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Retraction

Retracted: Application of Nanofluid Electrochemistry in Heat Dissipation of Permanent Magnet Synchronous Motors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] X. Lin and G. Xie, "Application of Nanofluid Electrochemistry in Heat Dissipation of Permanent Magnet Synchronous Motors," *Journal of Chemistry*, vol. 2022, Article ID 3681749, 7 pages, 2022.

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Research Article

Application of Nanofluid Electrochemistry in Heat Dissipation of Permanent Magnet Synchronous Motors

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In order to solve the problem of heat dissipation of permanent magnet synchronous motors, a technology using the principle of nanofluid electrochemistry is proposed. The main content of this technology is based on the characteristics and applications of nanofluids; according to the experimental system, the preparation and experimental parameters of nanofluids were determined; finally, by studying the influence of ultrasonic oscillation time and dispersant on the stability of nanofluids, it was concluded that the improvement of the thermal conductivity of nanofluids contributed to the improvement of the heat transfer rate of nanofluids. Experimental results show that when the volume fraction is 0.5, the increase rate of thermal conductivity is 1.51, the increase rate of convective heat transfer coefficient is 20.33, and the increase rate of convective heat transfer coefficient is greater than that of thermal conductivity, which shows that nanofluids have very good heat dissipation ability. It is proved that the technical research of nanofluid can meet the heat dissipation requirements of a permanent magnet synchronous motor.

1. Introduction

In recent years, the country has taken new energy vehicles as the key direction of future research and development; among them, the drive motor technology represented by a permanent magnet synchronous motor (PMSM) for electric vehicles significantly improves the performance and comfort of electric vehicles [1]. The temperature rise of the motor directly affects the performance of the motor and high temperature will destroy the insulation of the motor windings and limit the output of the motor; for permanent magnet motors, high temperature will seriously affect the magnetism of the permanent magnet and even cause irreversible demagnetization [2].

During the operation of the permanent magnet synchronous motor, in order to make it run stably and well, it is necessary to pay more attention to the heat dissipation of the motor, and this requires simulation analysis of the heat dissipation of the permanent magnet synchronous motor and further optimization, so as to solve the problem of heat dissipation of the permanent magnet synchronous motor; the treatment is more scientific and reasonable and provides effective support and basis for ensuring the normal and stable operation of the permanent magnet synchronous motor. The development of key support fields such as new energy vehicles, robots, and high-precision CNC machine tools has put forward higher requirements for performance indicators such as motor efficiency, power density, response speed, and vibration and noise; promoting the motor to develop in the direction of high precision, high power density, miniaturization, lightweight, mechatronics, etc., has brought about problems such as a sharp increase in the internal heat generation of the motor and a serious shortage of effective heat dissipation space; therefore, the heat dissipation problem has become a further development of the motor system, the bottleneck of the development of power density direction [3].

In the actual operation and application process of the current permanent magnet synchronous motor, in order to ensure the effectiveness and stability of the permanent magnet synchronous motor operation, it is necessary to pay more attention to and study all aspects, and the heat dissipation of the motor is a key issue that needs to be paid attention to; in the case of ideal heat dissipation of the motor, its operation can be better guaranteed. An efficient and reliable cooling system is used to quickly transfer the heat generated during the operation of the motor to the outside, which is of great significance to the life, efficiency, and operational safety of the motor [4].

2. Literature Review

With the country's vigorous development of electric vehicles, under the current background, permanent magnet synchronous motors are widely used in electric vehicles due to their small size and high power density; however, due to their high loss density and relatively closed working environment, the internal temperature is often rising too high; in severe cases, the stator insulation will fail, the permanent magnet material will be demagnetized, and the operating performance, efficiency, and life of the drive motor will be affected [5]. Therefore, a reasonable heat dissipation structure designed to control the temperature rise of the heating components of the drive motor within a safe range seems particularly important. Most modern motors use higher electromagnetic loads, so it is necessary to effectively analyze the temperature field of the motor, and on this basis, research methods to reduce motor losses and improve motor cooling are needed; in the current actual operation and application of permanent magnet synchronous motors, solving the heat dissipation problem of the motor has always been a key task, and it is also an important way and method to improve the efficiency and effectiveness of the motor. In order to effectively solve the problem of heat dissipation of permanent magnet synchronous motor, relevant researchers are required to simulate and analyze the heat dissipation of permanent magnet synchronous motor, carry out reasonable optimization according to the simulation analysis results, and carry out scientific and reasonable design for all aspects, thereby, the heat dissipation of the permanent magnet synchronous motor can achieve satisfactory results, and on this basis, the effective operation of the permanent magnet synchronous motor can be realized. We cause the motor temperature to rise further and form a vicious circle, which will seriously affect the life of the motor and the safety of the motor operation; an efficient cooling system is an important basis for restraining motor temperature rise, improving motor operation stability, and prolonging motor life [6].

