

# Analysis of the Vibration Type and Characteristics of the Electric Motor

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**Abstract:** Motor is a commonly used equipment in modern industrial production, vibration is an important basis to reflect the operation of the motor. The analysis of the vibration types and characteristics of the motor is of great significance to the performance, reliability and life of the motor. Through the analysis, it can effectively grasp the operation and performance status of the motor, and provide a basis for the maintenance work. Based on this, this paper analyzes the vibration types and characteristics of motors and proposes some effective prevention and treatment measures.

**Keywords:** Motor; Vibration Type; Characteristics

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## Introduction

As a kind of power equipment widely used in industrial production and life, the operation stability and reliability of electric motor are directly related to the normal progress of production and life. However, in the operation process of the motor, due to various reasons, there will be different types of vibration, which brings great hidden dangers to the normal operation and use of the motor. Therefore, the study of the vibration types and characteristics of the motor is of great theoretical and practical significance for improving the operation stability and reliability of the motor.

## 1. Analysis of the vibration type of the electric motor

Motor have various types of vibration, which can be classified according to the causes of vibration, the transmission mode of vibration and the frequency range of vibration. The vibration types and characteristics of the motor are introduced in detail below.

### 1.1 Mechanical vibration

Mechanical vibration refers to the vibration caused by the failure, loosening, wear and tear of the internal parts (rotor, bearing, gear, etc.) of the motor<sup>[1]</sup>. This vibration is characterized by low frequency, usually below 10Hz, with large vibration amplitude, which will cause the whole motor to swing or produce resonance, and the vibration energy is concentrated in the low frequency band. Common causes of mechanical vibration include bearing failure, transmission part failure, rotor imbalance and so on.

### 1.2 Electromagnetic vibration

Electromagnetic vibration refers to the vibration generated by the motor during its operation due to the action of the electromagnetic force. This vibration is characterized by high frequency, usually above 100Hz, small vibration amplitude, but for a long time will lead to motor wear, noise, and even motor damage, the vibration energy is concentrated in the high frequency band. The main cause of electromagnetic vibration is the uneven or instability of motor magnetic field, such as stator winding fault, rotor bad contact.

### 1.3 Fluid dynamic vibration

Fluid dynamic vibration refers to the vibration generated due to the instability of the fluid medium flow inside the motor. This vibration is characterized by high frequency, large vibration amplitude, and vibration energy concentrated in the medium and high frequency bands. The common reasons of hydrodynamic vibration are the imbalance of fluid medium flow

inside the rotor, and the fluid pulsation inside the pipeline.

## **1.4 Magnetic field vibration**

Magnetic field vibration refers to the vibration generated due to the change of the magnetic field inside the motor. This vibration is characterized by high frequency, small vibration amplitude, and vibration energy concentrated in the high frequency band. The main cause of magnetic field vibration is the magnetic field instability, such as magnetic pole offset and unequal magnetic flux.

## **1.5 Resonant vibration**

Resonant vibration refers to the vibration caused by the resonance of the internal structure of the motor and the external environment. This vibration is characterized by a wide frequency range, large vibration amplitude, and uneven vibration energy distribution<sup>[2]</sup>. The common causes of resonance vibration include the insufficient stiffness of the motor support structure, and the matching between the frequency of the external shock source and the vibration frequency of the motor itself.

The characteristics of the above five vibration types are different, but there are some connections between them. For example, mechanical vibration and electromagnetic vibration may occur in resonance under certain conditions, and fluid dynamic vibration may also cause mechanical vibration and electromagnetic vibration. Therefore, in the vibration analysis and fault diagnosis of motor, various vibration types should be considered.

## **2. Analysis of the vibration characteristics of the electric motors**

Motor vibration characteristic analysis is to determine the cause and nature of the motor vibration through the acquisition, processing and analysis of the motor vibration signal.

### **2.1 Collection of vibration signals**

The vibration signal of the motor requires the use of vibration sensor, converting the vibration signal into electrical signal, and then analyzing it through analog circuit or digital circuit.

### **2.2 Analyze the vibration frequency spectrum**

Analyzing the vibration frequency spectrum is a common method to analyze the motor vibration, which can analyze the influence of the vibration signal of different frequency on the motor. For mechanical vibration, its frequency is mainly concentrated below 10Hz, while for electromagnetic vibration, its frequency is mainly concentrated above 100Hz.

### **2.3 Analyze the vibration waveform**

The vibration waveform can show the time change of the vibration signal of the motor, and can analyze the vibration trend and vibration amplitude of the vibration signal. By analyzing the vibration waveform, we can judge whether the motor has unbalanced, loose and other problems, and then take corresponding measures.

