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Core Loss Analysis of Permanent Magnet Linear Synchronous Generator with Slotless Stator

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This paper presents core loss analysis of 5kW permanent magnet linear synchronous generator (PMLSG) with slotless stator. PMLSGs are widely used in various applications. Due to the advantages of high efficiency, high power density, and low maintenance cost. Moreover, slotless stator has the advantages of reducing the detent force and magnets barely impact the electrical steel's saturation due to higher air-gap length. Core loss analysis is essential to improve PMLSG's efficiency. Core loss is typically calculated using the classical Steinmetz equation, which only considers hysteresis loss and eddy current loss. However, the use of this equation leads to a significant disparity in the theoretically calculated results and the experimentally obtained results. In order to reconcile this observed discrepancy, modifications to the equation have been proposed in Bertotti's model. Bertotti's model proposes the inclusion of an excess loss parameter that accounts for the loss associated with a material's thickness, cross-sectional area, and conductivity, and a parameter that describes the material's microstructure. This modified Steinmetz equation accounts for hysteresis loss, eddy current loss, and excess loss. In this paper, the hysteresis loss coefficient, the eddy current loss coefficient, and the excess loss coefficient of stator core for the modified Steinmetz equation are derived from the Epstein test data using a curve fitting method. Owing to the core loss occurs in the rotating field is much more than that occurring in the alternating field, we separate the rotating and alternating field and they can be distinguished using the axial ratio of loci. Finally, core loss at slotless stator is calculated using a modified Steinmetz equation that considers rotating field and flux path. More detailed discussions and analysis results will be presented in the final paper.

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