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MESHING SIMULATION AND STRENGTH CALCULATION OF A CARBURIZED GEAR PAIR

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Abstract
The material in the carburized layer of a carburized gear is nonlinear. However, no systematic theory and method is available to analyse the strength of nonlinear materials; thus, calculating the exact strength of carburized gears is difficult. The traditional method of calculating the strength of carburized gears considered the material as uniform, which is susceptible to make errors. To address this problem, a hierarchical simulation method was proposed to calculate the strength of carburized gears. The strength calculation principle of carburized gears was first analysed. Then, a solid modelling method of carburized gears was presented based on the extraction technology of the layered homogeneous material. Finally, the meshing process of carburized gears was simulated, and the distribution and variation laws of the root, contact, and shear stresses during the meshing process were determined accurately. Results show that the shear stress of carburized gears initially increases and then decreases along with depth direction, and the maximum value appears in the surface below. However, the shear stress of non-carburized gears decreases linearly. The equivalent stress of the two kinds of gears decreases linearly with depth direction, whereas the decreasing amplitude of the carburized gears is larger than that of the non-carburized gears. A significant error in the calculation of the strength of carburized gears can be clearly observed using the traditional method. By selecting the appropriate parameters, the method proposed in this study can be used to simulate the meshing process of the carburized gear pair and calculate its strength accurately.
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Key Words: Carburized Cylindrical Gears, Strength Analysis, Modelling, Transient Simulation Analysis

1. INTRODUCTION

Gear transmission is an important mechanical transmission mechanism and is widely used in various industrial fields [1]. Carburization is important in ensuring wear resistance and bending resistance during high speed and overloading [2, 3]. The carbon concentration at each point in the gear surface and below becomes different after carburization. Thus, a carburized gear is considered a heterogeneous material, and the elastic modulus decreases gradually from the carburized surface. When a carburized gear is loaded, the equivalent and shear stresses at different carburized depths become nonlinear. Therefore, the strength of carburized gears should be calculated according to the heterogeneous materials. However, no mature method has accurately calculated the strength of carburized gears to date. The majority of the existing gear design methods consider carburized gears as homogeneous materials without considering the nonlinearity of the material, which leads to a large error in strength calculation. Testing the strength of the parts after design completion is necessary to ensure the reliability of the design [4]; however, this process is costly and time-consuming. Finite element method (FEM) can be used to calculate the strength of heterogeneous materials; however, the accuracy of its calculation depends on the correctness of finite element modelling. In recent years, several scholars have studied the method of calculating the strength of carburized gears using FEM. However, establishing a finite element model of carburized gears is yet to be accomplished