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Wed-Mo-Po.06-09: Optimal Design of Heat Pipes and Heat Sinks for Thermal Management of Permanent Magnets in PMSM

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With the rapid growth of the electric vehicle (EV) market, the demand for high-efficiency and high-power motors has steadily
increased. Consequently, the use of rare-earth materials such as neodymium (Nd) permanent magnets has also risen. However, the
monopolistic supply chain and price volatility of rare-earth elements limit their wide adoption. In this study, we propose a motor structure
that eliminates the use of dysprosium (Dy)—a rare-earth element critical for maintaining coercivity in high-temperature environments—
to address concerns related to supply instability and cost escalation. While Dy plays a key role in preventing irreversible demagnetization
by preserving magnet coercivity under elevated temperatures, this research demonstrates that stable performance can still be achieved
at high temperatures without Dy by integrating a heat pipe into the motor design. The heat pipe effectively reduces the temperature of
the permanent magnets; however, poor structural design may exacerbate eddy current losses, leading to further temperature increases.
Hence, we conducted a thermal equivalent circuit analysis to verify that the heat pipe successfully controls magnet temperature rise and
prevents irreversible demagnetization. The proposed structure is expected to reduce the consumption of rare-earth materials while
enhancing both the efficiency and reliability of the motor

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