学 位 論 文 内 容 の 要 旨

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学 位 論 文 題 名

A study on Enhancing Efficiency of IPMSM Adopting Concentrated Winding Structure
（集中巻を用いた永久磁石同期モータの高効率化に関する研究）

According to calculations, consumption of electromotors accounts for about half of total power generation. On the other hand, taking Japan as an example, 75.7% of power generation in 2019 came from burning fossil fuels, which produced a large amount of greenhouse gas. With global warming and the depletion of fossil fuels, energy-saving and emission reductions have become a problem that cannot be ignored.

Generators or electromotors are generally rotating electric machines. Considering the electrical energy generated or consumed by rotating electric machines, even a tiny increase in the efficiency of rotating electric machines can result in significant energy-saving and emission reductions. Moreover, the heat dissipation system can be reduced or eliminated by enhancing efficiency and reducing losses, which can decrease system complexity can increase operational reliability. Among rotating electric machines, interior permanent magnet synchronous machines (IPMSMs) are widely used for rotating electric machines in recent years because of their outstanding characteristics, such as simply structure, high power density, and high efficiency.

On the other hand, although the efficiency of IPMSMs should be enhanced as much as possible, manufacturing difficulties and costs are always a major concern for enterprises. Compared with disturbed windings, concentrated windings have been widely adopted in IPMSMs for their shorter coil ending, which can cut manufacturing costs by reducing the usage of copper, and at the same time, the limited space effectively can be effectively used. Therefore, the objective of this paper is to enhance the efficiency of IPMSMs adopting concentrated windings while taking manufacturing difficulties and costs into account.

This paper mainly consists of two topics. The first topic proposes a novel rotor structure which can enhance the efficiency of an IPMSM adopting concentrated windings in the wide-speed, middle-torque operating area. The second topic focuses on the reduction in eddy current loss of special rectangular windings in a high-torque IPMSM used for a wind generator. Both two topics are discussed by FEM (finite element method) first, and prototype machines are manufactured to verify the FEM results.