Abstract

„Impact of hybrid gear tooth profiles in gear pumps on acoustic and hydraulic properties"

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Hydrostatic drive systems are fundamental to modern engineering, finding applications in heavy industry, construction, agriculture, and municipal management. Due to their high reliability, operational flexibility, and the ability to precisely control performance under varying load conditions, hydrostatic drives are increasingly used for tasks requiring high energy efficiency and minimal environmental impact, including low noise emissions to the surroundings.

This study focuses on the analysis and development of an innovative solution for evaluating the flow pulsation of gear pumps based on a hybrid tooth profile. The research aimed to reduce noise levels, limit dynamic loads, and extend the lifespan of hydraulic system components by mitigating flow pulsations. The developed hybrid gear profile allows for a reduction in pulsation amplitude and ensures a more uniform flow of the working medium, thereby eliminating the need for passive damping systems and reducing noise emissions.

The research encompassed a detailed analysis of the influence of gear design parameters, such as the face width and shape of the gear, on the flow characteristics of hydrostatic gear pumps. Advanced numerical simulations were used, and mathematical models and algorithms were developed to describe flow pulsation based on the geometric parameters of the gears. Using the obtained results, a prototype low-pulsation pump was constructed and tested under laboratory conditions. The experiments analyzed flow pulsations, noise levels, and static hydraulic characteristics under various operational parameters.

The results confirmed that the developed authorial models and algorithms enable the prediction of flow pulsations during the pump design stage with a hybrid gear profile, which paves the way for the future popularization of these solutions. The low pulsation amplitude compared to commercial solutions allowed for a reduction in noise emissions by several decibels, depending on the rotational speed and load conditions of

the pump. These findings have significant practical implications, facilitating the production of a wide range of low-pulsation gear pumps without the need for custom tools and fixtures while maintaining stable hydraulic parameters and low noise levels. The developed low-pulsation pump design also holds substantial commercial potential, contributing significantly to the advancement of hydrostatic drives in line with global trends in enhancing energy efficiency and minimizing environmental impact.

In summary, this study provides a comprehensive exploration of issues related to the design of instantaneous performance in gear pumps with a hybrid tooth profile. The results contribute to the advancement of theoretical and practical knowledge in the field of hydraulic drives, opening new possibilities for applications in sectors demanding quiet and efficient pump systems that comply with modern technological market requirements.