In response to the abovementioned problems, the author proposed the application of nanofluids in the heat dissipation of permanent magnet synchronous motors [7]. The main content of this technology is based on the characteristics and applications of nanofluids, according to the experimental system, the preparation of nanofluids, and the determination of experimental parameters; finally, by studying the influence of ultrasonic oscillation time and dispersant on the stability of nanofluids, it is concluded that the improvement of the thermal conductivity of nanofluids contributes to the improvement of the heat transfer rate of nanofluids. It mainly analyzes and discusses the heat dissipation simulation of permanent magnet synchronous motor and realizes the optimization of heat dissipation simulation analysis from various aspects, so that the research on motor heat dissipation can obtain more ideal results and achieve the better application of permanent magnet synchronous motors [8].

3. Research Methods

3.1. Nanofluid Research

3.1.1. Characteristics and Applications of Nanofluids. Nanofluid is a new type of heat transfer working fluid with uniform, stable, and high thermal conductivity formed by adding nanoparticles to liquid in a certain way and proportion. Since the concept of nanofluids was proposed by Argonne National Laboratory in the United States in 1995, the research on nanofluids has gradually become a research hotspot in chemical engineering, metallurgy, electronics, materials science, and other disciplines.

In the past ten years of research, it has been found that nanofluids have better thermal properties than ordinary fluids, and their potential advantages are mainly in the following aspects: ① The high heat transfer surface greatly promotes the heat transfer between the nanoparticles and the fluid; ② due to the significant Brownian motion of the nanoparticles, the nanofluid has good dispersion stability, and the sedimentation of the particles is smaller than that of the general large particles, two-phase fluid is stable; ③ the miniaturization of the equipment reduces the flow rate and operating cost of traditional fluids; ④ compared with pure fluids, under the same heat transfer intensity, nanofluids containing few nanoparticles can improve the fluid thermal conductivity and greatly reduce the pumping power; and ⑤ compared with the traditional two-phase fluid with large particles, the agglomeration tendency of particles is greatly reduced, and it can be used as a cooling fluid for microchannels [9].

Due to the abovementioned advantages of nanofluids, nanofluids are widely used in industrial production, such as in construction machinery and transportation industry engines that have a strong demand for improved cooling technology; microelectromechanical systems; heating, ventilation, and air conditioning systems [10]. In addition, it can be used in heat storage equipment, transformers, nuclear fuel reactors, etc.

3.1.2. Nanofluidic Experimental System. According to the experimental content, the authors divided it into a nanofluid stability experimental system and a nanofluid convective heat transfer system [11].

(1) In the nanofluid stability experimental system, the author uses a combination of visual inspection and transmittance to evaluate the stability of nanofluids, and the experimental phenomenon and experimental data are verified each other, the main experimental system is a 721–100 visible spectrophotometer with

