Frequency Capture Characteristics of Gearbox Bidirectional Rotary Vibration System

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According to the characteristics of the gearbox and Lagrange mechanics, in this paper a bidirectional rotary vibration system dynamics model of the gearbox is established, using MATLAB to simulate the model, study the vibration characteristics of the system in both horizontal and vertical directions, and compare it to existing simplified models. Through the analysis of the model, the conditions of the system that produce frequency trapping are studied, and the frequency factors of the system are obtained. The results indicate that reducing eccentric mass, eccentricity, and rotary damping, and increasing damping movement, bearing stiffness, and input torque can improve system response speed and reduce the amplitude, which can avoid frequency trapping of the system. The study provides a theoretical basis for optimization and installation of the gearbox system.

1. INTRODUCTION

Due to the rapid development of modern industry, gears have become one of the key parts in the modern industry. The gear box has a fixed gear ratio, transmission torque, compact structure, etc., which is now widely used in various machines. But the gearbox forces are complex. Elastic and inertial forces needed to withstand the complex alternating load. The frequency of trapping will happen, allowing the system deformation or vibration, which affects the normal operation of the machine, or even damages it.

Frequency capture is a special nonlinear vibration phenomenon. During this phenomenon, when the external excitation frequency is close to the natural frequency of the system, the external excitation frequency will synchronize with the system's natural frequency, the frequency trapping.[5] It has been established that a class of non- ideal vertical vibration system vibration models, are being used to study the movement and rotary damping effect on the frequency capture, but it did not analyse other parameters on the frequency trapping effects.[1] A reverse rotation dual-drive vibration system model has been created to study the vibration frequency of the system model that achieves trapping conditions.[2] A vertical direction vibration model has been simplified to a general autonomy system, and the frequency of trapping phenomenon has been included, but it is not specific to the analysis of the physical parameters.[3] Research[4] on frequency capture simulation established the elastic support rotor system of the digital prototype model to study the torque and spring stiffness on the frequency of trapping effects. Researchers have studied the wind turbine blade fatigue loading frequency trapping.[5] Other research[6] studied the engineering nonlinear vibration problem, emphasizing the need to effectively take advantage of favourable nonlinear vibration and control of harmful nonlinear vibration.

This selection of a particular model of a gear transmission gearbox as the research object, which is based on the existing research,[7–14] regards the gearbox system as a nonlinear vibration system, takes into account the horizontal and vertical vibration of the gearbox, studies the frequency trapping conditions in the course of gearbox work, analyses the system parameters on frequency capture by a numerical simulation method, and achieves a frequency trapping gearbox digitization and visualization, which provides a theoretical basis for the dynamic optimization of the gearbox system.

2. MATHEMATICAL MODEL OF GEARBOX BIDIRECTIONAL ROTARY VIBRATION SYSTEM

A gearbox is mainly composed of the input shaft, output shaft, driving wheel, driven wheel, the motor (power source), the lid, and the support member. The gearbox is operated by driving the motor under the effect of the input operation, which leads to the driven wheel running. In the gearbox bidirectional rotary vibration system model shown in Fig. 1, m1 and m2, respectively, represent the driving wheel and the driven wheel produced by the eccentricity. When the motor rotates, the eccentric block generates two driven body vibration exciting forces. The vibration body from the horizontal, vertical, and torsional vibration in the direction, taking into account the torsional vibration little effect on the system,[2] thus ignoring the reverse direction vibrations.

In the simplified model, the body motion coordinates x, y, and two eccentric rotations of the rotor phase indicate the