Evaluation method for magnetic properties of actual laminated stator core using interpolated core

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In this paper, a method for evaluating magnetic properties of actual laminated stator cores is investigated. To investigate the magnetic properties of a laminated stator core, a closed magnetic circuit including a back yoke and teeth was constructed using an interpolated core, and the magnetic properties were measured. The use of an interpolated core creates an air gap and decreases the magnetic permeability. Therefore, a modification was made and the B-H loop of the teeth was calculated. Although this modification underestimates the iron loss, the magnetic properties can be calculated for any location in the closed magnetic circuit.

Keywords: Actual laminated stator core; Magnetic properties; Interpolated core

1. Introduction

Reducing power consumption is required as a countermeasure against global warming. Since motors account for about 46 % of the world's electricity consumption, it is important to improve motor efficiency [1]. In addition, reduction of loss is necessary for higher efficiency of motors, and iron loss of laminated stator cores, in particular, has a significant impact on motor performance. Therefore, accurate evaluation of iron loss is required. However, current evaluation methods based on catalogue magnetic properties and equivalent circuits do not sufficiently reproduce the magnetic properties of actual laminated stator cores. Therefore, the purpose of this paper is to establish a method to properly evaluate the magnetic properties of actual laminated stator cores and to contribute to higher efficiency motors.

2. Results and discussion

Figure 1 shows the actual laminated stator core used in this paper. The following studies were conducted to establish a method for evaluating the magnetic properties of a laminated stator core [2]. To calculate the magnetic properties of a laminated stator core, it is necessary to construct a closed magnetic circuit using only the laminated stator core. This closed magnetic circuit consists only of the back yoke, and the magnetic properties of the back yoke section are measured. The stacked stator core must also evaluate the magnetic properties of the teeth that pass the magnetic flux to the rotor. By inserting an interpolated core, a closed magnetic circuit including the teeth can be configured as shown in Figure 2. By using this closed magnetic path, it is possible to measure the magnetic properties including those of the teeth, and the evaluation of the magnetic properties of the teeth can be studied.

Figure 3 shows the B-H loop with a back yoke controlled to 0.6 T and the B-H loop with an interpolated core. The B-H loop with the interpolated core shows an increase in field strength compared to the B-H loop with the back yoke. This increase in field strength is due to the decrease in the average permeability of the closed magnetic circuit due to the air gap between the teeth and the interpolated core. Therefore, the air gap length was determined using a magnetic circuit. The magnetic field strength and flux density of the teeth were then calculated, and Figure 4 shows the calculated B-H loop of the teeth and the B-H loop of the back yoke controlled to 0.3 T. The B-H loop of the teeth is shown in Figure 5. The B-H loop of the teeth is more inclined than the B-H loop of the back yoke, indicating that the teeth section has lower magnetic permeability. In addition, the iron loss is expected to be higher in the back yoke section, although there is a slight difference in magnetic flux density.

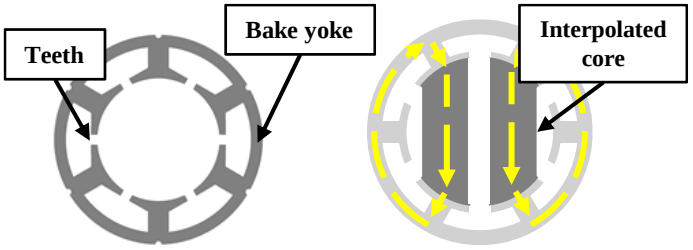

Figure 1: Schematic diagram of a laminated stator core.

Figure 2: Closed magnetic circuit with interpolated core.

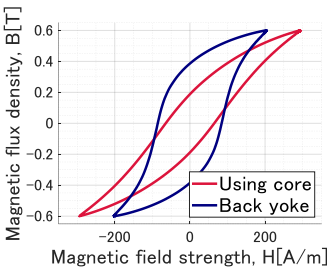

Figure 3: B-H loop comparison.

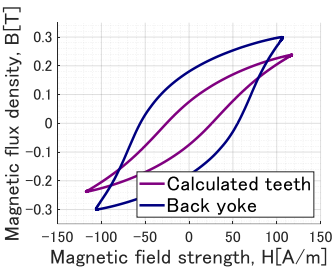

Figure 4: B-H loop of the teeth.

To calculate the magnetic properties of the teeth, we measured the magnetic properties of the back yoke and the interpolated core. The magnetic properties of the teeth are calculated by modifying the obtained magnetic properties using a magnetic circuit. In the presentation, the details of the study and the method for calculating the magnetic properties of the teeth will be described.

References

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