EXPERIMENTAL TESTING AND DATA ANALYSIS OF THE SOUNDING CHARACTERISTICS OF NICKEL-ZINC FERRITE

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Abstract

This paper primarily conducts experimental testing on the relationship between the sound intensity of nickel zinc ferrite and magnetic field strength, and performs statistical analysis on the experimental data.

Keywords: ferrite, nickel-zinc ferrite, sound characteristics, data analysis.

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1. Introduction

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Nickel-zinc ferrite is one of the most common soft magnetic ferrites. It is a ferromagnetic composite oxide composed of multiple metals including nickel, zinc, and iron, exhibiting the softest magnetic properties and the greatest ease of magnetization and demagnetization [1].

Nickel-zinc ferrite exhibits outstanding properties, including magnetostriction under alternating magnetic fields, high magnetic permeability, high resistivity, and low loss at high frequencies [2]. These characteristics represent current research hotspots, exemplified by Yu's study on the preparation and application of magnetic nickel-zinc ferrite-based nanocomposites.

This paper primarily investigates the acoustic properties of nickel-zinc ferrite materials through relevant experiments and analysis. It focuses on examining the effect of applied magnetic field strength on the sound intensity of nickel-zinc ferrite, thereby opening new avenues for the practical application of magneto-strictive sound generation phenomena.

2. Experimental Results and Data Analysis

2.1. Experimental Principle

The magnetic field strength and frequency were altered by adjusting the output voltage and current of the signal generator, as well as the number of turns in the energized solenoid. For an infinitely long current carrying copper coil, the magnetic field magnitude inside it, as derived from Biot-Savart Law, is given by

$$B = B_0 \sin(\omega t + \varphi) = \mu_0 n l_0 \sin(\omega t + \varphi), \tag{1}$$

where B is the magnetic field strength inside the copper coil, B_0 the initial magnetic induction strength, ω the angular velocity of the current change, φ the initial phase of the current variation, μ_0 the vacuum permeability, n the number of turns of the coil, l_0 the initial strength of the AC current in the copper coil.

According to Equation (1), an alternating magnetic field is generated in the copper coil energized by alternating current, and the magnetic field frequency is identical to the current frequency. Furthermore, the magnetic flux density inside the copper coil can be altered by changing the turn density of the coil and the output voltage/current

To determine the acoustic loudness of nickel-zinc ferrite under varying coil turns and output voltages, a correlation analysis model (1) linking acoustic loudness to magnetic field loudness can be constructed using the controlled variable method.

Figure 1 indicates that the sound intensity of nickel-zinc ferrite increases significantly with the number of coil turns. Similarly, Figure 2 shows that although sound intensity rises with increasing output voltage, it exhibits certain fluctuations and a relatively weak correlation.
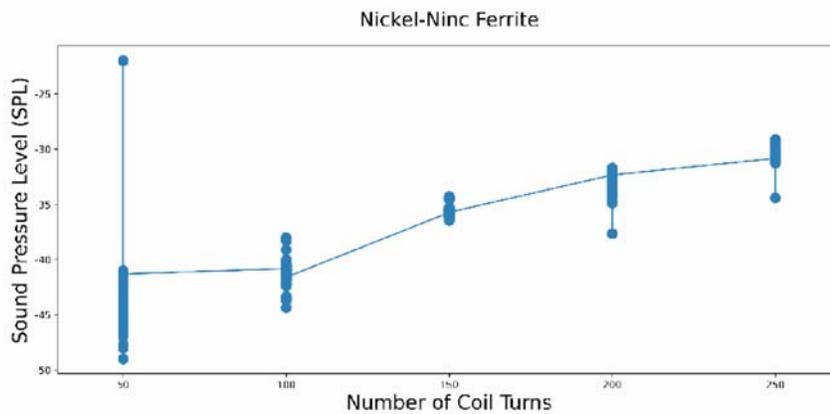

Figure 1. Relationship between number of coil turns and sound pressure level of Ni-Zn ferrite.
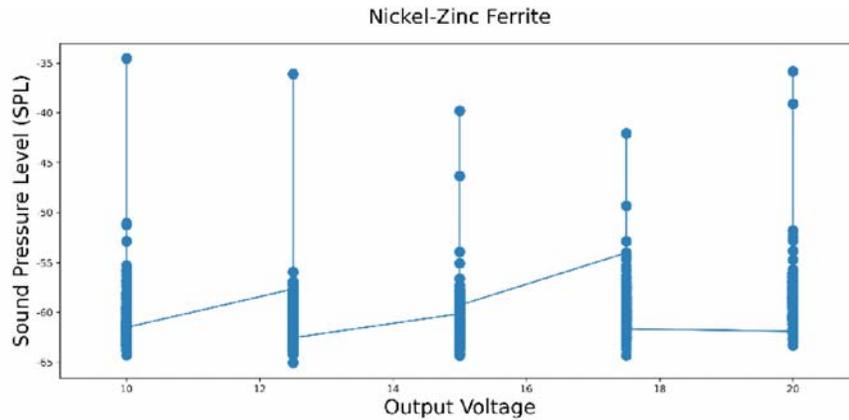
Figure 2. Relationship between output voltage and sound pressure level of Ni-Zn ferrite.

Furthermore, applying statistical principles, Table 1 reveals (1) the correlation coefficient between the number of coil turns in nickel-zinc ferrite and sound intensity is 0.9497, indicating a significant positive correlation. The corresponding p-value is far below 0.05, confirming that the experimental results are statistically significant and possess high reliability; (2) The correlation coefficient between the output voltage of nickel-zinc ferrite and sound intensity is 0.2686, with a corresponding p-value far below 0.05. This indicates a weak but statistically significant correlation between output voltage and sound intensity.

Table 1. Correlation analysis results between nickel-zinc ferrite SPL and magnetic field intensity

Variable Pairs	Correlation Coefficient r	p-value
Coil Turn Number and Sound Pressure Level	0.9497	0.0
Output Voltage and Sound Pressure Level	0.2686	$3.081*10\text{-}14$

Acknowledgements

References

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[2] L. G. Petrescu, M. C. Petrescu, V. Lone, E. Cazacu and C. D. Constantinescu, Magnetic properties of manganese-zinc soft ferrite ceramic for high frequency applications, Materials 12(19) (2019), 3173.

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