

**EXPERIMENTAL INVESTIGATION OF TRIBOLOGICAL
CHARACTERISTICS OF WATER-LUBRICATED
BEARINGS MATERIALS ON A PIN-ON-DISK TEST RIG**

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ABSTRACT

Friction is the most fundamental phenomenon accompanying the sliding motion of solid bodies. Friction, vibration, and wear under conditions of contaminated water lubrication are extremely important in many engineering applications such as water-lubricated bearings, water pumps, and braking systems.

The aim of this project is to investigate the factors that could lead to an improvement in the performance of water-lubricated bearings materials.

Previous studies have revealed the main factors contributing to power loss are friction-induced vibrations, and wear in water-lubricated bearings. Those factors are the result of contamination of the lubricant (sea water); bearing alignment (parallelism of the shaft and shell); material characteristics; and condition of the contact (sliding) surfaces. The contact mechanics of the water-lubricated bearings as well as the performance characteristics of the bearings components on which friction is exerted also have a substantial influence on the tribological characteristics of water-lubricated bearings materials.

Thus, the focus of the present study is on the effect of water contamination on the friction coefficient, vibration, wear and the vibration–wear relationship under varying operational conditions.

An experimental program was conducted to develop new methods and investigate the effect of water contamination on the tribological characteristics of pairs of materials under different operational conditions for water-lubricated bearings.

A Pin-on-Disk test rig was designed and built to adopt the operational environment of a real water-lubricated bearing. This test rig was used to obtain experimental data regarding the effect of water contamination on the long-term behaviour of the bearing systems, and to investigate the friction, vibration, wear, and vibration-wear characteristics of the materials. The effect of various parameters, such as the friction conditions, damping, and operational environment on the behaviour of the bearing materials was also investigated.

The experiments demonstrated that all three factors, namely contamination, material properties and surface conditions, have a significant influence on the tribological characteristics of water-lubricated bearings. It was also demonstrated that when the operation of the water-lubricated bearing takes place in boundary and mixed regimes, the adhesive and abrasive mechanisms of friction are significant and contribute to the generation of excessive wear and vibration. This is contrary to what is claimed by many manufacturers. It was observed that the wear mechanism in the water-lubricated bearing materials was associated with low-frequency vibrations and severe contamination of the lubricant. Also, as expected, the vibration–wear relationship of the water-lubricated bearing materials was significantly affected by the contamination of the lubricant and can be changed by magnetic field damping.

The present study identified the primary mechanism responsible for the high friction coefficient, vibration, and wear to be a three-body mechanism caused by the abrasive nature of the water contaminant. It was found that there was a significant increase in the friction coefficient, vibration, and specific wear rate at the slowest sliding speed of 0.393 m/s. This is due to the boundary regime of lubrication, the adhesive-abrasive wear mechanism, and specific material properties of NF22 (Railko) material. It was also explored and reported that for a specific applied load of 8 N, at low and high sliding speeds, and water contamination levels, damping has a strong effect on the vibration–wear relationship which is also dependent on sliding speed and, as a result, on the lubrication regime.

The significance of this experimental study is to improve the selection of water-lubricated bearings materials and as a result, improve their performances. The outcomes of this research project are:

- Analysis of the existing types of materials, and experimental models and techniques for modelling and simulating the operational conditions of water-lubricated bearings
- Identification of the existing problems associated with the contemporary technology of water-lubricated bearings materials
- Development of an experimental methodology and technique for the application of a Pin-on-Disk test rig and determination of the main contributing factors

- Identification and analysis of various lubrication and operational conditions for water-lubricated bearing materials and systems and development of further recommendations for future work.

DECLARATION

I, Yuriy Solomonov, certify that this work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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Yuriy Solomonov

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