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Comparative Analysis of Hybrid and Non-hybrid Cooled 185 KW High-Speed Permanent Magnet Synchronous Machine for Air Suspension Blower

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Abstract : High-speed Permanent magnet synchronous machine (HSPMSM) uses in different industrial applications like blowers, compressors as a result of its superb performance. Nevertheless, the over-temperature rise of both winding and PM is one of their substantial problem for a high-power HSPMSM, which affects its lifespan and performance. According to the literature, HSPMSM with a Hybrid cooling configuration has a much lower temperature rise than non-hybrid cooling. This paper presents the design 185kW, 26K rpm with two different cooling configurations, i.e., hybrid cooling configuration (forced air and housing spiral water jacket) and non-hybrid (forced air cooling assisted with winding's potting material and sleeve's material) to enhance the heat dissipation of winding and PM respectively. Firstly, the machine's electromagnetic design is conducted by the finite element method to accurately account for machine losses. Then machine's cooling configurations are introduced, and their effectiveness is validated by lumped parameter thermal network (LPTN). Investigation shows that using potting, sleeve materials to assist non-hybrid cooling configuration makes the machine's winding and PM temperature closer to hybrid cooling configuration. Therefore, the machine with non-hybrid cooling is prototyped and tested due to its simplicity, lower energy consumption and can still maintain the lifespan and performance of the HSPMSM.

Keywords : airflow network, axial ventilation, high-speed PMSM, thermal network
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