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Worm Gears:
General Information, Calculations, Dynamics and Reliability

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Abstract

The monograph is intended especially for research workers, developers and designers of technical systems, students of technical universities oriented to drives with toothed gears. It presents theoretical and practical knowledge related to analysis of dynamic load of the individual drive elements containing worm gears. The monograph describes general principles of worm gear systems and methods of creation of dynamic model of worm reducer or of an entire drive. It indicates possibilities of reduction of dynamic load of a gear in the mode of frequent start-ups and halts of the drive.

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1 INTRODUCTION

In development of structural discipline the modern branches are directed towards systematization of process taking into consideration all influential factors and understanding the structural process as a complex [1]. Increasing economic pressure cause higher demands regarding optimality of proposed solutions. The facts shift the focus of development of branch of machine parts towards grasping the structural processes in intimate connection of their relation to system surroundings, broadening of theory of technical systems and development of selection of suitable SW for complex computer support.

Steadily growing demands related to machine parameters are reflected in increase of dynamics of loading which are caused especially by rise of absolute or of relative speed values of the individual parts in nodes of kinematic chains. Therefore in case of machines the action of internal and external forces must be taken into account as well as dynamics of the processes occurring in them.

Modern scientific researches in the field of design proposal and structure of machines move in direction of development of methods of phenomena analysis. The development is connected with development of the branches as follows: general mechanics, mathematics, theory of optimization, mechanics of continuum, tribology, theory of stochastic processes, and theory of reliability, experimental methods and methods of research of particular machines under actual operating conditions. The conditions can be either actual or created artificially or are mathematically modelled, i.e. realized by means of so-called simulation research with the application of modern computer technology.

Dynamics of machines perceived in a modern manner represents dynamics of systems requiring dual approach: on the one hand i tis a detailed research of individual parts of the system and on the other hand it is a complex analytical research of the entire system.

Modal analysis is a modern branch of dynamics [2] which for description of oscillatory processes and of oscillating behaviour of engineering structures and of their parts uses possibility of disintegration of a complex oscillating process into partial, i.e. modal constituent. Each

constituent is consequently characterized by modal frequency and by modal shape of oscillation.

Worm reducers represent basic nodes of machine drives and have a broad scope of utilization in diverse fields of industrial practice. Therefore great attention is constantly being paid to increase their serviceability. The most frequently the issue is solved by means of traditional methods, i.e. through increase of quality and through heat treatment of worm materials or of a worm wheel with the use of modern lubricants. However, in case of more complicated modes connected with high frequency of start-ups, halts and reversal the effective results are not achieved.

Worm reducers are used in case of drives of a number of modern machinery of diverse technological direction, especially in mechanical engineering, construction industry, road transportation, agriculture, metallurgical engineering, chemical and food industry, consumer industry, etc. Their technical level and load capacity in a high degree determine technical, economical and operational characteristics of machines the part of which they become after assembling. Thus the need to assure increase of service life of worm reducers represent significant and up-to-date task.

The monograph should contribute to clarification of influence of dynamic load upon service life of worm reducers.