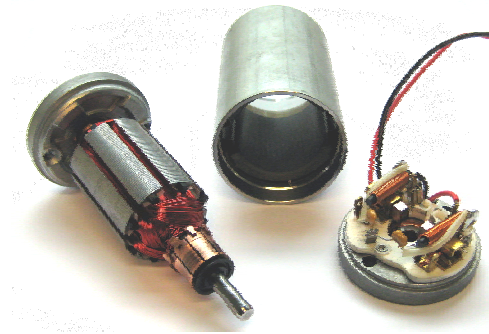


Figure 1 disassembled permanent-magnet DC motor and sketch of cross section

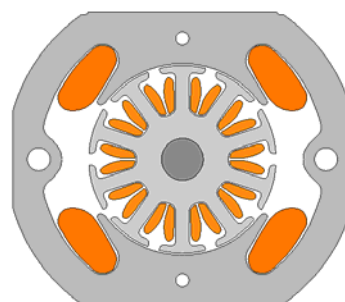
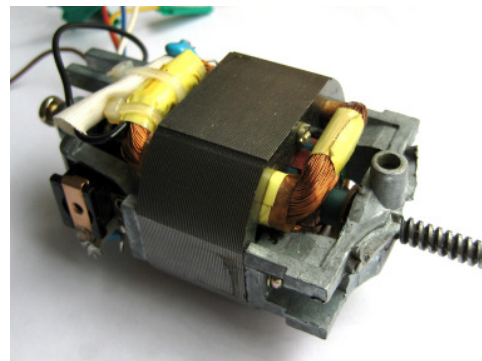


Figure 2 commutator series motor for AC current (universal motor) with cross-section

3. ASSESSMENT OF THE SIMULATIONS RESULTS

Based on measurement results the simulation is evaluated. The Figure 3 shows a comparison of the motor currents for the PMDC motor with characteristic ripples. After adjustment of the contact system parameters a good correlation between current and torque curves could be achieved. The required parameters for describing the transition brush-commutator were determined on a direct measurement on the mechanical contact system.

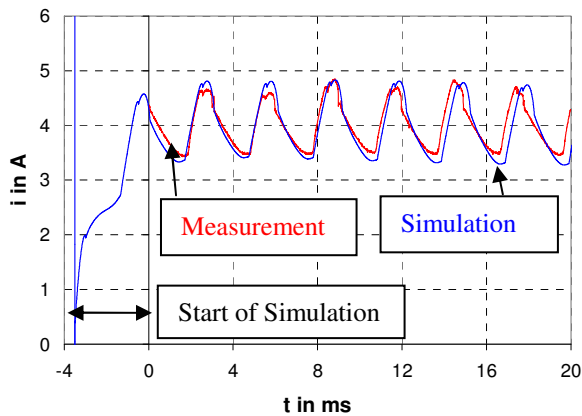


Figure 3 Comparison of the motor current from the measurement and transient 2D FEM for the PMDC motor

The Figure 4 shows the simulation and measurement results for the series motor. The comparison results in a good match to the areas around the vertices of the motor voltage and the corresponding current. These deviations can be explained by the fact that in the simulation an ideal sine wave form of the terminal voltage was applied. The power supply during measurement provides a distorted sine wave.

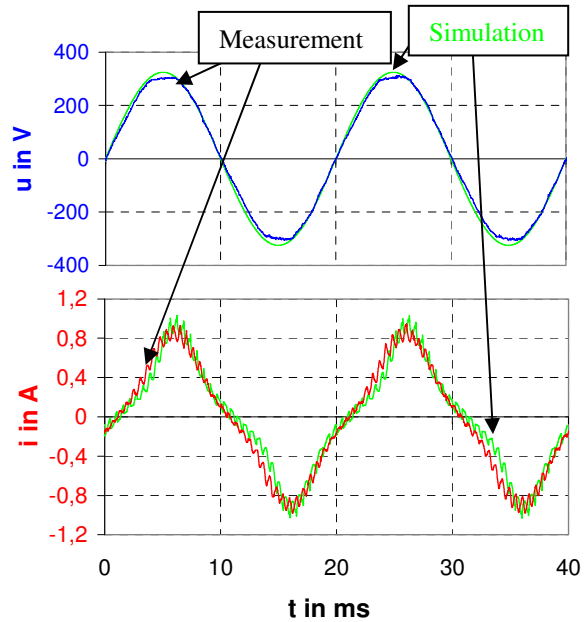


Figure 4 Comparison of measured and calculated motor currents and voltages for the commutator series motor

4. SUMMARY

The good correlation between simulation and measurement results shows the way to lift the modeling of commutator motors to a new level. This provides new opportunities to advance computation and optimization. The typical development with many measurements and experiments can be supplemented with simulation results. Therefore the knowledge of the material data and the exact behavior of the contact system are necessary for realistic simulation models. Additionally the mapping of motors with different axial stator and rotor length in a 2D FEM model requires a modification of the material parameters.

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