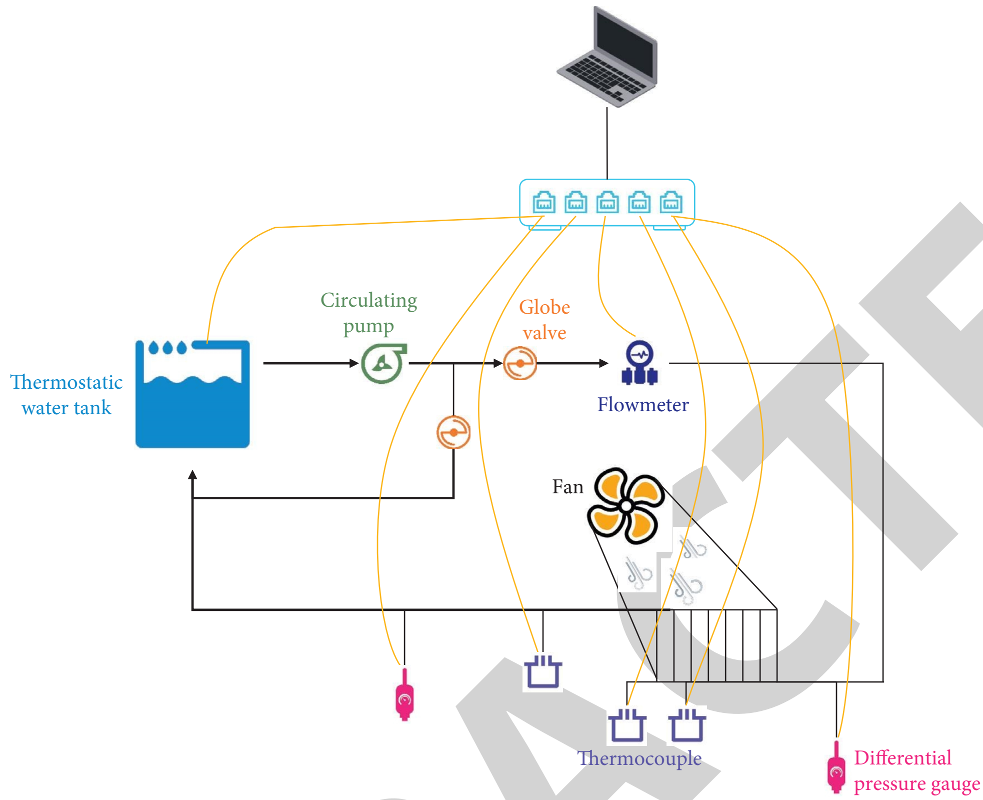

Figure 1: Experimental system.

accurate wavelengths, degree ±2 nm, transmittance accuracy ±1% T, stability ≤ ± 0.004 A/h [12].

(2) In the nanofluid convective heat transfer system, the experimental system is shown in Figure 1, which is divided into a working fluid circulation system, data acquisition system, constant temperature heating system, and cooling and heat dissipation system. After the nanofluid is heated to the temperature required for the experiment in the constant temperature tank, it enters the car radiator for cooling through the driving force of the circulating pump, and the cooled nanofluid re-enters the constant temperature tank for heating, thus completing the entire loop [13].

Among them, the constant temperature tank is a cylindrical glass tank with a diameter of 300 mm and a height of 490 mm, which is equipped with a 1.5 kW electric heater and is controlled and adjusted by PID. A globe valve is installed after the circulating pump to adjust the flow rate of the entire system. The cooling system is composed of a car radiator and a fan with a length of 548 mm ±2 mm and a height of 380 mm ±2 mm, inside the radiator are 54 equally spaced flat tubes separated by fins. On the opposite side of the radiator, the fan runs at constant power and the wind speed is 3 m/s. Six K-shaped thermocouples are set on the surface of the radiator to measure the surface temperature of the radiator, and one thermocouple is set at the inlet and outlet to measure the temperature at the inlet and outlet; we set up a flow meter, a Rosemount differential pressure gauge, and a power meter in the circulation pipeline to measure the corresponding flow, differential pressure, and effective pump work, respectively. Among them are the K-type thermocouple output temperature signal, flowmeter, and Rosemount differential pressure meter output current signal [14]. These signals are collected by the data collector, processed, and fed back by the computer, and the power meter can directly read the value.

3.1.3. Preparation of Nanofluids and Determination of Experimental Parameters. MWCNT nanoparticles with different volume fractions were dispersed in an 80% water-20% ethylene glycol mixed solution [15]. The selected dispersants are sodium dodecyl benzene sulfonate (SDBS) and cetyltrimethyl ammonium chloride (CTAC); the two dispersants will have different stabilities of nanofluids due to their different properties. The author aims to prepare nanofluids with better stability; therefore, it is necessary to verify the stability of the two dispersants to nanofluids through experiments, so as to select the dispersants with better stability to nanofluids [16]. The nanoparticles and dispersant are mixed well in the base liquid and then shaken in an ultrasonic shaker. The volume fractions of nanoparticles used in the experiments were 0.05%, 0.1%, 0.15%, 0.3%, and 0.5%. The volume fraction of the nanofluid is calculated according to formula (1).

