Abstract

The rapid growth of the hybrid auto (HEV) and electric vehicle (EV) industries is expected to increase demand for small, high-efficiency/high-power drive motors. High-temperature, high-mass, permanent magnets are necessary to realize the high performance of the driving motor. The supply shortage is deepening in China, which accounts for more than 80% of the world’s rare earth production, has implemented a policy to limit the upper limit of annual rare earth mining. In this paper, the shape of the rotor that maximized the Coercive force so that it can be operated at the actual motor operating temperature (140°C) while completely excluding the rare earth content is studied. For this reason, in this paper, we developed a rotor technology to compensate for the lack of coercive force of electric permanent magnet and motor.

1. Introduction

As the core sector of the 4th industry, the rapid growth of the hybrid vehicle (HEV) and electric vehicle (EV) industries, which are already deployed or are expected to be commercialized, is expected to increase the demand for small, high-efficiency, high-power drive motors. In order to realize the high performance of the motor, a high heat-resistant permanent magnet is required. In fact, about 0.25 kg for one HEV and about 0.6 kg for one EV, Nd-based bulk magnets are used, which are already deployed or are expected to be commercialized, is expected to increase the demand for small, high-performance permanent magnets required in the future power-based automobile electric drive motor industry was studied.

2. Motor Design Target Specification

In order to analyze the irreversible demagnetization according to the shape of the rotor, the research was conducted based on three shapes: Bar Type, V Type, and Double Type. In case of double type, bar type magnet close to airgap is defined as sub magnet and V type magnet close to shaft as main magnet.

3. Magnet Specification and Irreversible Demagnetization Analysis Technique

4. Characteristic analysis by motor type

5. Result and discussion

6. Conclusion

In this paper, a robust design of an irreversible device was proposed to compensate for the coercive force of a motor manufactured using a magnet that excludes rare earths. By dividing the rotor shape of the IPMSM into three types, we assigned design variables to each type and investigated the irreversible demagnetization in each type. In the Double Type model, the magnetic flux flows from both ends of the main magnet, near the bridge and ribs, and thus is affected by demagnetization. The magnetic flux flowing into the sub magnet is affected by the high permeability rotor core next to the magnet and is more affected by the main magnet located behind it. Because of this phenomenon, even though demagnetization is in progress in the main magnet, the magnet is not affected by the sub magnet.

In the case of the V Type, it can be seen that the amount of change in the counter electromotive force decreases as the angle increases. It is considered that the amount of decrease in Nodal EMF is small because it is concentrated in the form of collecting magnetic flux by the shape of the magnet. On the other hand, demagnetization decreases with increasing magnet angle. As the angle increases, the reverse magnetic field from the stator does not directly touch the magnet. THD has a slight change in angle and is lower in distribution winding than in concentration winding.

In the case of the Double Type, the magnet usage is the same and the length of the Sub magnet is reduced to have the same magnet usage as the length of the Main magnet increases. As the main magnet length increases, the sub EMF and demagnetization increases above a certain size. The deeper the magnet insertion depth, the more the leakage magnetic flux was generated and the counter electromotive force was also reduced. In the Double Type model, the magnetic flux flows from both ends of the main magnet, near the bridge and ribs, and thus is affected by demagnetization. The magnetic field coming into the sub magnet is affected by the high permeability rotor core next to the magnet and is more affected by the main magnet located behind it. Because of this phenomenon, even though demagnetization is in progress in the main magnet, the magnet is not affected by the sub magnet.

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