### **2.4 Analysis of the characteristic value**

Through the Fourier transform or wavelet transform of the vibration signal, the characteristic values such as maximum amplitude, maximum frequency and effective value can be obtained. These characteristic values can be used as an important basis for the analysis of motor vibration characteristics, helping to judge the cause and nature of motor vibration, so as to take targeted measures for repair and maintenance.

### **2.5 Analysis of the vibration direction**

Motor vibration will not only produce vibration signal, but also produce vibration direction. By analyzing the vibration direction, the cause and nature of the motor vibration can be determined. For example, if the motor vibration direction is radial, it may be caused by bearing damage or bearing loosening; if the motor vibration direction is axial, it may be caused by the rupture of bearing oil film or loosening of mechanical parts.

## **3. Detection and diagnosis of electric motor vibration**

The detection and diagnosis of motor vibration is a very important part in the motor repair and maintenance work. For the detection and diagnosis of motor vibration, there are mainly the following several methods<sup>[3]</sup>.

### **3.1 Manual detection method**

Manual detection method refers to the vibration detection and diagnosis through manual methods such as observation, hearing and hand feel. This method is simple and easy to do, but the accuracy and accuracy are limited, and can only be used for the preliminary judgment of the motor vibration.

### **3.2 Vibration detector method**

Vibration detector method refers to the measurement, analysis and diagnosis of the motor vibration through the vibration detection instrument. This method can measure the amplitude, frequency, phase and other parameters of the motor vibration, and can more accurately judge the type of the motor vibration and its severity.

### **3.3 Spectrum analysis method**

Spectrum analysis refers to the analysis of the motor vibration signal through the frequency spectrum analysis instrument to obtain the amplitude and phase information of different frequency components, so as to judge the type of the motor vibration and its causes. This method can accurately analyze the characteristics and rules of motor vibration, and is one of the most commonly used methods in motor vibration analysis and fault diagnosis.

### **3.4 Vibration mapping method**

Vibration spectrum method refers to the analysis and diagnosis of motor vibration by drawing the frequency spectrum map and phase spectrum map of motor vibration. This method can intuitively reflect the characteristics and laws of motor vibration, and is helpful to quickly and accurately judge the type and severity of motor vibration, but it requires a high technical level and analytical ability.

The above four methods can be used alone or in combination to detect and diagnose the motor vibration. Usually, manual detection method and vibration detector method are used to judge the motor vibration, and if necessary, use spectrum analysis method or vibration spectrum method for in-depth analysis and diagnosis.

## **4. Prevention and treatment measures of motor vibration**

The prevention and treatment of motor vibration is an important measure to ensure the normal operation of motor and improve the service life of motor. In work practice, it is necessary to take corresponding prevention measures according to the type and cause of motor vibration.

### **4.1 Preventive measures**

(1) Strengthen maintenance: regular repair and maintenance of the motor, maintain the motor in good condition, reduce the occurrence of mechanical vibration and electromagnetic vibration.

(2) Dynamic balance treatment: the rotor of the motor for dynamic balance treatment, to reduce the occurrence of mechanical vibration. The motor winding structure with low noise and low vibration is adopted.

(3) Choose high-quality bearings: choose high-quality bearings to improve the bearing capacity and life of the bearings. Improve the ventilation structure of the motor and reduce the aerodynamic noise between the motor core and the coil.

(4) Adopt shock absorption measures: install shock absorbers or shock absorption pads and other devices to reduce the impact of motor vibration on the surrounding environment. Reduce the electromagnetic noise of the motor and reduce the influence of the electromagnetic field on the mechanical structure.

### **4.2 Treatment measures**

(1) Adjust the motor rotor balance: for mechanical vibration, the vibration can be eliminated by adjusting the motor rotor balance.

(2) Replace the damaged bearings: for the vibration caused by the damaged or loose bearings, the damaged bearings should be replaced in time to restore the normal operation of the motor.

(3) Adjust the motor transmission parts: for the vibration caused by mechanical vibration or loosening, the vibration can be eliminated by adjusting the gap of the motor transmission parts.

(4) Adjust the motor current: for the electromagnetic vibration, the vibration can be eliminated by adjusting the current

of the motor.

## **Conclusion**

To sum up, motor vibration type and characteristics analysis is a very important part of motor maintenance and fault handling. Only through scientific analysis methods and effective measures, can ensure the normal operation of the motor and improve the reliability and service life of the motor. The analysis of the vibration types and characteristics of the motor is of great significance for the performance, reliability, life and other aspects of the motor. By analyzing the vibration signal of the motor, the cause and nature of the motor vibration can be judged, so as to take corresponding measures for repair and maintenance to ensure the normal operation of the motor.

## **References**

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