$$\varphi = \frac{1}{(100/\phi_{wt})(\rho_p/\rho_{nf})}. \tag{1}$$

The thermophysical properties of 80%:20% ethylene glycol aqueous solution at different temperatures were obtained, and the thermophysical properties of MWCNT nanoparticles were obtained according to the manufacturer. The SNB-3 digital rotational viscometer was used to measure the viscosity of the nanofluid and base fluid, and the DRE-III thermal conductivity meter was used to measure the thermal conductivity; comparing the measurement results with the relevant calculation formulas of solid-liquid two-phase flow, the error between the two is less than 5%, as mentioned in formulas (2)–(5).

$$\rho_{nf} = \varphi\rho_p + (1-\varphi)\rho_{bf}, \tag{2}$$

$$c_{p,nf} = 1 - \varphi\frac{\rho_{bf}}{\rho_{nf}}c_{p,bf} + \varphi\frac{\rho_p}{\rho_{nf}}c_{p,p}, \tag{3}$$

$$k_{nf} = \frac{k_p + (\phi-1)k_{bf} - \varphi(\phi-1)\left(k_{bf}-k_p\right)}{k_p + (\phi-1)k_{bf} + \varphi\left(k_{bf}-k_p\right)}k_{bf}, \tag{4}$$

$$\mu_{nf} = \mu_{bf}(1+2.5\varphi), \tag{5}$$

where φ is the shape factor, calculated from $\varphi = 3/\psi$, and ψ is the sphericity of the nanoparticle surface area (sphere, $\psi = 1.0$; rod, $\psi = 0.6$). In the text, if ψ is taken as 0.6, then φ is equal to 5.

Because the transmittance of the nanofluid measured at the optimal absorption wavelength can more accurately reflect the stability of the nanofluid, therefore, the optimal absorption wavelength of the MWCNT nanofluid should be measured first, and then, the stability of the nanofluid should be evaluated according to the change of transmittance in different time periods [17]. The method of testing the optimal absorption wavelength of nanofluid is as follows: The wavelength of the prepared MWCNT-water/ethylene glycol mixed-based nanofluid with a volume fraction of 0.15% is scanned with a spectrophotometer, the optimal absorption wavelength is selected by comparing the transmittance changes at different wavelengths, that is, the nanofluid absorbs more light at the optimal absorption wavelength, the transmission ratio is small, so the optimal absorption wavelength should appear at the position where the transmittance is in the trough, as shown in Figure 2. As can be seen from Figure 2, the optimal absorption wavelength of MWCNT-water/ethylene glycol mixed-based nanofluid is concentrated at 240 nm. In order to verify the reliability of the experiment, multiple wavelength scans were performed on the MWCNT-water/ethylene glycol mixed-based nanofluid with a volume fraction of 0.15%.

In the convective heat transfer experiment, under the control of PID, the nanofluid was heated to 45°C, 55°C, and 65°C in a constant temperature tank, and under the driving force of the circulating pump, we adjust the shut-off valve to make the nanofluid circulate in the whole system at 2 L/min, 4 L/min, and 6 L/min, respectively [18]. The fan runs with a certain constant power and the wind speed is kept at 3 m/s. The different fluid temperatures represent the engine operating at different powers, and the fluid temperature and

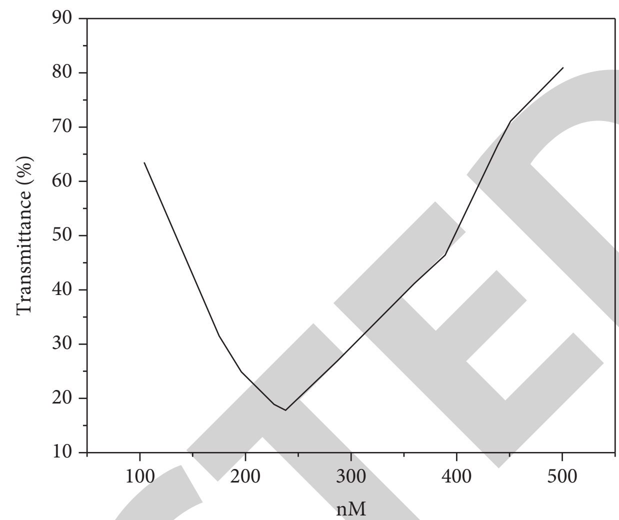

Figure 2: Wavelength scanning results of nanofluids.

flow rates were varied to better simulate engine conditions operating under real-world conditions.

