

MINIMIZATION OF THE DYNAMIC RESPONSE OF INDUCTION MOTORS USING THE TOPOLOGY OPTIMIZATION METHOD

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Abstract

Two-pole induction motors are widely used in industry due to their reliability and efficiency. However, these machines present significant challenges related to vibration, mainly caused by electromagnetic forces associated with the characteristic component at twice the line frequency ($2 \times LF$). This phenomenon may lead to increased noise levels, reduced service life, and compromised operational performance. Therefore, the development of strategies capable of mitigating these effects is essential to improve reliability, efficiency, and durability. The stator housing plays a fundamental role in the dynamic behavior of the assembly, since its stiffness and mass distribution directly influence the natural frequencies and vibration response of the structure. Nevertheless, its design involves conflicting requirements between stiffness, weight, and manufacturing constraints, which makes it challenging to the achievement of structurally efficient configurations using conventional design approaches. In this work, topology optimization is applied to the redesign of the stator housing with the objective of maximizing the first natural frequency and reducing the structural response to electromagnetic excitations. The optimization problem is formulated under volume, displacement and global stress constraints employing a SIMP-based material parameterization, sensitivity analysis, and a sequential optimization strategy integrated with finite element models developed in ANSYS Mechanical APDL. The results demonstrate that the systematic redistribution of material increases the natural frequencies of the structure and reduces overall vibration response when compared to the original configuration. Therefore, the developed methodology constitutes a systematic and effective solution for the dynamic-oriented structural design of induction motor stator housings.