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A Two-Dimensional Analytic Thermal Model for a High-Speed PMSM Magnet

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Abstract

(PMSMs) are well suited for high-speed (HS) applications due to their high efficiency, power density, and dynamic response capability. The heat extraction area decreases as the speed increases, making thermal effects more dominant at high speed. The temperature-dependent properties of permanent magnets necessitate high-detail thermal models. This paper presents a 2-D analytical model for a HS PMSM magnet. The diffusion equation is solved where three of the PM boundaries experience convection heat flow; as the case is in radial flux machines. The heat generated on the rotor surface due to eddy currents is also taken into account. The model is verified using numerical techniques and shows good correlation (within 1.5%). The model is also validated through experiments performed on a 4 kW, 30 000 r/min PMSM.