When the nanofluid is heated to the temperature required by the experiment in the constant temperature tank, the circulating pump is turned on to make the nanofluid circulate through the radiator of the car and circulate in the whole system, and the flow required for the experiment can be obtained by adjusting the shut-off valve. After the whole system is stable, the surface temperature signals of 6 thermocouples, the temperature signals of 2 inlets and outlets, and the current signals of pressure difference and flow rate are recorded by the data collector, and the change of the power indicator of the power meter is recorded in real-time [19].

3.2. Nanofluid Stability Experiment

3.2.1. The Effect of Ultrasonic Oscillation Time on the Stability of Nanofluids. The MWCNT-water/ethylene glycol mixed-based nanofluid with a volume fraction of 0.15% was prepared by the "two-step method" for the ultrasonic oscillation experiment. In order to distinguish the influence of ultrasonic time on stability, the oscillation time was changed from 0 to 2 h and the interval was 30 min. However, after 3 days, the nanofluid in several test tubes showed great changes, which were 0 h, 0.5 h, 1 h, 1.5 h, and 2 h, respectively. The color of the nanofluid in the test tube has been different, and the nanofluid in the test tube at 0 h has an obvious layering phenomenon, and the state of the supernatant liquid and the lower turbid liquid appears. The nanofluid layering phenomenon in the test tube after shaking for 30 min is not obvious, but a little flocculation phenomenon can be seen. The nanofluid in the test tube after shaking for 1 h and 1.5 h still maintains good dispersion, and further experimental analysis is required. A little layering phenomenon has also appeared in the test tube after shaking for 2 hours, and a little flocculent material floats. The phenomenon shows that ultrasonic oscillation can

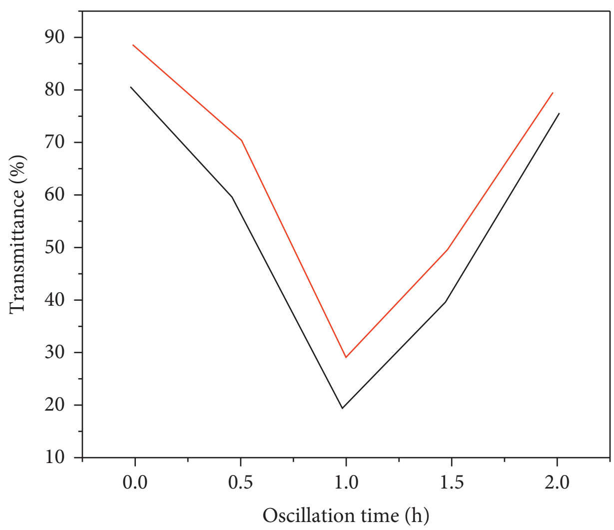

FIGURE 3: Variation of transmittance of nanofluids with oscillation time.

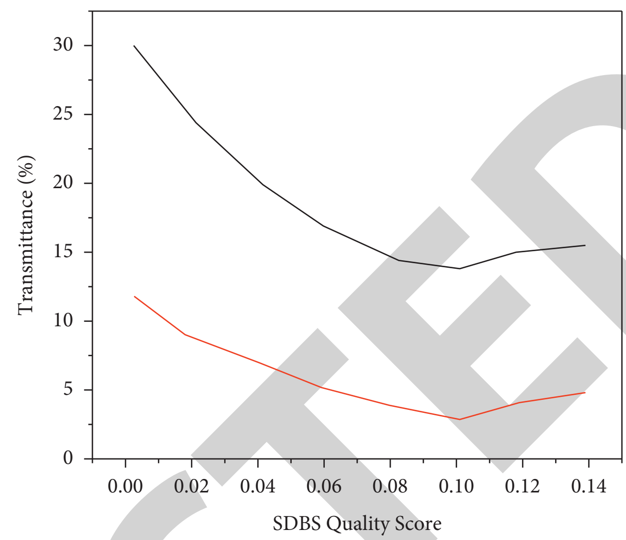

FIGURE 4: Stability of nanofluids in the addition of SDBS.

