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Numerical Analysis of Variable Flux Memory Motor Considering Characteristics of Permanent Magent Load-Line

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In order to achieve high efficiency over wide-speed operation, variable flux memory motor (VFMM) has been proposed. This new class of motor can control the magnetization state by applying direct-axis (d-axis) current pulses. When designing VFMM, it is important to study nonlinear magnetization state considering the electrical constrains, since the PM magnetization strength must be controlled only with limited current fed by inverter. Meanwhile, the PM magnetization characteristics of VFMM are highly correlated with how PMs are arranged in the rotor. In other words, it is significant for designers to select structural topologies for VFMM properly in initial design stage, which has great effect on the magnetization capability. In this paper, we investigated PM load-lines to identify and compare the magnetization characteristics for two general types of PM type VFMMs. The PM load-line is an essential factor to examine magnetization characteristics of VFMMs, which can be obtained with the mandatory condition to yield the PM operating points in accordance with different values of remanence flux density via finite element analysis (FEA). If the main flux path of VFMM becomes saturated, the PM load-line is distorted. Hence, the PM load-line is derived via nonlinear FEA considering magnetic saturation phenomenon in this study. Generally, it is known that if d-axis current is applied to PM motor, the PM load-line is shifted the magnetic flux density-axis horizontally on the B-H characteristic curve of the PM. However, the results showed that it does not move horizontally but in askew direction on account of magnetic saturation. The magnetization characteristics of analysis models are compared, by identifying these change of the PM load-line with respect to various d-axis current conditions. Finally, we confirm the performance of the models when those are both demagnetized and magnetized states.

Submitters Country

south korea

Authors: HAN, Wonseok (Sungkyunkwan University); Prof. JUNG, Sang-Yong (Sungkyunkwan Univ)

Co-authors: Prof. KIM, Yong-Jae (Chosun University); Mr SONG, Jun-Young (School of Electronic and Electrical Engineering, Sungkyunkwan University)

Presenter: HAN, Wonseok (Sungkyunkwan University)

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