Contribution ID: **181** Contribution code: **WED-PO2-718-04** Type: **Poster**

Dynamic magnetic hysteresis modeling based on improved parametric magneto-dynamic model

Wednesday, November 17, 2021 10:30 AM (20 minutes)

Due to the extensive application of soft magnetic materials in transformers, motors, reactors and other electrical equipment, the research of accurate iron loss prediction method becomes an indispensable part to ensure the safe operation of power system and to realize the optimal design of electrical equipment. However, the development of appropriate methods for predicting iron loss is hampered by various complex physical mechanisms in different magnetic materials. Because of the inhomogeneous distribution of magnetic variables caused by eddy current and hysteresis in magnetic materials, the parametric magneto-dynamic (PMD) model is improved in this paper by using a non-linear segmentation method when the thin sheet model is divided into several slices. By combining the fact that the magnetic field changes rapidly in the inner slice and slowly in the outer slice, this method appropriately reduces the thickness of the outer slice and increases the thickness of the inner slice when applying the parametric magnetic dynamic model. The improved parametric magneto-dynamic model can accurately predict the loss while considering the complex physical phenomena in ferromagnetic materials by using the nonuniform piecewise constant function to approximate the distribution of magnetic variables in the thin sheet. Simultaneously, the hysteresis properties of materials need to be stimulated by an appropriate hysteresis model when applying the improved parametric magneto-dynamic model. The parameter identification of the hysteresis model depends on the static hysteresis loop. To solve the problem that static hysteresis loops are not easy to measure, this paper extracts static hysteresis loops from dynamic hysteresis loops by using the inverse loss separation model. In this paper, the feasibility of the static hysteresis loop calculation method is also verified by velocity-controlled particle swarm optimization (VCPSO) to identify the hysteresis model parameters.

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Session Classification: WED-PO2-718 Design and Analysis I