METHODS FOR REDUCING VIBRATIONS IN MECHANICAL MOTION TRANSMISSION SYSTEMS

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Abstract: *This research focuses on reducing vibration in mechanical power transmission systems through the development of an improved design of a worm gear reducer. The main objective is to enhance the durability, operational stability, and efficiency of the transmission system by applying structural modifications. An experimental study was conducted to evaluate the influence of an elastic coating applied to the contact surfaces of the reducer components. The results demonstrated that the proposed design significantly reduced vibration levels, improved energy efficiency, and extended the service life of the system.*

Keywords: *vibration reduction, mechanical transmission, worm gear reducer, damping material, elastic coating, improved design, vibration analysis.*

Introduction

Vibration is one of the main problems in mechanical power transmission systems, leading to noise, wear, and even failure of components. In worm gear reducers, which are widely used in industry, vibrations negatively affect operational accuracy, efficiency, and reliability. The main causes of vibration include gear meshing errors, imbalance, misalignment, and dynamic loads. To address this issue, a new design of a worm gear reducer was developed and experimentally tested. The proposed approach involves applying an elastic coating to selected contact surfaces of the gear housing and bearing supports.[1]This coating acts as a damping element, absorbing vibration energy and preventing its transmission through the system. Previous studies have suggested various methods to reduce vibration — such as optimizing gear geometry, improving lubrication, and using vibration-absorbing materials. However, these approaches often require complex redesigns or high manufacturing costs. In contrast, the use of elastic coatings offers a simple and cost-effective solution. This research aims to experimentally evaluate the effectiveness of this method for reducing vibration in worm gear transmissions.

Methodology

The experimental study was conducted on a standard industrial worm gear reducer with a transmission ratio of 1:40. The main components of the reducer—the worm shaft, worm wheel, bearings, and housing—remained unchanged. Only an elastic coating with a thickness of 2–3 mm was applied to the inner surfaces of the housing and bearing seats. A polymer-based damping material was used, which effectively absorbs vibration energy without affecting the mechanical alignment of the gears. Vibration levels were measured using the VIP Expert device. Measurements were recorded under identical operating conditions before and after the modification. The main parameters evaluated included vibration amplitude, frequency, and noise level. The collected data were analyzed statistically to assess the effectiveness of the proposed design.

Results and Discussion

The experimental results showed a noticeable reduction in vibration amplitude after applying the elastic coating. The average vibration level decreased, and the operational noise was also reduced. The worm gear reducer with the new coating demonstrated more stable performance during prolonged operation. Smoother motion transmission reduced stress on the contact surfaces, which in turn lowered friction and heat generation, contributing to an increase in the reducer's operational lifespan. Additionally, the elastic coating effectively minimized resonance phenomena that can occur at certain rotational speeds. This improvement is particularly important for industrial applications where the reducer operates under variable load and speed conditions.[2] Overall, the results confirm that applying an elastic damping layer is a practical, cost-effective, and easily implementable method for improving the performance and stability of mechanical power transmission systems.

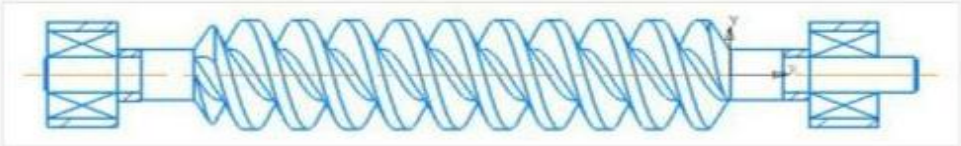


FIGURE 2. Curvilinear shaft with elastic elements [1]

Conclusion

The study demonstrated an effective method for reducing vibration in mechanical power transmission systems through an improved worm gear reducer design. The proposed approach involves applying an elastic coating to the internal surfaces of the reducer, which acts as a damping element to absorb vibration and stabilize operation. Experimental results confirmed the practical benefits of this modification: vibration was reduced, noise decreased, and the operational stability and lifespan of the reducer improved.[3] A key advantage of this design is its simplicity.

The modification requires minimal changes and can be easily implemented in existing systems without additional manufacturing costs. This method can be recommended for various types of gear transmissions to enhance efficiency, stability, and service life. Future research will focus on optimizing the coating's properties and developing models to more accurately predict its damping behavior under different operating conditions.

References

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