NOISE ANALYSIS AND OPTIMIZATION OF GEARBOXES

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Gearboxes and similar machines containing rotating parts are complex systems with complicated structure and couplings. Generally they can be decomposed into more simple subsystems. These subsystems are usually rotating shafts with gears joined by gear couplings and housing coupled with rotating shafts by bearings. The paper is aimed at the mathematical modelling of gearboxes with spur helical gears considered including their interior rotating shaft system and housing. The used bearing model respects real number of rolling elements and roller contact forces acting between the journals and the outer housing. The model of a complete gearbox is created using the modal synthesis method. The kinematic transmission errors in gear couplings are viewed as sources of excitation. Vibration and noise analysis of the gearbox housing is performed by means of the created model. Four types of objective functions suitable for optimization from the radiated noise point of view are proposed. The presented methodology is applied to the simple test-gearbox.

Key words: *vibrations, noise, optimization, gearbox, modal synthesis method*

1. Introduction

Various sounds and noises can be easily perceived by humans in their environment. Noise is usually feeled as an undesirable and troublesome phenomenon and therefore it is important to reduce existing or possible sources of noise. One class of the noise sources is characterized by vibrating structures surrounded by fluid (mostly by air) that radiate acoustic power to the environment and produce noise. Typical representants of this class are machines containing moving parts performing reciprocating or rotating motion. Their noise can arise from certain impacts and frictions of the moving parts or it can be the result of dynamic forces in couplings between the rotating or moving and non-rotating (stator) parts. This is so called structure borne noise. Second class of the noise sources, that aren't mentioned in this paper, are aerodynamic sources [3] caused by air movement or fluid flow.

Gearboxes and similar machines containing rotating parts coupled with some stator are significant noise sources if the coupling forces generate the vibrations of the flexible housing. There must exist certain tools and analysis methodology before their noise could be understood and reduced. This contribution is aimed at the vibration modelling and acoustic analysis methodology of the large rotating systems with consideration of the flexible housing. The kinematic transmission errors in the gear couplings are viewed as the main sources of vibrations that are transmitted to the housing. Contrary on the other papers, e.g. [10], this contribution is goaled rather on the vibration and acoustic analysis of the housing than on the shafts vibration and analysis of the coupling forces and deformations in gearings. The new original approach to the modelling of bearing couplings [8] is used for the connection

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