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Methodology of Incorporating Mechanical and Electromagnetic Characteristics Analysis for Separated Pole-Piece Type Ferrite Magnet Motor

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A novel separated pole-piece type ferrite magnet motor (FMM) is comprises pole-pieces and webs separated from each other in order to maximize its magnetic performance and to minimize leakage flux. However, since such disconnected pole-pieces and webs are constrained only by end plates and rivets, the motors are vulnerable in terms of mechanical integrity at high rotating speeds (and thus under large centrifugal forces). Therefore, both electromagnetic and mechanical requirements must be satisfied when a motor is being designed. This paper proposes a methodology of incorporating mechanical and electromagnetic characteristics analysis for separated pole-piece type FMMs and the suggested motor design was validated by comparing the actual experimental results with the predicted results from the model. The volume ratio of magnets and nonmagnetic material is determined through irreversible demagnetization analysis, and stress analysis is conducted based on the suggested configuration. Electromagnetic excitation forces applied on tooth surfaces are calculated, and the resulting vibration and noise are then predicted. Eddy current loss inside the rivets and end plates, as well as loss from the coil and core, is calculated and then applied to thermal analysis. The proposal enhanced the accuracy of the electromagnetic simulation results such as loss and heating source, and led to an improvement in prediction of temperature, vibration, and acoustic noise. The process was validated by comparing the predicted data with the actual measurements. It was suggested that the accuracy of the prediction would be remarkably improved by incorporating motor control in a coupled analysis, to include the effect of current harmonics on electromagnetic forces and loss.

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