MACHINE DESIGN, VOL.6(2014) NO.4, ISSN 1821-1259 PP. 127-130

Preliminary note

COMPARATIVE ANALYSIS OF ANALYTICAL CALCULATION AND OPTIMIZATION ON GEARBOX DIMENSIONS AND VOLUME

Nenad MARJANOVIC[1,*] - Nenad KOSTIC[1] - Nenad PETROVIC[1] - Mirko BLAGOJEVIC[1] - Milos MATEJIC[1] - Biserka ISAILOVIC[2]
[1] Faculty of Engineering, University of Kragujevac, Kragujevac, Serbia
[2] Vertex star d.o.o., Kragujevac, Serbia

Received (27.10.2014); ***Revised*** (21.11.2014); ***Accepted*** (25.11.2014)

Abstract: *For the purposes of this research analytical and numerical calculations of gearboxes have been done. In the process of numerical calculation optimization was implemented. Optimization was done according to four different criteria: length, width, height and volume, whose values are compared to the analytical calculations according to the aforementioned criteria individually. This approach shows better gearbox performance which vary from 3% to 47% depending on the analytical calculation. The analytical calculations were conducted using suggestions from ISO standards, Petrisevic, GOST standards, and Kudrijavcev. For optimization, the Complex Box method has been used and an original software has been developed for these purposes. All real constraints have been taken into account in order to have the optimal results be usable in real applications.*

Key words: *gearbox, calculation, optimization, comparative analysis*

1. INTRODUCTION

Gearboxes have a widespread practical application, and represent a current research interest. Modern research is oriented on achieving optimal characteristics of these gearboxes and increase their efficiency. In order for these benefits to be achievable, it is necessary to include optimization in the gearbox design process.

For a successful optimization it is necessary to completely understand the operations and behavior of gearboxes. The interaction between optimization and the construction is achieved through a complex formulated mathematical model [1-2]. Detailed knowledge of the problem, such as analysis of clearances and deformations [3] of gearboxes enables the creation of a mathematical model for optimization. In order to optimize, it is necessary to use an optimization method. Some authors [4] using genetic algorithm methods have optimized the mass of a two stage coaxial gearbox, while other authors [5] have automated the design process of two stage reducers. Volume is one of the more important criteria for optimization of multistage gearboxes. Many authors [6] have worked on minimizing volume from the aspect of toothing parameters or with simultaneous maximization of stiffness of gear pairs [7-8]. For optimizing geared transmissions in use are also other optimization algorithms, a minimization is done according to various criteria [9-10-11]. Certain authors worked on generating general mathematical models for usual gear rations [12] or constraint functions in the mathematical model [13]. This approach enables flexibility in the optimization process.

The field of optimization of gearboxes opens a vast research space. This research is oriented on achieving optimal gearbox characteristics in terms of length, width, height and volume of the gearbox and comparing them to analytical calculation results. Optimization represents an alternative to designing gearboxes of desired characteristics. For this specific case optimization of a two stage gearbox has been done using the Complex Box method, and achieved values have been compared to analytical calculation results.

2. CALCULATION METHODS

Designing gearboxes represents a complex task due to the large number of influencing parameters on their work. Design solutions can be achieved analytically and numerically. For the purposes of this research analytical calculations according to suggestions based on ISO standards [14], suggestions according to A.I. Petrusevic, according to GOST standard [15], and according to suggestions by Kudrijavcev [16] have been done. A numerical calculation which included an optimization process was also completed.

The idea is to achieve beneficial characteristics of the gearbox, achieving an optimal length, width, height, and volume of the gearbox in question. Analytical and optimal solutions have been compared in order to show the measure of improvement in the design process. Input/output parameters for all calculations, numerical and analytical, are identical. For this set of input values all four analytical calculation methods give different design parameters due to the variance in determining the partial gear ratio, resulting in each calculation giving a different set of gears for the same input/output parameters. Optimization looks for the same input/output characteristics as analytical calculations with simultaneous minimization according to dimension parameters. The optimization used a Complex Box method for the purposes of this research has been

* Correspondence Author's Address: Faculty of Engineering, University of Kragujevac, Sestre Janjic 6, 34000 Kragujevac, Serbia, nesam@kg.ac.rs