

Winding Modelling Including Eddy Currents and Capacitances

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Abstract

Two crucial points of winding modelling in electromagnetic devices are discussed, one given by correct eddy-current computation depending on turn arrangement and network topology of the winding, the other by the role of displacement currents in the quasi-static approach. As an example, a cylindrical magnetizer coil is investigated for low frequency sinusoidal excitation and in a transient operation mode including a sudden interrupt of the supply circuit.

Concerning the first mentioned point two different modelling approaches are presented for the investigated Bitter coil. An axisymmetric time harmonic field analysis for two frequencies is carried out. Therein, each single turn is modelled as a solid conductor separated from neighbouring turns by insulation layers. The winding is formed by a series connection of all conductors. The resulting input impedances are compared to turn number transformed results of a calculation with turns in parallel violating the equality of turn currents. The later case exhibits a current distribution similar to that of one massive conductor representing the complete winding cross-section by a homogenized conductivity. The example shows that the connectivity of winding turns has to be taken into account correctly, although the error of equivalent circuit parameters of max. 12 % achieved by the simplifying assumption is not as large as expected.

Concerning the treatment of displacement currents a time-stepping field computation including capacitive effects is carried out in a much lower time scale. As a simplification these effects are lumped together in cumulated inter-turn capacitances and modelled as external supplementary elements of the network.

Suggested appropriate topics:

A5 Coupled Problems (network to numerical field computation)

B1 Finite Difference and Finite Volume Methods (FD used here)

B7 Hybrid Methods (cumulating displacement currents in external capacitances)