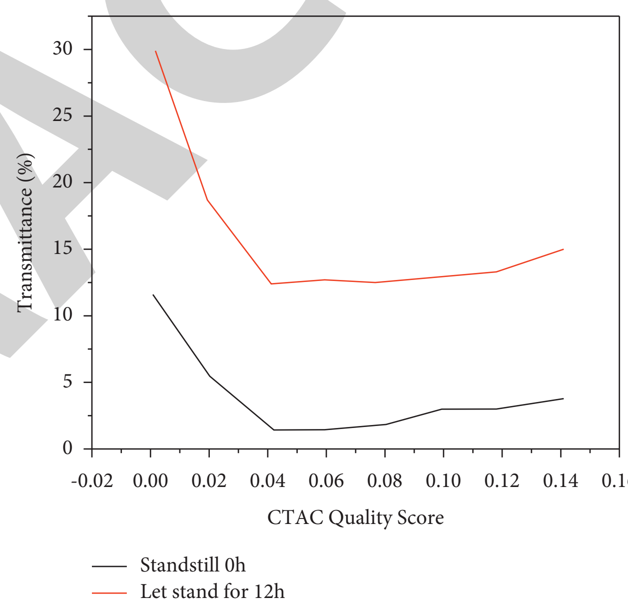

FIGURE 5: Stability of nanofluids in addition of CTAC.

effectively improve the stability of nanofluids, and the effect on the stability of nanofluids varies with the oscillation time, it is not that the longer the oscillation time, the better [20].

In order to determine the oscillation time of the ultrasonic wave, the transmittance experiment was carried out on the nanofluid after oscillating for different times; by comparing the change of transmittance, the quantitative analysis could be more intuitive, and the transmittance experiment was performed again after 72 hours; the results are shown in Figure 3; with the increase of the oscillation time, the transmittance of the nanofluid shows a trend of first decreasing and then increasing; it is in a trough at 1 h, and the transmittance is the smallest, which means that the stability of the nanofluid is the best; the author chose the oscillation time of ultrasonic oscillation as 1 h. In addition, the transmittance of the just-prepared nanofluid is generally lower than that of the nanofluid after 72 hours, indicating that the stability of the just-prepared nanofluid is better; with the increase of time, the stability will be weakened, the conclusion is in line with people's general cognition [21].

3.2.2. Effects of Dispersants on the Stability of Nanofluids. In order to select a dispersant with better stability to nanofluids and appropriate dosage, a 0.15% MWCNT-water/ethylene glycol mixed-based nanofluid was prepared, and sodium dodecyl benzene sulfonate (SDBS) and hexadecane were added, respectively; cetyltrimethyl ammonium chloride (CTAC) was used as a surface dispersant, and the addition amount was increased from 0 to 0.14% by a mass fraction with an interval of 0.02%. The experimental results are shown in Figures 4 and 5.

4. Analysis of Results

Different volume fractions of nanofluids have different effects on convective heat transfer. The convective heat transfer effect of nanofluids with different volume fractions at different flow rates was tested under constant temperature. The Nusselt number increases with the nanoparticle volume fraction and flow rate, which means that increasing the nanoparticle concentration can effectively increase the heat transfer rate [22, 23].

The improvement of the thermal conductivity of nanofluids contributes to the improvement of the heat transfer rate of nanofluids. Table 1 shows the increased rate of thermal conductivity and convective heat transfer coefficient of nanofluids (relative to the base fluid at 45°C, 2 L/min) when the volume fraction is 0.5, the thermal conductivity increase rate is 1.51, and the convective heat transfer coefficient increases rate 20.33. It can be seen that the increase rate of the convective heat transfer coefficient is greater than that of the thermal conductivity, which indicates that the improvement of the heat transfer ability of the

Table 1: Comparison of increases in thermal conductivity and convective heat transfer coefficients of nanofluids.

Volume fraction/%	Thermal conductivity increase rate/%	Convective heat transfer coefficient increase rate/%
0.05	0.15	5.64
0.10	0.30	8.53
0.15	0.45	10.13
0.30	0.90	17.14
0.50	1.51	20.33

nanofluid not only depends on the optimization of the thermal conductivity but also the small size effect of the nanoparticles has a significant effect, effects, such as smaller nanoparticles leading to more collisions inside the nanofluid, microconvection, etc., all help to enhance heat transfer [24, 25].

5. Conclusion

The characteristics and applications of nanofluids, according to the experimental system, determine the preparation and experimental parameters of nanofluids; finally, by studying the influence of ultrasonic oscillation time and dispersant on the stability of nanofluids, it is concluded that the improvement of the thermal conductivity of nanofluids contributes to the improvement of the heat transfer rate of nanofluids. Finally, it is proved that the technical research of nanofluid can meet the heat dissipation demand of permanent magnet synchronous motor. Thus, it is ensured that the permanent magnet synchronous motor always works at a suitable temperature, which is of great significance to the life, efficiency, and operational safety of the permanent magnet synchronous motor.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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