REFUNCTION TECHNIQUES OF ELECTRICAL STEEL SHEETS BY SECONDARY CURRENT HEATING FOR HIGH EFFICIENCY MOTORS

Y. Tsuchida[1,a], M. Enokizono[2,b]

[1] *Faculty of Science and Technology, Oita University, Oita, Japan*
[2] *Vector Magnetic Characteristic Technical Laboratory, Oita, Japan*
[a]*tsuchida@oita-u.ac.jp,* [b]*enoki@oita-u.ac.jp*

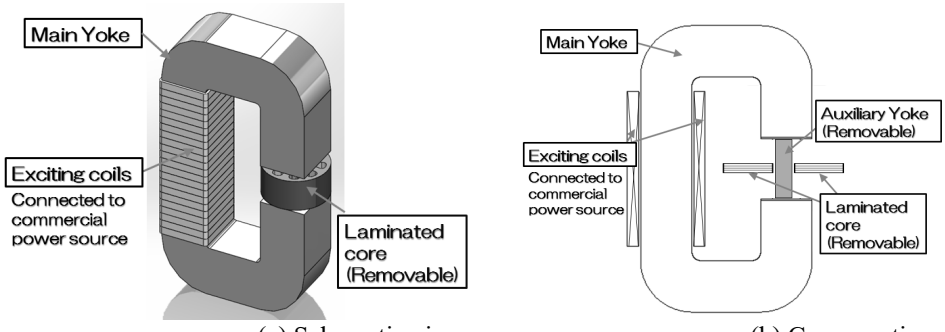
Abstract. This paper presents the newly proposed heating method names as "Secondary Current Heating Method" to reduce the iron loss on laminated electrical steel sheet cores for high efficiency electrical motors. It is well known that the magnetic properties of electrical steel sheets, which are used for electrical motor cores, are deteriorated by the residual stress during manufacturing the electrical motors, and then the iron loss of the laminated electrical steel sheet cores of the electrical motors increases inevitably. The newly proposed Secondary Current Heating Method can improve the magnetic properties on laminated electrical steel sheet cores and reduce the iron loss of them in the very short time in comparison with conventional methods. In this paper, the electromagnetic and heating characteristics of the specimens by proposed method were confirmed, and then it was applied into the laminated cores to reduce iron loss.

1. Introduction

This paper presents the newly proposed heating method names as "Secondary Current Heating Method" to reduce the iron loss on laminated electrical steel sheet cores for high efficiency electrical motors. Conventionally, the residual stress had been removed by the annealing process with a huge-size electric furnace after assembling electrical motors [1, 2]. However, a huge-size electric furnace itself is very expensive and the annealing process by it costs a lot and is very time-consuming (normally, it takes about 12 hours), therefore, the annealing process has been eliminated for the cost performance. Especially, the annealing process has never been applied into the "industrial electrical motors" in Japan for these twenty or thirty years. It means that the industrial electrical motors have been used with high iron loss for many years. In this paper, the electromagnetic and heating characteristics of the specimens by proposed method were confirmed, and then it was applied into the laminated cores to reduce iron loss. The measured results of the magnetic properties and iron loss are discussed for high efficiency electrical motors.

2. Secondary Current Heating Method

Fig. 1 shows the setup of the newly proposed heating method names as "Secondary Current Heating Method". It consists of the main yoke, exciting coils, auxiliary yoke and laminated core (specimen) from electrical steel sheets as shown in Fig. 1 (a). The cross section of the heating equipment and specimen by proposed method is shown in Fig. 1 (b). The exciting coils are connected to the normal commercial power source (200V, 60Hz) as shown in the both figures. The special and expensive power source which are essential for high-frequency induction heating is not needed in this proposed method. The exciting coils make the magnetic flux in the main yoke and



(a) Schematic view (b) Cross-section

Fig.1. Setup of Yokes and Specimens by Secondary Current Heating Method.

auxiliary yoke, and the secondary current is induced in the laminated core due to the variation of the magnetic flux across it. The laminated core can be considered as electrical shorten circuit, therefore, the induced secondary current occurs Joule's heat on the laminated core itself. This Joule's heat can increase the temperature of the laminated core, remove the residual stress, and reduce the iron loss of it. The high-frequency induction heating can heat the only surface on the specimen because of the skin depth. On the other hand, our

proposed method can heat the internal region of the specimen, too. The auxiliary yoke and specimens (laminated cores) are removable to assume to apply this method into the real industrial manufacturing line from the beginning.

3. Measurement of Magnetic properties and reduction of iron loss

Magnetic properties before and after the heat-treatment by proposed Secondary Current Heating Method were measured by the magnetic measurement system. Fig. 2 shows the measured magnetic properties before and after the heat treatment by the proposed Secondary Current Heating method. The B-H loops in Fig. 2 were measured under the 10-Hz excitation and the magnetic flux density, B, are controlled as to be 1.0 [T]. All electrical steel sheets were made by the punching process before lamination process, therefore, some residual stress must be on them by punching and lamination processes. As described above, the heating time is decided as 0, 2.5, 5.0, 7.5, and 10 [minutes]. By comparing these five B-H loops, the magnetic properties improved in the case of the 7.5, and 10 [minutes] processes. The total iron loss was decreased more in the case of the 10 [minutes] process than in the case of the 7.5 [minutes] process. Fig. 3 shows the total iron loss derived from the B-H loops shown in Fig. 2. The total iron loss can be decreased approximately 10 % in the case of the 10 [minutes] process by comparing the non-heat treatment specimen.

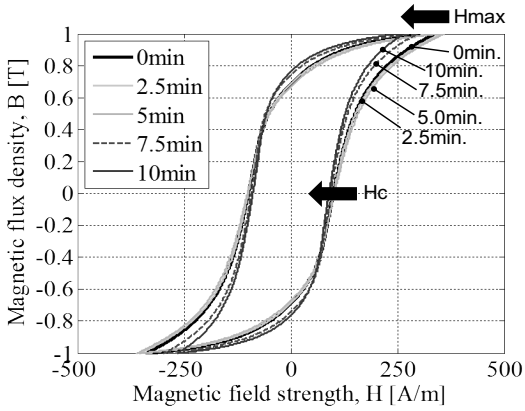


Fig. 2 Variation of B-H loops by secondary current method.

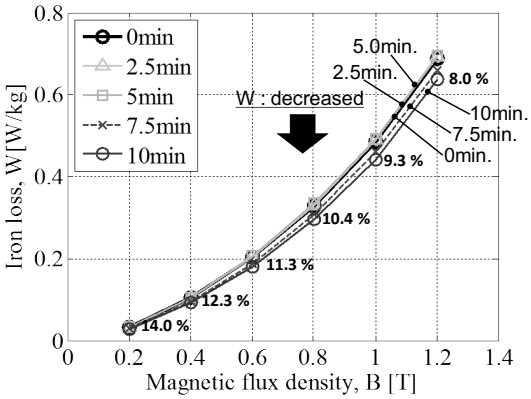


Fig. 3 Reduction of iron loss by secondary current method changing magnetic flux density.

Conclusions

The newly heat treatment name as "Secondary Current Heating" has been proposed, and the effectiveness of the proposed method were discussed in this paper. The Secondary Current Heating method was newly proposed. The proposed method was applied into the ring-shaped laminated electrical steel sheet cores, and then the total iron loss can be reduced by proposed method. And it was shown that the hysteresis loss could be mainly reduced because the proposed method can improve the magnetic properties of the specimens.

References

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