Low Loss of Mg-Mn-Zn Ferrite for Deflection Yoke

K. Ikegami, Y. Masuda, H. Takei and T. Maeda

FDK Corporation, Kosai Factory, 2281 Washizu, Kosai-shi, Shizuoka 431-04, Japan

Abstract. We examined the reduction of the core loss of Mg-Mn-Zn ferrite for deflection yoke cores. We tried to decrease hysteresis loss by selection of composition and additive, because hysteresis loss is much larger than eddy current loss in Mg-Mn-Zn ferrite having high resistance. We succeeded in decreasing hysteresis loss and improved the core loss approximately 30% compared with conventional materials. And as the result of a simulation, we can expect that the rising temperature of it is smaller than that of our conventional materials for deflection yoke at high frequencies and high magnetic flux density.

1. INTRODUCTION

A deflection yoke for highly detailed and wide display is used at higher frequencies more than 100 kHz. Therefore, low loss Mg-Mn-Zn ferrite at a high frequency for deflection yoke is required. In order to reduce the core loss of Mg-Mn-Zn ferrite, we examined its composition and additives.

2. EXPERIMENTAL PROCEDURE

In this examination, we obtained samples in the following method. Raw materials were mixed to obtain various ferrite compositions. These mixtures were calcined in the air and pulverized in a ball mill. Then, each powder sample was granulated and pressed into toroidal sample and was sintered in the air.

We measured the core loss, curie point and surface resistance of these samples.

3. RESULTS AND DISCUSSION

Figure 1. Relationships between quantity of Fe_2O_3 , MnO, ZnO and core loss.

Figure 1 shows a core loss and table 1 shows characteristics of each sample. Figure 1 indicates that the core loss is reduced with increment of ZnO quantity and $\text{MnO}/(\text{Fe}_2\text{O}_3+\text{MnO})$. But table 1 shows that surface resistance is decreased with rising $\text{MnO}/(\text{Fe}_2\text{O}_3+\text{MnO})$, because Fe^{2+} lowered resistance of ferrites. And Fe^{2+} is increased with increment of Mn^{2+} in order to hold electric charge balance. And the curie point is also declined greatly, because the rate of the quantity of Fe_2O_3 to ZnO is decreasing.

Table 1. Characteristics of samples (ZnO: 18mol%)

$\text{MnO}/(\text{Fe}_2\text{O}_3+\text{MnO})$	%	11.5	15.1	19.2	23.1
Surface Resistance	MΩ	1,050	7,000	1,100	300
Curie Point	°C	166	152	140	125

Figure 2 shows that the core loss is separated into a hysteresis loss and eddy current loss in the sample of ZnO 18 mol %. In this figure, hysteresis and eddy current losses were calculated by core loss/f-f plots. As MnO/(Fe₂O₃+MnO) is increased, hysteresis loss is greatly reduced, but eddy current loss is hardly influenced. Therefore, a reduction of core loss by increasing MnO/(Fe₂O₃+MnO) is due to decreasing of hysteresis loss.

Figure 3 shows sintered density and core loss of samples in relation to addition of Bi₂O₃. The composition of samples is MnO/(Fe₂O₃+MnO): 19.2 % and ZnO: 18 mol %. As an addition of Bi₂O₃ increases, sintered density becomes higher and the core loss is reducing. It is well known that addition of Bi₂O₃ is effectual for rising sintered density[1]. Increment of sintered density by addition of Bi₂O₃ is caused by that impurities and vacant lattice are removed to the boundary layer. As a result, a magnetic domain wall can be easily transported and the core loss reduces. But in case an addition of Bi₂O₃ is more than 0.6wt%, crystal sizes become non-uniformity, because of large particles caused by abnormal grain growth. Therefore, a core loss is not reduced.

Figure 2. Relationships between quantity of Fe₂O₃, MnO and core loss, hysteresis loss, eddy current loss. (Fe₂O₃+MnO : constant)

Figure 3. Relationships between contents of Bi₂O₃ and core loss, sintered density.

Figure 4 shows the temperature characteristic of the core loss and table 2 shows a result of simulation of heat generation of each material used as deflection yoke of display. X106 is controlled composition of Fe₂O₃, MnO and ZnO, and contents of Bi₂O₃. H44 and H44F are our conventional materials. The heat generation is calculated for the distribution of magnetic flux density of a core computed by the magnetic moment method and core loss database.[2]

Figure 4. Temperature characteristic of core loss. (measured condition : f=100kHz, Bm=30mT)

Core loss database is measured to some conditions of magnetic flux density, frequency and temperature. According that result, we expect X106 to be suitable for the deflection yoke for the display used under the condition of high frequency and high magnetic flux density.

Table 2. Result of simulation of heat generation

	unit	f=96kHz	f=110kHz
H44	W	3.78	4.45
H44F	W	3.41	3.99
X106	W	3.24	3.79

4.CONCLUSION

- 1) As a method of reducing the core loss of Mg-Mn-Zn ferrite, it is effective to reduce a hysteresis loss by controlling ratio of MnO/(Fe₂O₃+MnO) and contents of ZnO.
- 2) The core loss can be reduced by addition of Bi₂O₃. Reduction of core loss is caused by increment of sintered density.

5.REFERENCES

[1] K. Yasuhara, K. Horino, T. Nomura, and T. Sato "Magnetic Properties of Highly Permeable MnZn ferrite", JOURNAL OF THE MAGNETICS SOCIETY OF JAPAN ,19(1995) pp.417-420.
[2] H. Rikukawa, I. Sasaki "COMPUTER AIDED ENGINEERING FOR FERRITE PRODUCTS" , Proceedings of ICF7(1996).