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Impact of Rotor Eccentricity and Current Harmonics on High-Speed Permanent Magnet Generator Performance for Microturbine Applications

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Abstract —This work investigates the effect of rotor eccentricity and current harmonics on the performance of high-speed permanent magnet (PM) generators (HSPMG) with multi-physical analysis. First, the effect of rotor eccentricity in the no-load and load conditions on the distributions of magnetic flux density and electromagnetic force in the generator is studied and the allowed tolerance of rotor eccentricity is determined. Then, the current harmonics generated by the rectifier are injected into the generator armature to study the distribution of core loss, eddy current loss, and temperature rise (particularly on the rotor). Moreover, the resonance impact of rotor eccentricity and current harmonics on the electromagnetic force distribution is also evaluated. The results show that the increase of losses, temperature, vibration, and mechanical strength in HSPMG depends on the amplitude and percentage of total current harmonic distortion injected into the HSPMG under an allowable rotor eccentricity. Finally, the performance of the generator in multi-physical fields is validated through experimental studies.

Model and Analysis Method —A 200kW high-speed generator is studied here and the current harmonics (with 16.8% THD) generated due to the rectifier that is connected to a load of 375A output current is injected when the generator reached the peak power at the 45000 rpm speed. FEA is utilized to comprehensively evaluate the impact of rotor eccentricity and current harmonics on the electromagnetic field, loss distribution, temperature field, vibration, and mechanical strength of the high-speed generator.

Conclusion —This effect of rotor eccentricity and current harmonics on the performance of a high-speed generator has been analyzed, and the results show that the iron loss and temperature of the generator are worsened with the effect of current harmonics. The detail analysis and experimental results will be reported in the full paper.

Primary author: Dr HUYNH, Thanh Anh (National Cheng Kung University)

Co-author: Prof. HSIEH, Min-Fu (National Cheng Kung University)

Presenter: Dr HUYNH, Thanh Anh (National Cheng Kung University)

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