Distributions of flux and electromagnetic force in induction motors: A finite element approach

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Abstract: This paper explains the numerical modelling of magnetic field for a squirrel-cage induction motor fed by various voltage sources. The aim of the work is to gain an insight of the flux and magnetic force distributions through the cross-sectional area of an induction motor. A two-dimensional nonlinear time-stepping finite element method (FEM) is used for electromagnetic field approximation in the motor operating with full-load steady-state rotor revolution. To solve this time-dependent problem, numerical backward-difference integration is applied. Due to the saturation characteristic of the magnetic materials, the combined Newton-Raphson (N-R) and bi-conjugate gradient (BCG) method is employed to handle the nonlinearity, and to solve the linearized equations. Extensive computation was conducted against a three-phase, four-pole, 5-hp, squirrel-cage induction motor with double layer winding fed by three different sources to assess our modelling and computing approaches. Our computing task was divided into three cases according to motor's excitations: i) a purely sinusoidal source, ii) a PWM voltage- source-inverter (VSI), and iii) a six-step VSI. Moreover, the paper presents the results and discussions on the space-time distribution of electromagnetic forces resulting from the magnetic flux acting on the stator teeth around the air-gap.

Ei controlled terms: **Induction motors** - Rotors - Magnetic flux - Electromagnetic fields - Mathematical models - Finite element method - Approximation theory - Linear equations - Gradient methods - Computer simulation